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APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/341,618	01/25/2022	11230656	MEWE-072	1000

93726 7590 01/05/2022

EPA - BOZICEVIC FIELD & FRANCIS LLP
BOZICEVIC, FIELD & FRANCIS
201 REDWOOD SHORES PARKWAY
SUITE 200
REDWOOD CITY, CA 94065

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment is 151 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

INVENTOR(s) (Please see PAIR WEB site http://pair.uspto.gov for additional inventors):

Javier Eduardo Moya Raposo, Cambridge, Cambridgeshire, UNITED KINGDOM;
Alexander Avramenko, Cambridge, Cambridgeshire, UNITED KINGDOM;
Lluís Manosa Carrera, Barcelona, SPAIN;
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APPLICANT(s) (Please see PAIR WEB site http://pair.uspto.gov for additional applicants):

Cambridge Enterprise Limited, Cambridge, Cambridgeshire, UNITED KINGDOM
Universitat Politècnica de Catalunya, Barcelona, SPAIN
Universitat de Barcelona, Barcelona, SPAIN

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/341,618	04/12/2019	Javier Eduardo Moya Raposo	MEWE-072	1000

93726 7590 12/27/2021

EPA - BOZICEVIC FIELD & FRANCIS LLP
BOZICEVIC, FIELD & FRANCIS
201 REDWOOD SHORES PARKWAY
SUITE 200
REDWOOD CITY, CA 94065

EXAMINER
DUKE, EMMANUEL E

ART UNIT	PAPER NUMBER
3763	

NOTIFICATION DATE	DELIVERY MODE
12/27/2021	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

docket@bozpat.com

Response to Rule 312 Communication	Application No.	Applicant(s)	
	16/341,618	Moya Raposo et al.	
	Examiner	Art Unit	AIA (FITF) Status
	EMMANUEL E DUKE	3763	Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

1. ☑ The amendment filed on 10 November 2021 under 37 CFR 1.312 has been considered, and has been:

a) ☐ entered.

b) ☑ entered as directed to matters of form not affecting the scope of the invention.

c) ☐ disapproved because the amendment was filed after the payment of the issue fee.

Any amendment filed after the date the issue fee is paid must be accompanied by a petition under 37 CFR 1.313(c)(1) and the required fee to withdraw the application from issue.

d) ☐ disapproved. See explanation below.

e) ☐ entered in part. See explanation below.

/EMMANUEL E DUKE/
Primary Examiner, Art Unit 3763

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IPR2024-01235

VIA ELECTRONIC FILING November 10, 2021

AMENDMENT UNDER 37 C.F.R. §1.312	Attorney Docket No.	MEWE-072
	Confirmation No.	1000
	First Named Inventor	Javier Eduardo Moya Raposo
	Application Number	16/341,618
	Filing Date	April 12, 2019
	Group Art Unit	3763
	Examiner Name	Emmanuel E. Duke
Address to: Mail Stop Issue Fee Commissioner for Patents P.O. Box 1450 Alexandria, VA 22313-1450	Title: "Use of Barocaloric Materials and Barocaloric Devices"	

Sir:

This amendment is responsive to the Notice of Allowance and Fees Due dated September 9, 2021. Applicants submit that the amendments set forth below raise no new issues and simply corrects a minor typographical error. Entry of these amendments is thus respectfully requested.

AMENDMENTS TO THE CLAIMS

Claim 1-30. (Cancelled)

31. (Previously Presented) A method comprising employing an organic material as a barocaloric cooling or heating agent, wherein the method comprises:

(i) applying hydrostatic pressure to an organic material;

(ii) permitting heat flow from or to the organic material;

(iii) releasing hydrostatic pressure from an organic material that is under applied pressure; and

(iv) permitting heat flow to or from the organic material.

32. (Previously Presented) The method according to claim 31, wherein the organic material is an organic compound or a salt thereof optionally wherein at least one of the following is present:

the organic material has a molecular weight of at most 2,000;

the organic material has a molecular weight of at least 50;

the organic material is an organic compound or a salt thereof, and the organic compound has two or more carbon-carbon bonds;

the organic material is an organic compound or a salt thereof, and the organic compound has two or more carbon-hydrogen bonds; and

the organic material is a liquid crystal or a plastic crystal.

33. (Previously Presented) The method according to claim 31, wherein the organic material is a plastic crystal optionally wherein:

the plastic crystal comprises a cycloalkyl group, and the cycloalkyl group is an adamantantyl group optionally substituted with one or more groups selected from the group consisting of alkyl, halo, hydroxyl and oxo; or

the plastic crystal comprises an alkyl group, and the alkyl group is a C_{4-20} alkyl group, optionally substituted with one or more groups selected from the group consisting of hydroxyl, amino and nitro.

34. (Previously Presented) The method according to claim 31, wherein the organic material is a liquid crystal optionally wherein the liquid crystal comprises one or more groups selected from alkyl, cycloalkyl and aryl.

35. (Previously Presented) The method according to claim 31, wherein the organic material is an alkyl carboxylic acid or an alkyl carboxylate salt optionally wherein the alkyl group has three or more carbon atoms; or the organic material is a hydrocarbon.

36. (Previously Presented) The method according to claim 31, wherein the organic material has a phase transition at a temperature within the range 200 to 450 K, optionally wherein the phase transition of the organic material is a first-order phase transition.

37. (Previously Presented) The method according to claim 31, wherein at least one of the following is present:

the organic material has an entropy change at a phase transition, $|\Delta S_0|$, of at least 10 J K^{-1} kg^{-1};

a phase transition in the organic material displays a latent heat, $|Q_0|$, that is at least 1 kJ kg^{-1};

the organic material has a volume change at the phase transition of at least 1.0 mm^3 g^{-1}; and

the organic material is provided within a pressure-transmitting medium.

38. (Previously Presented) The method according to claim 31, wherein hydrostatic pressure is applied to the organic material at a temperature that is within 50 K, of a phase transition temperature of the organic material, where the phase transition

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temperature is the temperature for the phase transition in the absence of the hydrostatic pressure optionally wherein:

the applied hydrostatic pressure is at most 1.0 GPa; or

the applied hydrostatic pressure is at least 0.1 MPa.

39. (Previously Presented) A method of barocaloric cooling or heating, the method comprising the steps of:

(i) applying hydrostatic pressure to an organic material;

(ii) permitting heat flow from or to the organic material;

(iii) releasing hydrostatic pressure from an organic material that is under applied pressure; and

(iv) permitting heat flow to or from the organic material.

40. (Previously Presented) The method according to claim 39, wherein the organic material is an organic compound or a salt thereof optionally wherein at least one of the following is present:

the organic material has a molecular weight of at most 2,000;

the organic material has a molecular weight of at least 50;

the organic material is an organic compound or a salt thereof, and the organic compound has two or more carbon-carbon bonds;

the organic material is an organic compound or a salt thereof, and the organic compound has two or more carbon-hydrogen bonds; and

the organic material is a liquid crystal or a plastic crystal.

41. (Previously Presented) The method according to claim 39, wherein the organic material is a plastic crystal optionally wherein:

the plastic crystal comprises a cycloalkyl group, and the cycloalkyl group is an adamantantyl group optionally substituted with one or more groups selected from the group consisting of alkyl, halo, hydroxyl and oxo; or

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the plastic crystal comprises an alkyl group, and the alkyl group is a C_{4-20} alkyl group, optionally substituted with one or more groups selected from the group consisting of hydroxyl, amino and nitro.

42. (Previously Presented) The method according to claim 39, wherein the organic material is a liquid crystal optionally wherein the liquid crystal comprises one or more groups selected from alkyl, cycloalkyl and aryl.

43. (Previously Presented) The method according to claim 39, wherein the organic material is an alkyl carboxylic acid or an alkyl carboxylate salt optionally wherein:

the alkyl group has three or more carbon atoms; or the organic material is a hydrocarbon.

44. (Previously Presented) The method according to claim 39, wherein the organic material has a phase transition at a temperature within the range 200 to 450 K, optionally wherein the phase transition of the organic material is a first-order phase transition.

45. (**Currently Amended**) The method according to claim 39, wherein at least one of the following is present:

the organic material has an entropy change at a phase transition, $|\Delta S_0|$, of at least 10 J K^{-1} kg^{-1};

a phase transition in the organic material displays a latent heat, $|Q_0|$, that is at least 1 kJ kg^{-1}; and

the organic material has a volume change at the phase transition of at least 1.0 mm^3 g^{-1}; or the organic material is provided within a pressure-transmitting medium.

46. (Previously Presented) The method according to claim 39, wherein hydrostatic pressure is applied to the organic material at a temperature that is within 50 K, of a phase transition temperature of the organic material, where the phase transition

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temperature is the temperature for the phase transition in the absence of the hydrostatic pressure optionally wherein:

the applied hydrostatic pressure is at most 1.0 GPa; or

the applied hydrostatic pressure is at least 0.1 MPa.

47. (Previously Presented) A cooling or heating apparatus comprising an organic material as a barocaloric cooling or heating agent and a means for transferring heat to and from the organic material, wherein the means for transferring heat to and from the organic material is suitable to transfer heat for a barocaloric transition with a latent heat, $|Q_0|$, that is at least 25 kJ kg^{-1}.

48. (Previously Presented) The apparatus according to claim 47, wherein the organic material is an organic compound or a salt thereof optionally wherein at least one of the following is present:

the organic material has a molecular weight of at most 2,000;

the organic material has a molecular weight of at least 50;

the organic material is an organic compound or a salt thereof, and the organic compound has two or more carbon-carbon bonds;

the organic material is an organic compound or a salt thereof, and the organic compound has two or more carbon-hydrogen bonds; and

the organic material is a liquid crystal or a plastic crystal.

49. (Previously Presented) The apparatus according to claim 47, wherein the organic material is a plastic crystal optionally wherein:

the plastic crystal comprises a cycloalkyl group, and the cycloalkyl group is an adamantantyl group optionally substituted with one or more groups selected from the group consisting of alkyl, halo, hydroxyl and oxo; or

the plastic crystal comprises an alkyl group, and the alkyl group is a $C_{4\text{-}20}$ alkyl group, optionally substituted with one or more groups selected from the group consisting of hydroxyl, amino and nitro.

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50. (Previously Presented) The apparatus according to claim 47, wherein the organic material is a liquid crystal optionally wherein the liquid crystal comprises one or more groups selected from alkyl, cycloalkyl and aryl.

51. (Previously Presented) The apparatus according to claim 47, wherein the organic material is an alkyl carboxylic acid or an alkyl carboxylate salt optionally wherein the alkyl group has three or more carbon atoms; or
the organic material is a hydrocarbon.

52. (Previously Presented) The apparatus according to claim 47, wherein the organic material has a phase transition at a temperature within the range 200 to 450 K optionally wherein the phase transition of the organic material is a first-order phase transition.

53. (Previously Presented) The apparatus according to claim 47, wherein at least one of the following is present:

the organic material has an entropy change at a phase transition, $|\Delta S_0|$, of at least 10 J K^{-1} kg^{-1};

a phase transition in the organic material displays a latent heat, $|Q_0|$, that is at least 1 kJ kg^{-1};

the organic material has a volume change at the phase transition of at least 1.0 mm^3 g^{-1}; and

the organic material is provided within a pressure-transmitting medium.

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CONCLUSION

Claim 45 has been amended to add "1", which was accidentally omitted in the response to the Ex Parte Qualye Action filed on July 14, 2021.

The Commissioner is hereby authorized to charge any underpayment of fees up to a strict limit of $500.00 beyond that authorized on the credit card, but not more than $500.00 in additional fees due with any communication for the above referenced patent application, including but not limited to any necessary fees for extensions of time, or credit any overpayment of any amount to Deposit Account No. 50-0815, order number MEWE-072.

Respectfully submitted,
BOZICEVIC, FIELD & FRANCIS LLP

Date: November 10, 2021

By: /Bret E. Field, Reg. No. 37,620/
Bret E. Field
Registration No. 37,620

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IPR2024-01235

Electronic Patent Application Fee Transmittal

Application Number:	16341618
Filing Date:	12-Apr-2019
Title of Invention:	Use of Barocaloric Materials and Barocaloric Devices
First Named Inventor/Applicant Name:	Javier Eduardo Moya Raposo
Filer:	Bret E. Field/Eri Baker
Attorney Docket Number:	MEWE-072

Filed as Large Entity

Filing Fees for U.S. National Stage under 35 USC 371

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
UTILITY APPL ISSUE FEE	1501	1	1200	1200

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**1200**

Electronic Acknowledgement Receipt

EFS ID:	44250753
Application Number:	16341618
International Application Number:	
Confirmation Number:	1000
Title of Invention:	Use of Barocaloric Materials and Barocaloric Devices
First Named Inventor/Applicant Name:	Javier Eduardo Moya Raposo
Customer Number:	93726
Filer:	Bret E. Field/Eri Baker
Filer Authorized By:	Bret E. Field
Attorney Docket Number:	MEWE-072
Receipt Date:	10-NOV-2021
Filing Date:	12-APR-2019
Time Stamp:	16:03:12
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$1200
RAM confirmation Number	E2021A0G03293380
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	MEWE-072_Transmittal_Issue_Fee.pdf	193586 5860bd66f32c7fec94ddab8fa31c592e592e9ff0	no	1
Warnings:					
Information:					
2		MEWE_072_312_Amendment.pdf	56032 845d4ae16d991e3004c5070c60caacaef9743985	yes	8

Multipart Description/PDF files in .zip description

Document Description	Start	End
Amendment after Notice of Allowance (Rule 312)	1	1
Claims	2	7
Applicant Arguments/Remarks Made in an Amendment	8	8

Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	37984 ced46739045ae17242abf3e03d8c0a532022e2e9	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	287602		

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

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93726 7590 09/09/2021

EPA - BOZICEVIC FIELD & FRANCIS LLP
BOZICEVIC, FIELD & FRANCIS
201 REDWOOD SHORES PARKWAY
SUITE 200
REDWOOD CITY, CA 94065

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(Typed or printed name)

(Signature)

(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/341,618	04/12/2019	Javier Eduardo Moya Raposo	MEWE-072	1000

TITLE OF INVENTION: Use of Barocaloric Materials and Barocaloric Devices

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1200	$0.00	$0.00	$1200	12/09/2021

EXAMINER	ART UNIT	CLASS-SUBCLASS
DUKE, EMMANUEL E	3763	165-104170

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-09 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 Michael J. Blessent
2 Bret E. Field
3 Bozicevic, Field & Francis LLP

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE	(B) RESIDENCE: (CITY and STATE OR COUNTRY)
Cambridge Enterprise Limited	Cambridge, Cambridgeshire, United Kingdom
Universitat Politècnica de Catalunya	Barcelona, Spain
Universitat de Barcelona	Barcelona, Spain

Please check the appropriate assignee category or categories (will not be printed on the patent) : ☐ Individual ☒ Corporation or other private group entity ☐ Government

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5. **Change in Entity Status** (from status indicated above)

☐ Applicant certifying micro entity status. See 37 CFR 1.29

☐ Applicant asserting small entity status. See 37 CFR 1.27

☐ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

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Authorized Signature /Bret E. Field, Reg. No. 37,620/ Date November 10, 2021

Typed or printed name Bret E. Field Registration No. 37,620

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IPR2024-01235

UNITED STATES PATENT AND TRADEMARK OFFICE

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NOTICE OF ALLOWANCE AND FEE(S) DUE

93726 7590 09/09/2021

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REDWOOD CITY, CA 94065

EXAMINER
DUKE, EMMANUEL E

ART UNIT	PAPER NUMBER
3763	

DATE MAILED: 09/09/2021

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/341,618	04/12/2019	Javier Eduardo Moya Raposo	MEWE-072	1000

TITLE OF INVENTION: Use of Barocaloric Materials and Barocaloric Devices

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1200	$0.00	$0.00	$1200	12/09/2021

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

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If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

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IPR2024-01235

PART B - FEE(S) TRANSMITTAL

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P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

93726 7590 09/09/2021

EPA - BOZICEVIC FIELD & FRANCIS LLP
BOZICEVIC, FIELD & FRANCIS
201 REDWOOD SHORES PARKWAY
SUITE 200
REDWOOD CITY, CA 94065

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/341,618	04/12/2019	Javier Eduardo Moya Raposo	MEWE-072	1000

TITLE OF INVENTION: Use of Barocaloric Materials and Barocaloric Devices

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1200	$0.00	$0.00	$1200	12/09/2021

EXAMINER	ART UNIT	CLASS-SUBCLASS
DUKE, EMMANUEL E	3763	165-104170

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-09 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,

(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 _____

2 _____

3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. Fees submitted: ❑ Issue Fee ❑ Publication Fee (if required) ❑ Advance Order - # of Copies _____

4b. Method of Payment: *(Please first reapply any previously paid fee shown above)*

❑ Electronic Payment via EFS-Web ❑ Enclosed check ❑ Non-electronic payment by credit card (Attach form PTO-2038)

❑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. _____

5. **Change in Entity Status** (from status indicated above)

❑ Applicant certifying micro entity status. See 37 CFR 1.29

❑ Applicant asserting small entity status. See 37 CFR 1.27

❑ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

PTOL-85 Part B (08-13) Approved for use through 07/31/2013 OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Pascal Technologies, Ex. 1002, page 19
Pascal Technologies v. Cambridge Enterprise Limited, Universitat De Barcelona, and Universitat Politècnica De Catalunya
IPR2024-01235

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/341,618	04/12/2019	Javier Eduardo Moya Raposo	MEWE-072	1000

93726 7590 09/09/2021

EPA - BOZICEVIC FIELD & FRANCIS LLP
BOZICEVIC, FIELD & FRANCIS
201 REDWOOD SHORES PARKWAY
SUITE 200
REDWOOD CITY, CA 94065

EXAMINER	
DUKE, EMMANUEL E	
ART UNIT	PAPER NUMBER
3763	

DATE MAILED: 09/09/2021

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

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IPR2024-01235

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

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IPR2024-01235

Notice of Allowability	Application No. 16/341,618	Applicant(s) Moya Raposo et al.	
	Examiner EMMANUEL E DUKE	Art Unit 3763	AIA (FITF) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☑ This communication is responsive to Claims filed on 07/14/2021.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

3. ☑ The allowed claim(s) is/are 31-53 . As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see **http://www.uspto.gov/patents/init_events/pph/index.jsp** or send an inquiry to **PPHfeedback@uspto.gov.**

4. ☑ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☑ All b) ☐ Some* c) ☐ None of the:

   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☑ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____ .

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____ .

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☑ Notice of References Cited (PTO-892)
2. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____.
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material _____.
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date. _____.
5. ☐ Examiner's Amendment/Comment
6. ☑ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/EMMANUEL E DUKE/
Primary Examiner, Art Unit 3763

DETAILED ACTION

Notice of Pre-AIA or AIA Status

The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Allowable Subject Matter

1. Claims 31-53 are allowed.

Reason for Allowance

2. The following is an examiner's statement of reasons for allowable: The prior art of record when consider as a whole, alone or in combination, neither anticipates nor renders obvious: the method comprising employing an organic material as a barocaloric cooling or heating agent, wherein the method comprises: applying hydrostatic pressure to an organic material; permitting heat flow from or to the organic material; releasing hydrostatic pressure from an organic material that is under applied pressure; and permitting heat flow to or from the organic material of instant independent claim 31; and the cooling or heating apparatus comprising an organic material as a barocaloric cooling or heating agent and a means for transferring heat to and from the organic material, wherein the means for transferring heat to and from the organic material is suitable to transfer heat for a barocaloric transition with a latent heat, that is at least 25 kJ kg^{-1} of instant independent claim 47.

The following references (Giant Barocaloric Effect at Low Pressure.... Publication) to Lloveras et al., and (US 20160017462 A1) to Samanta; Tapas et al.; are the most relevant references. However, above mentioned references fail to anticipate or render obvious the

invention of independent claims 31 and 47. Therefore, the independent claims and dependent claims thereof have been found to be allowable.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to EMMANUEL E DUKE whose telephone number is (571)270-5290. The examiner can normally be reached on Monday thru Friday; 8:30 AM to 4:30 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, FRANTZ JULES can be reached on (571)272-6681. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/EMMANUEL E DUKE/

Primary Examiner, Art Unit 3763

08/25/2021

Notice of References Cited	Application/Control No. 16/341,618	Applicant(s)/Patent Under Reexamination Moya Raposo et al.	
	Examiner EMMANUEL E DUKE	Art Unit 3763	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-20160017462-A1	01-2016	Samanta; Tapas	C22C30/00	420/581
	B					
	C					
	D					
	E					
	F					
	G					
	H					
	I					
	J					
	K					
	L					
	M					

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	Lloveras et al., Giant barocaloric effects at low pressure in ferrielectric ammonium sulphate, Nov 2015, Macmillan, page 1-6 (Year: 2015)
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

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Pascal Technologies v. Cambridge Enterprise Limited, Universitat De Barcelona, and Universitat Politècnica De Catalunya
IPR2024-01235

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/341,618	Moya Raposo et al.
	Examiner	**Art Unit**
	EMMANUEL E DUKE	3763

CPC							
Symbol						**Type**	**Version**
C09K	/	5	/	06		F	2013-01-01

CPC Combination Sets								
Symbol						**Type**	**Set**	**Ranking**	**Version**
	/		/						

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	23	
/EMMANUEL E DUKE/ Primary Examiner, Art Unit 3763	25 August 2021	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	47	1

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/341,618	Moya Raposo et al.
	Examiner	**Art Unit**
	EMMANUEL E DUKE	3763

INTERNATIONAL CLASSIFICATION				
CLAIMED				
C09K	/	5	/	06

NON-CLAIMED				
	/		/	

US ORIGINAL CLASSIFICATION	
CLASS	**SUBCLASS**
165	104.17

CROSS REFERENCES(S)						
CLASS	**SUBCLASS (ONE SUBCLASS PER BLOCK)**					

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	23	
/EMMANUEL E DUKE/ Primary Examiner, Art Unit 3763	25 August 2021	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	47	1

U.S. Patent and Trademark Office

Part of Paper No.: 20210825

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/341,618	Moya Raposo et al.
	Examiner	**Art Unit**
	EMMANUEL E DUKE	3763

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIMS

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
	1		10		19		28	7	37	16	46				
	2		11		20		29	8	38	17	47				
	3		12		21		30	9	39	18	48				
	4		13		22	1	31	10	40	19	49				
	5		14		23	2	32	11	41	20	50				
	6		15		24	3	33	12	42	21	51				
	7		16		25	4	34	13	43	22	52				
	8		17		26	5	35	14	44	23	53				
	9		18		27	6	36	15	45						

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	23	
/EMMANUEL E DUKE/ Primary Examiner, Art Unit 3763	25 August 2021	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	47	1

U.S. Patent and Trademark Office

Part of Paper No.: 20210825

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/341,618	Moya Raposo et al.
	Examiner	Art Unit
	EMMANUEL E DUKE	3763

CPC - Searched*		
Symbol	Date	Examiner
C09K5/06,14,02	01/20/2021	ED
F25B23/00	01/20/2021	ED
C04B35/645	01/20/2021	ED

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
Inventors search conducted on EAST and PALM	01/20/2021	ED
Text search conducted on EAST and IP.COM	01/20/2021, 01/21/2021	ED
Text modified search conducted (see EAST search history)	01/20/2021	ED
Reviewed and considered PCT/EP2017/076203 written opinion	01/20/2021	ED
Updated search conducted (see EAST search history)	06/01/2021, 06/02/2021	ED
Updated search conducted (see EAST search history)	08/25/2021	ED

/EMMANUEL E DUKE/ Primary Examiner, Art Unit 3763	

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Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/341,618	Moya Raposo et al.
	Examiner	Art Unit
	EMMANUEL E DUKE	3763

Interference Search			
US Class/CPC Symbol	**US Subclass/CPC Group**	**Date**	**Examiner**
EAST	Conducted text search on EAST for Interference	08/25/2021	ED
165/C09K	104.170/5/06	08/25/2021	ED

/EMMANUEL E DUKE/ Primary Examiner, Art Unit 3763	

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Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/341,618	Moya Raposo et al.
	Examiner	Art Unit
	EMMANUEL E DUKE	3763

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	01/21/2021	08/25/2021							
	1	-	-							
	2	-	-							
	3	-	-							
	4	-	-							
	5	-	-							
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	30	-	-							
1	31	✓	=							
2	32	✓	=							
3	33	✓	=							
4	34	✓	=							
5	35	✓	=							
6	36	✓	=							
7	37	✓	=							
8	38	✓	=							
9	39	=	=							
10	40	=	=							
11	41	=	=							
12	42	=	=							

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Pascal Technologies v. Cambridge Enterprise Limited, Universitat De Barcelona, and Universitat Politècnica De Catalunya
IPR2024-01235

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/341,618	Moya Raposo et al.
	Examiner	**Art Unit**
	EMMANUEL E DUKE	3763

CLAIM		DATE								
Final	Original	01/21/2021	08/25/2021							
13	43	=	=							
14	44	=	=							
15	45	=	=							
16	46	=	=							
17	47	=	=							
18	48	=	=							
19	49	=	=							
20	50	=	=							
21	51	=	=							
22	52	=	=							
23	53	=	=							

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	1	((("Moya") near3 ("Raposo") near3 ("Javier") near3 ("Eduardo"))).INV.	US-PGPUB; USPAT; USOCR	OR	OFF	2021/01/20 07:13
S2	1	((("Avramenko") near3 ("Alexander"))).INV.	US-PGPUB; USPAT; USOCR	OR	OFF	2021/01/20 07:14
S3	0	((("Manosa") near3 ("Carrera") near3 ("LluÃs"))).INV.	US-PGPUB; USPAT; USOCR	OR	OFF	2021/01/20 07:14
S4	0	((("Tamarit") near3 ("Mur") near3 ("Josep") near3 ("LluÃs"))).INV.	US-PGPUB; USPAT; USOCR	OR	OFF	2021/01/20 07:15
S5	0	((("Lloveras") near3 ("MuntanÃ©") near3 ("Pol") near3 ("Marcel"))).INV.	US-PGPUB; USPAT; USOCR	OR	OFF	2021/01/20 07:15
S6	25,693	(C09K5/06 or C09K5/14 or C09K5/02 or F25B23/00 or C04B35/645).cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2021/01/20 07:42
S7	1,233	C09K5/06.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2021/01/20 07:43
S8	7,559	C09K5/14.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	OFF	2021/01/20 07:44

			DERWENT ; IBM_TDB			
S9	368	C09K5/02.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT ; IBM_TDB	OR	OFF	2021/01/20 07:45
S10	887	F25B23/00.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT ; IBM_TDB	OR	OFF	2021/01/20 07:45
S11	15,869	C04B35/645.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT ; IBM_TDB	OR	OFF	2021/01/20 07:46
S12	6	ORGANIC MATERIAL BAROCALORIC COOL$3 HEAT$3 AGENT	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT ; IBM_TDB	AND	OFF	2021/01/20 07:48
S13	6	S6 ORGANIC MATERIAL BAROCALORIC COOL$3 HEAT$3 AGENT	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT ; IBM_TDB	AND	OFF	2021/01/20 07:49
S14	13	S6 BAROCALORIC COOL$3 HEAT$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT ; IBM_TDB	AND	OFF	2021/01/20 07:49

S15	3	ORGANIC MATERIAL BAROCALORIC COOL$3 HEAT$3 ((LIQUID OR PLASTIC) NEAR2 CRYSTAL) PRESSURE (PHASE NEAR2 TRANSITION)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/20 09:46
S16	2,054,195	((LIQUID OR PLASTIC) NEAR2 CRYSTAL)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/20 11:01
S17	6	BAROCALORIC COOL$3 HEAT$3 ((LIQUID OR PLASTIC) NEAR2 CRYSTAL)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/20 11:05
S18	88,935	(ORGANIC NEAR2 MATERIAL) ((LIQUID OR PLASTIC) NEAR2 CRYSTAL)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/20 11:06
S19	19,714	COOL$3 HEAT$3 (ORGANIC NEAR2 MATERIAL) ((LIQUID OR PLASTIC) NEAR2 CRYSTAL)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/20 11:07
S20	6	COOL$3 HEAT$3 (ORGANIC NEAR2 MATERIAL) ((LIQUID OR PLASTIC) NEAR2 CRYSTAL) BAROCALORIC	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/20 11:07
S21	2,218	COOL$3 HEAT$3 (ORGANIC NEAR2 MATERIAL) ((LIQUID OR PLASTIC)	US-PGPUB;	AND	OFF	2021/01/20 11:09

		NEAR2 CRYSTAL) HYDROXYL AMINO NITRO	USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S22	131	COOL$3 HEAT$3 (ORGANIC NEAR2 MATERIAL) ((LIQUID OR PLASTIC) NEAR2 CRYSTAL) HYDROXYL AMINO NITRO ALKYL HALO HYDROXYL OXO	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/20 11:11
S23	8	BAROCALORIC (ORGANIC NEAR2 MATERIAL) COOL$3 HEAT$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/20 11:54
S24	10	BAROCALORIC (ORGANIC NEAR2 MATERIAL)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/20 11:54
S25	121,593	(ORGANIC NEAR2 MATERIAL) COOL$3 HEAT$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/20 11:55
S26	19,714	(ORGANIC NEAR2 MATERIAL) COOL$3 HEAT$3 ((LIQUID OR PLASTIC) NEAR2 CRYSTAL)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/20 11:56
S27	138	(ORGANIC NEAR2 MATERIAL) COOL$3 HEAT$3 ((LIQUID AND PLASTIC) NEAR2 CRYSTAL)	US-PGPUB; USPAT; USOCR;	AND	OFF	2021/01/20 11:56

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
S28	5,809	(ORGANIC NEAR2 MATERIAL) ((COOL$3 OR HEAT$3) NEAR2 AGENT)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/21 05:49
S29	3,441	(ORGANIC NEAR2 MATERIAL) ((COOL$3 OR HEAT$3) NEAR2 AGENT) ((ORGANIC NEAR2 COMPOUND) OR SALT)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/21 05:50
S30	1,054	(ORGANIC NEAR2 MATERIAL) ((COOL$3 OR HEAT$3) NEAR2 AGENT) ((ORGANIC NEAR2 COMPOUND) OR SALT) CARBON HYDROGEN BONDS	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/21 05:52
S31	326	(ORGANIC NEAR2 MATERIAL) ((COOL$3 OR HEAT$3) NEAR2 AGENT) ((ORGANIC NEAR2 COMPOUND) OR SALT) CARBON HYDROGEN BONDS ((LIQUID OR PLACTIC) NEAR2 CRYSTAL)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/21 05:52
S32	2	(ORGANIC NEAR2 MATERIAL) ((COOL$3 OR HEAT$3) NEAR2 AGENT) ((ORGANIC NEAR2 COMPOUND) OR SALT) CARBON HYDROGEN BONDS ((LIQUID OR PLACTIC) NEAR2 CRYSTAL) (ALKYL OR CYCLOALKYL) ADAMANTANTYL	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/21 05:55
S33	197	(ORGANIC NEAR2 MATERIAL) ((COOL$3 OR HEAT$3) NEAR2 AGENT) ((ORGANIC NEAR2 COMPOUND) OR SALT) CARBON HYDROGEN BONDS ((LIQUID OR PLACTIC) NEAR2 CRYSTAL) (ALKYL OR CYCLOALKYL)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	AND	OFF	2021/01/21 05:55

			DERWENT; IBM_TDB			
S34	2	(ORGANIC NEAR2 MATERIAL) ((COOL$3 OR HEAT$3) NEAR2 AGENT) ((ORGANIC NEAR2 COMPOUND) OR SALT) CARBON HYDROGEN BONDS ((LIQUID OR PLACTIC) NEAR2 CRYSTAL) (ALKYL OR CYCLOALKYL) HYDROSTATIC PRESSURE	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/21 05:56
S35	197	(ORGANIC NEAR2 MATERIAL) ((COOL$3 OR HEAT$3) NEAR2 AGENT) ((ORGANIC NEAR2 COMPOUND) OR SALT) CARBON HYDROGEN BONDS ((LIQUID OR PLACTIC) NEAR2 CRYSTAL) (ALKYL OR CYCLOALKYL) TEMPERATURE	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/21 05:57
S36	14	(ORGANIC NEAR2 MATERIAL) ((COOL$3 OR HEAT$3) NEAR2 AGENT) ((ORGANIC NEAR2 COMPOUND) OR SALT) CARBON HYDROGEN BONDS ((LIQUID OR PLACTIC) NEAR2 CRYSTAL) (ALKYL OR CYCLOALKYL) TEMPERATURE (PHASE NEAR2 TRANSITION)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/21 05:58
S37	2	(BAROCALORIC NEAR2 (COOL$3 AND HEAT$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	NEAR	OFF	2021/01/21 06:31
S38	3	(BAROCALORIC NEAR12 (COOL$3 AND HEAT$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	NEAR	OFF	2021/01/21 06:32
S39	3	(BAROCALORIC NEAR20 (COOL$3 AND HEAT$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	NEAR	OFF	2021/01/21 06:34

S40	1,993	((ORGANIC NEAR2 MATERIAL) NEAR20 (COOL$3 AND HEAT$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	NEAR	OFF	2021/01/21 06:34
S41	10	((ORGANIC NEAR2 MATERIAL) NEAR20 (COOL$3 AND HEAT$3)) HYDROSTATIC PRESSURE	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/21 06:43
S43	55,447	(ORGANIC NEAR2 MATERIAL) (COOL$3 OR HEAT$3) ((LIQUID OR PLACTIC) NEAR2 CRYSTAL)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/21 09:03
S44	6,594	((ORGANIC NEAR2 MATERIAL) near12 (COOL$3 OR HEAT$3)) ((LIQUID OR PLACTIC) NEAR2 CRYSTAL)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/21 09:04
S45	2,761	((ORGANIC NEAR2 MATERIAL) near12 (COOL$3 OR HEAT$3)) ((LIQUID OR PLACTIC) NEAR2 CRYSTAL) (cycloalkyi or alkyl)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/21 09:06
S46	2	((ORGANIC NEAR2 MATERIAL) near12 (COOL$3 OR HEAT$3)) ((LIQUID OR PLACTIC) NEAR2 CRYSTAL) (cycloalkyi or alkyl) adamantantyl	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/21 09:08
S47	13	((ORGANIC NEAR2 MATERIAL) near12 (COOL$3 OR HEAT$3)) ((LIQUID OR	US-PGPUB;	AND	OFF	2021/01/21 09:08

		PLACTIC) NEAR2 CRYSTAL) (cycloalkyi or alkyl) alkyl halo hydroxyl oxo	USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S48	10	((ORGANIC NEAR2 MATERIAL) near12 (COOL$3 OR HEAT$3)) ((LIQUID OR PLACTIC) NEAR2 CRYSTAL) (cycloalkyi or alkyl) alkyl halo hydroxyl oxo cycloalkyl aryl	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/21 09:10
S49	2	(ORGANIC NEAR2 MATERIAL) (BAROCALORIC NEAR2 (COOL$3 OR HEAT$3)) ((LIQUID OR PLACTIC) NEAR2 CRYSTAL) (cycloalkyi or alkyl) alkyl halo hydroxyl oxo cycloalkyl aryl	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/21 11:00
S54	26	plastic crystal alkyl cycoalkyl	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 14:52
S57	3	plastic crystal alkyl cycoalkyl halo hydroxyl oxo	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 14:53
S59	2	(plastic near2 crystal) adamantantyl	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 14:55
S60	47	adamantantyl	US-PGPUB; USPAT; USOCR;	AND	OFF	2021/01/22 14:56

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
S61	2	COOL$3 HEAT$3 (ORGANIC NEAR2 MATERIAL) ((LIQUID and PLASTIC) NEAR2 CRYSTAL) HYDROXYL AMINO NITRO ALKYL HALO HYDROXYL OXO	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:04
S62	2	(ORGANIC NEAR2 MATERIAL) ((LIQUID and PLASTIC) NEAR2 CRYSTAL) HYDROXYL AMINO NITRO ALKYL HALO HYDROXYL OXO	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:05
S63	2	((LIQUID and PLASTIC) NEAR2 CRYSTAL) HYDROXYL AMINO NITRO ALKYL HALO HYDROXYL OXO	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:05
S64	405	(ORGANIC NEAR2 MATERIAL) ((LIQUID and PLASTIC) NEAR2 CRYSTAL)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:05
S65	60	(ORGANIC NEAR2 MATERIAL) ((LIQUID and PLASTIC) NEAR2 CRYSTAL) HYDROXYL	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:06
S66	54	(ORGANIC NEAR2 MATERIAL) ((LIQUID and PLASTIC) NEAR2 CRYSTAL) AMINO	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	AND	OFF	2021/01/22 15:07

			DERWENT ; IBM_TDB			
S67	30	(ORGANIC NEAR2 MATERIAL) ((LIQUID and PLASTIC) NEAR2 CRYSTAL) NITRO	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT ; IBM_TDB	AND	OFF	2021/01/22 15:07
S68	101	(ORGANIC NEAR2 MATERIAL) ((LIQUID and PLASTIC) NEAR2 CRYSTAL) ALKYL	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT ; IBM_TDB	AND	OFF	2021/01/22 15:07
S69	32	(ORGANIC NEAR2 MATERIAL) ((LIQUID and PLASTIC) NEAR2 CRYSTAL) HALO	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT ; IBM_TDB	AND	OFF	2021/01/22 15:08
S70	60	(ORGANIC NEAR2 MATERIAL) ((LIQUID and PLASTIC) NEAR2 CRYSTAL) HYDROXYL	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT ; IBM_TDB	AND	OFF	2021/01/22 15:08
S71	6	(ORGANIC NEAR2 MATERIAL) ((LIQUID and PLASTIC) NEAR2 CRYSTAL) cycloalkyl	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT ; IBM_TDB	AND	OFF	2021/01/22 15:09
S72	224	poly(methyl methacrylate) ((LIQUID and PLASTIC) NEAR2 CRYSTAL)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT ; IBM_TDB	AND	OFF	2021/01/22 15:14

S73	28	poly(methyl methacrylate) ((LIQUID and PLASTIC) NEAR2 CRYSTAL) hydroxyl amino nitro	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:15
S75	31	poly(methyl methacrylate) (PLASTIC NEAR2 CRYSTAL) CYCLOALKYL	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:26
S76	1	poly(methyl methacrylate) (PLASTIC NEAR2 CRYSTAL) CYCLOALKYL ALKYL HALO HYDROXYL OXO	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:27
S77	31	poly(methyl methacrylate) (PLASTIC NEAR2 CRYSTAL) CYCLOALKYL	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:28
S78	31	poly(methyl methacrylate) (PLASTIC NEAR2 CRYSTAL) CYCLOALKYL ALKYL	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:28
S79	6	poly(methyl methacrylate) (PLASTIC NEAR2 CRYSTAL) CYCLOALKYL ALKYL HALO	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:28

S80	17	poly(methyl methacrylate) (PLASTIC NEAR2 CRYSTAL) CYCLOALKYL ALKYL HYDROXYL	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:28
S81	7	poly(methyl methacrylate) (PLASTIC NEAR2 CRYSTAL) CYCLOALKYL ALKYL OXO	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:28
S82	604	(PLASTIC NEAR2 CRYSTAL) (ALKYL OR CYCLOALKYL)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:43
S83	391	(PLASTIC NEAR2 CRYSTAL) (ALKYL NEAR2 GROUP)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:44
S84	256	(PLASTIC NEAR2 CRYSTAL) (ALKYL NEAR2 GROUP) CARBON BOND$1	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:45
S85	171	(PLASTIC NEAR2 CRYSTAL) (ALKYL NEAR2 GROUP) CARBON BOND$1 HYDROXYL	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:46

S86	47	(ORGANIC NEAR2 MATERIAL) (PLASTIC NEAR2 CRYSTAL) (ALKYL NEAR2 GROUP) CARBON BOND$1 HYDROXYL	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 16:00
S87	6	((organic material) NEAR10 ((alkyl NEAR2(carboxylic NEAR2 acid)) OR (alkyl (carboxylate salt))))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	NEAR	OFF	2021/01/22 16:37
S90	7	((organic near2 material) near2 (plastic near2 crystal))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	NEAR	OFF	2021/01/23 12:19
S91	211	(organic near2 (plastic near2 crystal))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	NEAR	OFF	2021/01/23 12:22
S92	2	(ORGANIC NEAR2 MATERIAL) (BAROCALORIC NEAR2 ((COOL$3 OR NEAT$3) NEAR2 AGENT))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/01 14:39
S93	2	(BAROCALORIC NEAR2 ((COOL$3 OR NEAT$3) NEAR2 AGENT))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	NEAR	OFF	2021/06/01 14:53
S94	10	(BAROCALORIC NEAR2 (COOL$3 OR NEAT$3))	US-PGPUB;	NEAR	OFF	2021/06/01 14:54

			USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S95	3	(ORGANIC NEAR2 MATERIAL) (BAROCALORIC NEAR2 (MATERIAL OR DEVICE)) (COOL$3 OR NEAT$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/01 15:00
S96	6	(BAROCALORIC NEAR2 (MATERIAL OR DEVICE)) (COOL$3 OR NEAT$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/01 15:01
S97	26,775	(C09K5/06 or C09K5/14 or C09K5/02 or F25B23/00 or C04B35/645).cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2021/06/01 15:03
S98	6	S97 S94	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/01 15:03
S107	0	NEOPENTYL ALCOHOL TRIS(HYDROXYMETHYL)AMINOMETHANE BAROCALORIC AGENT COOLING HEATING HYROSTATIC PRESSURE	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/01 15:28
S108	0	NEOPENTYL ALCOHOL TRIS (HYDROXYMETHYL) AMINOMETHANE BAROCALORIC COOLING HEATING HYROSTATIC PRESSURE	US-PGPUB; USPAT; USOCR;	AND	OFF	2021/06/01 15:28

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
S109	1	NEOPENTYL ALCOHOL TRIS (HYDROXYMETHYL) AMINOMETHANE BAROCALORIC COOLING HEATING	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/01 15:28
S110	1	NEOPENTYL ALCOHOL (HYDROXYMETHYL) BAROCALORIC COOLING HEATING	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/01 15:29
S111	1	NEOPENTYL ALCOHOL TRIS(HYDROXYMETHYL)AMINOMETHANE BAROCALORIC	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/01 15:29
S112	0	BAROCALORIC COOLING HEATING HYROSTATIC PRESSURE	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/01 15:30
S113	19	BAROCALORIC COOLING HEATING	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/01 15:31
S115	7,381	(PLASTIC NEAR2 CRYSTAL)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	AND	OFF	2021/06/01 17:30

			DERWENT; IBM_TDB			
S116	47	(PLASTIC NEAR2 CRYSTAL) HYDROSTATIC PRESSURE	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/01 17:30
S117	2	(PLASTIC NEAR2 CRYSTAL) HYDROSTATIC PRESSURE CYCLOALKYL	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/01 17:32
S118	2	(PLASTIC NEAR2 CRYSTAL) HYDROSTATIC PRESSURE ADAMANTANTYL	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/01 17:32
S119	2	(PLASTIC NEAR2 CRYSTAL) HYDROSTATIC PRESSURE ALKYL	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/01 17:32
S120	2	(PLASTIC NEAR2 CRYSTAL) HYDROSTATIC PRESSURE HYDROXYL	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/01 17:33
S121	2	(PLASTIC NEAR2 CRYSTAL) HYDROSTATIC PRESSURE AMINO	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/01 17:33

S122	2	(PLASTIC NEAR2 CRYSTAL) HYDROSTATIC PRESSURE NITRO	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/01 17:33
S123	2	(PLASTIC NEAR2 CRYSTAL) HYDROSTATIC PRESSURE CARBOXYLIC	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/01 17:34
S124	2	(PLASTIC NEAR2 CRYSTAL) HYDROSTATIC PRESSURE CARBOXYLATE	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/01 17:34
S125	11	(PLASTIC NEAR2 CRYSTAL) HYDROSTATIC PRESSURE PHASE TRANSITION	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/01 17:34
S126	2	(PLASTIC NEAR2 CRYSTAL) CYCLOALKYL ADAMANTANTYL ALKYL HYDROXYL AMINO NITRO CARBOXYLIC CARBOXYLATE PHASE TRANSITION HYDROSTATIC PRESSURE	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/01 17:35
S128	44	ADAMANTANTYL (ALKYL OR HALO OR HYDROXYL OR OXO)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/02 06:13

S129	12	ADAMANTANTYL (ALKYL OR HALO OR HYDROXYL OR OXO) (COOLING OR HEATING)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/02 06:14
S130	26	barocaloric (cooling or heating)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/02 06:21
S131	352,930	(ORGANIC NEAR2 (MATERIAL OR COMPOUND)) (cooling or heating)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/02 06:33
S132	402,976	(ORGANIC NEAR2 (MATERIAL OR (COMPOUND OR SALT))) (cooling or heating)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/02 06:34
S133	9	(ORGANIC NEAR2 (MATERIAL OR (COMPOUND OR SALT))) (cooling or heating) BAROCALORIC	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/02 06:35
S134	437	(ORGANIC NEAR2 (MATERIAL OR (COMPOUND OR SALT))) (cooling or heating) (PLASTIC NEAR2 CRYSTAL)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/02 06:56
S135	2	(ORGANIC NEAR2 (MATERIAL OR (COMPOUND OR SALT))) (cooling or	US-PGPUB;	AND	OFF	2021/06/02 06:56

		heating) (PLASTIC NEAR2 CRYSTAL) ADAMANTANTYL	USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S136	236	(ORGANIC NEAR2 (MATERIAL OR (COMPOUND OR SALT))) (cooling or heating) (PLASTIC NEAR2 CRYSTAL) (ALKYL OR HALO OR HYDROXYL OR OXO)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/02 06:58
S137	32,245	(ORGANIC NEAR2 (MATERIAL OR (COMPOUND OR SALT))) (cooling or heating) ((PLASTIC OR LIQUID) NEAR2 CRYSTAL) (ALKYL OR HALO OR HYDROXYL OR OXO)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/02 06:59
S138	17,983	(ORGANIC NEAR2 (MATERIAL OR (COMPOUND OR SALT))) (cooling or heating) ((PLASTIC OR LIQUID) NEAR2 CRYSTAL) (ALKYL OR HALO OR HYDROXYL OR OXO) HYDROCARBON	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/02 07:05
S139	1,390	(ORGANIC NEAR2 (MATERIAL OR (COMPOUND OR SALT))) (cooling or heating) ((PLASTIC OR LIQUID) NEAR2 CRYSTAL) (ALKYL OR HALO OR HYDROXYL OR OXO) HYDROCARBON (PHASE NEAR2 TRANSITION)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/02 07:06
S141	25	(cooling or heating) ((PLASTIC OR LIQUID) NEAR2 CRYSTAL) (ALKYL OR HALO OR HYDROXYL OR OXO) HYDROCARBON (PHASE NEAR2 TRANSITION) (HYDROSTATIC NEAR2 PRESSURE)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/02 07:21
S143	1	(cooling or heating) ORGANIC (BAROCALORIC NEAR2 TRANSITION)	US-PGPUB; USPAT; USOCR;	AND	OFF	2021/06/02 07:30

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
S145	2	(ORGANIC NEAR2 (MATERIAL OR (COMPOUND OR SALT))) (cooling or heating) ((PLASTIC OR LIQUID) NEAR2 CRYSTAL) (ALKYL OR HALO OR HYDROXYL OR OXO) HYDROCARBON (PHASE NEAR2 TRANSITION) (HYDROSTATIC NEAR2 PRESSURE)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/02 10:56
S146	118,214	(ORGANIC NEAR2 (MATERIAL OR (COMPOUND OR SALT))) ((PLASTIC OR LIQUID) NEAR2 CRYSTAL)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/02 11:03
S147	91,304	(ORGANIC NEAR2 MATERIAL) (LIQUID NEAR2 CRYSTAL)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/02 11:05
S148	6	(ORGANIC NEAR2 MATERIAL) (LIQUID NEAR2 CRYSTAL) Barocaloric	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/02 11:05
S149	56,720	(ORGANIC NEAR2 MATERIAL) (LIQUID NEAR2 CRYSTAL) (Cool$3 or Heat$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/02 11:06
S150	411	(ORGANIC NEAR2 MATERIAL) (LIQUID NEAR2 CRYSTAL) (plastic near2 crystal)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	AND	OFF	2021/06/02 11:07

			DERWENT; IBM_TDB			
S162	3	(("20070099249") or ("20100060844") or ("3920414")).PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2021/08/25 12:11

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S151	1	(BAROCALORIC NEAR2 ((COOL$3 OR NEAT$3) NEAR2 AGENT))	US-PGPUB; USPAT	AND	OFF	2021/08/25 11:39
S152	2	(ORGANIC NEAR2 MATERIAL) (BAROCALORIC NEAR2 (MATERIAL OR DEVICE)) (COOL$3 OR NEAT$3)	US-PGPUB; USPAT	AND	OFF	2021/08/25 11:39
S153	3	(BAROCALORIC NEAR2 (MATERIAL OR DEVICE)) (COOL$3 OR NEAT$3)	US-PGPUB; USPAT	AND	OFF	2021/08/25 11:40
S154	13	(ORGANIC NEAR2 MATERIAL) ((COOL$3 OR HEAT$3) NEAR2 AGENT) ((ORGANIC NEAR2 COMPOUND) OR SALT) CARBON HYDROGEN BONDS ((LIQUID OR PLACTIC) NEAR2 CRYSTAL) (ALKYL OR CYCLOALKYL) TEMPERATURE (PHASE NEAR2 TRANSITION)	US-PGPUB; USPAT	AND	OFF	2021/08/25 11:41
S155	1	(ORGANIC NEAR2 MATERIAL) (BAROCALORIC NEAR2 (COOL$3 OR HEAT$3)) ((LIQUID OR PLACTIC) NEAR2 CRYSTAL) (cycloalkyi or alkyl) alkyl halo hydroxyl oxo cycloalkyl aryl	US-PGPUB; USPAT	AND	OFF	2021/08/25 11:41
S156	12	BAROCALORIC COOLING HEATING	US-PGPUB; USPAT	AND	OFF	2021/08/25 11:42
S157	1	(PLASTIC NEAR2 CRYSTAL) CYCLOALKYL ADAMANTANTYL ALKYL HYDROXYL AMINO NITRO CARBOXYLIC CARBOXYLATE PHASE TRANSITION HYDROSTATIC PRESSURE	US-PGPUB; USPAT	AND	OFF	2021/08/25 11:42
S158	1	(ORGANIC NEAR2 (MATERIAL OR (COMPOUND OR SALT))) (cooling or heating) ((PLASTIC OR LIQUID) NEAR2 CRYSTAL) (ALKYL OR HALO OR HYDROXYL OR OXO) HYDROCARBON (PHASE NEAR2 TRANSITION) (HYDROSTATIC NEAR2 PRESSURE)	US-PGPUB; USPAT	AND	OFF	2021/08/25 11:43
S159	1	(ORGANIC NEAR2 MATERIAL) (BAROCALORIC NEAR2 ((COOL$3 OR NEAT$3) NEAR2 AGENT))	US-PGPUB; USPAT	AND	OFF	2021/08/25 11:43

S160	4	(BAROCALORIC NEAR2 (COOL$3 OR NEAT$3))	US-PGPUB; USPAT	OR	OFF	2021/08/25 11:44
S161	240	C09K5/06.cpc.	US-PGPUB; USPAT	OR	OFF	2021/08/25 11:45

8/25/2021 12:26:48 PM
C:\Users\eduke\Documents\EAST\Workspaces\16341618.wsp

Bibliographic Data

Application No: 16/341,618

Foreign Priority claimed: (●) Yes ( ) No

35 USC 119 (a-d) conditions met: [✓] Yes [ ] No [ ] Met After Allowance

Verified and Acknowledged: /EMMANUEL E DUKE/ Examiner's Signature | Initials

Title: Use of Barocaloric Materials and Barocaloric Devices

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
04/12/2019	165	3763	MEWE-072
RULE			

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CONTINUING DATA

This application is a 371 of PCT/EP2017/076203 10/13/2017

FOREIGN APPLICATIONS

UNITED KINGDOM GB1617508.5 10/14/2016

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01/12/2020

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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 16/341,618	Filing Date 04/12/2019	☐ To be Mailed

ENTITY: ☑ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA		RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A		N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A		N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*		x $100 =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*		x $460 =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).				
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))					
* If the difference in column 1 is less than zero, enter "0" in column 2.				TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT	07/14/2021	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 23	Minus	** 23	= 0		x $100 =	0
	Independent (37 CFR 1.16(h))	* 3	Minus	*** 3	= 0		x $480 =	0
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	0

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=		x $0 =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=		x $0 =	
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.	
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".	/LISA R EPPS/
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The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.	

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 16/341,618	Filing Date 04/12/2019	☐ To be Mailed

ENTITY: ☑ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA		RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A		N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A		N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*		x $100 =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*		x $460 =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).				
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))					
* If the difference in column 1 is less than zero, enter "0" in column 2.				TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT	07/14/2021	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 23	Minus	** 23	= 0		x $100 =	0
	Independent (37 CFR 1.16(h))	* 3	Minus	*** 3	= 0		x $480 =	0
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	0

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=		x $0 =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=		x $0 =	
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.	LIE
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".	/ZURIASHWORK ZENEBE/
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Electronically Filed July 14, 2021

AMENDMENT AND RESPONSE TO EX PARTE QUAYLE COMMUNICATION	Attorney Docket No.	MEWE-072
	Confirmation No.	1000
	First Named Inventor	Javier Eduardo Moya Raposo
	Application Number	16/341,618
	Filing Date	April 12, 2019
	Group Art Unit	3763
Address to: Mail Stop Amendment Commissioner for Patents P.O. Box 1450 Alexandria, VA 22313-1450	Examiner Name	Emmanuel E. Duke
	Title: "*Use of Barocaloric Materials and Barocaloric Devices*"	

Commissioner:

This communication is responsive to the Ex Parte Quayle communication dated June 9, 2021, for which a two-month period for response was given, making this response due by August 9, 2021. As such, this response is timely filed.

AMENDMENTS TO THE CLAIMS

Claim 1-30. (Cancelled)

31. (**Currently Amended**) A method comprising employing an organic material as a barocaloric cooling or heating agent**, wherein the method comprises:**

(i) applying hydrostatic pressure to an organic material;

(ii) permitting heat flow from or to the organic material;

(iii) releasing hydrostatic pressure from an organic material that is under applied pressure; and

(iv) permitting heat flow to or from the organic material.

32. (**Currently Amended**) The method according to claim 31, wherein the organic material is an organic compound or a salt thereof optionally wherein at least one of **the following is present**:

the organic material has a molecular weight of at most 2,000;

the organic material has a molecular weight of at least 50;

the organic material is an organic compound or a salt thereof, and the organic compound has two or more carbon-carbon bonds;

the organic material is an organic compound or a salt thereof, and the organic compound has two or more carbon-hydrogen bonds; and

the organic material is a liquid crystal or a plastic crystal.

33. (Previously Presented) The method according to claim 31, wherein the organic material is a plastic crystal optionally wherein:

the plastic crystal comprises a cycloalkyl group, and the cycloalkyl group is an adamantantyl group optionally substituted with one or more groups selected from the group consisting of alkyl, halo, hydroxyl and oxo; or

the plastic crystal comprises an alkyl group, and the alkyl group is a $C_{4\text{-}20}$ alkyl group, optionally substituted with one or more groups selected from the group consisting of hydroxyl, amino and nitro.

Pascal Technologies, Ex. 1002, page 60
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IPR2024-01235

34. (Previously Presented) The method according to claim 31, wherein the organic material is a liquid crystal optionally wherein the liquid crystal comprises one or more groups selected from alkyl, cycloalkyl and aryl.

35. (Previously Presented) The method according to claim 31, wherein the organic material is an alkyl carboxylic acid or an alkyl carboxylate salt optionally wherein the alkyl group has three or more carbon atoms; or the organic material is a hydrocarbon.

36. (Previously Presented) The method according to claim 31, wherein the organic material has a phase transition at a temperature within the range 200 to 450 K, optionally wherein the phase transition of the organic material is a first-order phase transition.

37. (**Currently Amended**) The method according to claim 31, wherein at least one of **the following is present**:

the organic material has an entropy change at a phase transition, $|\Delta S_0|$, of at least 10 J K^{-1} kg^{-1}; [[and]]

a phase transition in the organic material displays a latent heat, $|Q_0|$, that is at least 1 kJ kg^{-1}; [[or]]

the organic material has a volume change at the phase transition of at least 1.0 mm^3 g^{-1}; [[or]] **and**

the organic material is provided within a pressure-transmitting medium.

38. (Previously Presented) The method according to claim 31, wherein hydrostatic pressure is applied to the organic material at a temperature that is within 50 K, of a phase transition temperature of the organic material, where the phase transition temperature is the temperature for the phase transition in the absence of the hydrostatic pressure optionally wherein:

the applied hydrostatic pressure is at most 1.0 GPa; or

the applied hydrostatic pressure is at least 0.1 MPa.

Pascal Technologies, Ex. 1002, page 61
Pascal Technologies v. Cambridge Enterprise Limited, Universitat De Barcelona, and Universitat Politècnica De Catalunya
IPR2024-01235

39. (Previously Presented) A method of barocaloric cooling or heating, the method comprising the steps of:

(i) applying hydrostatic pressure to an organic material;

(ii) permitting heat flow from or to the organic material;

(iii) releasing hydrostatic pressure from an organic material that is under applied pressure; and

(iv) permitting heat flow to or from the organic material.

40. (**Currently Amended**) The method according to claim 39, wherein the organic material is an organic compound or a salt thereof optionally wherein **at least one of the following is present**:

the organic material has a molecular weight of at most 2,000;

the organic material has a molecular weight of at least 50;

the organic material is an organic compound or a salt thereof, and the organic compound has two or more carbon-carbon bonds;

the organic material is an organic compound or a salt thereof, and the organic compound has two or more carbon-hydrogen bonds; [[or]]**and**

the organic material is a liquid crystal or a plastic crystal.

41. (Previously Presented) The method according to claim 39, wherein the organic material is a plastic crystal optionally wherein:

the plastic crystal comprises a cycloalkyl group, and the cycloalkyl group is an adamantantyl group optionally substituted with one or more groups selected from the group consisting of alkyl, halo, hydroxyl and oxo; or

the plastic crystal comprises an alkyl group, and the alkyl group is a $C_{4\text{-}20}$ alkyl group, optionally substituted with one or more groups selected from the group consisting of hydroxyl, amino and nitro.

42. (Previously Presented) The method according to claim 39, wherein the organic material is a liquid crystal optionally wherein the liquid crystal comprises one or more groups selected from alkyl, cycloalkyl and aryl.

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43. (Previously Presented) The method according to claim 39, wherein the organic material is an alkyl carboxylic acid or an alkyl carboxylate salt optionally wherein:

the alkyl group has three or more carbon atoms; or the organic material is a hydrocarbon.

44. (Previously Presented) The method according to claim 39, wherein the organic material has a phase transition at a temperature within the range 200 to 450 K, optionally wherein the phase transition of the organic material is a first-order phase transition.

45. (**Currently Amended**) The method according to claim 39, wherein **at least one of the following is present:**

the organic material has an entropy change at a phase transition, $|\Delta S_0|$, of at least 10 J K^{-1} kg^{-}; [[or]]

a phase transition in the organic material displays a latent heat, $|Q_0|$, that is at least 1 kJ kg^{-1}; [[or]]**and**

the organic material has a volume change at the phase transition of at least 1.0 mm^3 g^{-1}; or the organic material is provided within a pressure-transmitting medium.

46. (Previously Presented) The method according to claim 39, wherein hydrostatic pressure is applied to the organic material at a temperature that is within 50 K, of a phase transition temperature of the organic material, where the phase transition temperature is the temperature for the phase transition in the absence of the hydrostatic pressure optionally wherein:

the applied hydrostatic pressure is at most 1.0 GPa; or

the applied hydrostatic pressure is at least 0.1 MPa.

47. (Previously Presented) A cooling or heating apparatus comprising an organic material as a barocaloric cooling or heating agent and a means for transferring heat to and from the organic material, wherein the means for transferring heat to and from the organic material is suitable to transfer heat for a barocaloric transition with a latent heat, $|Q_0|$, that is at least 25 kJ kg^{-1}.

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48. (**Currently Amended**) The apparatus according to claim 47, wherein the organic material is an organic compound or a salt thereof optionally wherein **at least one of the following is present**:

the organic material has a molecular weight of at most 2,000;

the organic material has a molecular weight of at least 50;

the organic material is an organic compound or a salt thereof, and the organic compound has two or more carbon-carbon bonds;

the organic material is an organic compound or a salt thereof, and the organic compound has two or more carbon-hydrogen bonds; [[or]]**and**

the organic material is a liquid crystal or a plastic crystal.

49. (Previously Presented) The apparatus according to claim 47, wherein the organic material is a plastic crystal optionally wherein:

the plastic crystal comprises a cycloalkyl group, and the cycloalkyl group is an adamantantyl group optionally substituted with one or more groups selected from the group consisting of alkyl, halo, hydroxyl and oxo; or

the plastic crystal comprises an alkyl group, and the alkyl group is a C_{4-20} alkyl group, optionally substituted with one or more groups selected from the group consisting of hydroxyl, amino and nitro.

50. (Previously Presented) The apparatus according to claim 47, wherein the organic material is a liquid crystal optionally wherein the liquid crystal comprises one or more groups selected from alkyl, cycloalkyl and aryl.

51. (Previously Presented) The apparatus according to claim 47, wherein the organic material is an alkyl carboxylic acid or an alkyl carboxylate salt optionally wherein the alkyl group has three or more carbon atoms; or
the organic material is a hydrocarbon.

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52. (**Currently Amended**) The apparatus according to claim 47, wherein the organic material has a phase transition at a temperature within the range 200 to 450 K optionally wherein the phase **transition** of the organic material is a first-order phase transition.

53. (**Currently Amended**) The apparatus according to claim 47, wherein at least one of **the following is present**:

the organic material has an entropy change at a phase transition, $|\Delta S_0|$, of at least 10 J K^{-1} kg^{-1};

a phase transition in the organic material displays a latent heat, $|Q_0|$, that is at least 1 kJ kg^{-1}; [[or]]

the organic material has a volume change at the phase transition of at least 1.0 mm^3 g^{-1}; and

the organic material is provided within a pressure-transmitting medium.

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REMARKS

In view of the remarks put forth below, the Examiner is requested to withdraw the rejections and allow Claims 31-53, the only claims currently under examination in this application.

FORMAL MATTERS

Claims 31-53 are pending and under examination after entry of the amendments set forth herein.

Certain claims are amended for clarity and/or typographical reasons, and to recite particular options.

No new matter is added.

REJECTIONS UNDER 35 U.S.C. §112(b)

Claims 31-38

Claims 31-38 have been rejected under 35 U.S.C. §112(b) because the claims allegedly omit essential steps and are otherwise allegedly indefinite. Solely in order to move this application, amendments have been which obvious this rejection. As such, this rejection may be withdrawn.

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CONCLUSION

Applicant submits that all of the claims are in condition for allowance, which action is requested. If the Examiner finds that a telephone conference would expedite the prosecution of this application, please telephone the undersigned at the number provided.

The Commissioner is hereby authorized to charge any underpayment of fees up to a strict limit of $500.00 beyond that authorized on the credit card, but not more than $500.00 in additional fees due with any communication for the above referenced patent application, including but not limited to any necessary fees for extensions of time, or credit any overpayment of any amount to Deposit Account No. 50-0815, order number MEWE-072.

Respectfully submitted,
BOZICEVIC, FIELD & FRANCIS LLP

Date: July 14, 2021

By: /Bret E. Field, Reg. No. 37,620/
Bret E. Field
Registration No. 37,620

BOZICEVIC, FIELD & FRANCIS LLP
201 Redwood Shores Parkway, Suite 200
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Facsimile: (650) 327-3231

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Electronic Acknowledgement Receipt

EFS ID:	43247431
Application Number:	16341618
International Application Number:	
Confirmation Number:	1000
Title of Invention:	Use of Barocaloric Materials and Barocaloric Devices
First Named Inventor/Applicant Name:	Javier Eduardo Moya Raposo
Customer Number:	93726
Filer:	Bret E. Field/Eri Baker
Filer Authorized By:	Bret E. Field
Attorney Docket Number:	MEWE-072
Receipt Date:	14-JUL-2021
Filing Date:	12-APR-2019
Time Stamp:	14:20:07
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		MEWE-072_Rsp_to_ex_parte_quayle_dated_6-9-21.pdf	54209 fc41b64f6570e8fbb879a45202176fed3f791b72	yes	9

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Response after Ex Parte Quayle Action	1	1
	Claims	2	7
	Applicant Arguments/Remarks Made in an Amendment	8	9
Warnings:			
Information:			
	Total Files Size (in bytes):	54209	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/341,618	04/12/2019	Javier Eduardo Moya Raposo	MEWE-072	1000

93726 7590 06/09/2021

EPA - BOZICEVIC FIELD & FRANCIS LLP
BOZICEVIC, FIELD & FRANCIS
201 REDWOOD SHORES PARKWAY
SUITE 200
REDWOOD CITY, CA 94065

EXAMINER
DUKE, EMMANUEL E

ART UNIT	PAPER NUMBER
3763	

NOTIFICATION DATE	DELIVERY MODE
06/09/2021	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

docket@bozpat.com

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Office Action Summary	Application No. 16/341,618	Applicant(s) Moya Raposo et al.	
	Examiner EMMANUEL E DUKE	Art Unit 3763	AIA (FITF) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 2 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☑ Responsive to communication(s) filed on 05/26/2021.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL.** 2b) ☐ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☑ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☑ Claim(s) 31-53 is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6) ☑ Claim(s) 39-53 is/are allowed.

7) ☑ Claim(s) 31-38 is/are rejected.

8) ☐ Claim(s) _____ is/are objected to.

9) ☐ Claim(s) _____ are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☑ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☑ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☑ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☑ Notice of References Cited (PTO-892)

2) ☐ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date _____.

4) ☐ Other: _____.

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DETAILED ACTION

Notice of Pre-AIA or AIA Status

The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Allowable Subject Matter

1. As allowable subject matter has been indicated, applicant's reply must either comply with all formal requirements or specifically traverse each requirement not complied with. See 37 CFR 1.111(b) and MPEP § 707.07(a).

Claim Rejections - 35 USC § 112

2. **The following is a quotation of 35 U.S.C. 112(b):**

> (b) CONCLUSION.—The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the inventor or a joint inventor regards as the invention.

The following is a quotation of 35 U.S.C. 112 (pre-AIA), second paragraph:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 31-38 are rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as being incomplete for omitting essential steps, such omission amounting to a gap between the steps. See MPEP § 2172.01. The omitted steps are: (i) applying hydrostatic pressure to an organic material; (ii) permitting heat flow from or to the organic material (iii) releasing hydrostatic pressure from an organic material that is under applied pressure; and (iv) permitting heat flow to or from the organic material.

Claims 31-38 are rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor, or for pre-AIA the applicant regards as the invention. Attempts to claim a process/or method without setting forth any steps involved in the process generally raises an issue of indefiniteness under 35 U.S.C. 112(b) or pre-AIA 35 U.S.C. 112, second paragraph. For example, a claim which read: "[a] process for using monoclonal antibodies of claim 4 to isolate and purify human fibroblast interferon" was held to be indefinite because it merely recites a use without any active, positive steps delimiting how this use is actually practiced. *Ex parte Erlich*, 3 USPQ2d 1011 (Bd. Pat. App. & Inter. 1986). Although a claim should be interpreted in light of the specification disclosure, it is generally considered improper to read limitations contained in the specification into the claims. See *In re Prater*, 415 F.2d 1393, 162 USPQ 541 (CCPA 1969) and *In re Winkhaus*, 527 F.2d 637, 188 USPQ 129 (CCPA 1975), which discuss the premise that one cannot rely on the specification to impart limitations to the claim that are not recited in the claim.

Prosecution on the merits is closed in accordance with the practice under Ex parte Quayle, 25 USPQ 74, 453 O.G. 213, (Comm'r Pat. 1935).

A shortened statutory period for reply to this action is set to expire **TWO MONTHS** from the mailing date of this letter.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to EMMANUEL E DUKE whose telephone number is (571)270-5290. The examiner can normally be reached on Monday thru Friday; 6:00 AM to 2:00 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, FRANTZ JULES can be reached on (571)272-6681. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/EMMANUEL E DUKE/

Primary Examiner, Art Unit 3763

06/05/2021

Notice of References Cited	Application/Control No. 16/341,618	Applicant(s)/Patent Under Reexamination Moya Raposo et al.	
	Examiner EMMANUEL E DUKE	Art Unit 3763	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-20160017462-A1	01-2016	Samanta; Tapas	C22C30/00	420/581
	B					
	C					
	D					
	E					
	F					
	G					
	H					
	I					
	J					
	K					
	L					
	M					

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	Xie et al., Demonstration of liquid crystal for barocaloric cooling application, 09/26/2016 (Year: 2016)
	V	Vijayakumar et al., Pressure induced phase transitions and equation of state adamantane, 01/11/2001, Institute of Physics Publishing, Journal of Physics: Condensed Matter (Year: 2001)
	W	Hassine et al., Phase Transition in Hydrogen-Bonded 1-Adamantane-methanol, 06/29/2015, ACS Publication, Crystal Growth & Design (Year: 2015)
	X	De Oliveria N, Barocaloric effect and the pressure induced solid state refrigerator, 03/11/2011, Journal of Applied Physics 109, 053515 (Year: 2011)

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/341,618	Moya Raposo et al.
	Examiner	Art Unit
	EMMANUEL E DUKE	3763

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	01/21/2021								
	1	-								
	2	-								
	3	-								
	4	-								
	5	-								
	6	-								
	7	-								
	8	-								
	9	-								
	10	-								
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	36	✓								
	37	✓								
	38	✓								
	39	=								
	40	=								
	41	=								
	42	=								

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Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/341,618	Moya Raposo et al.
	Examiner	**Art Unit**
	EMMANUEL E DUKE	3763

CLAIM		DATE								
Final	Original	01/21/2021								
	43	=								
	44	=								
	45	=								
	46	=								
	47	=								
	48	=								
	49	=								
	50	=								
	51	=								
	52	=								
	53	=								

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Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/341,618	Moya Raposo et al.
	Examiner	Art Unit
	EMMANUEL E DUKE	3763

CPC - Searched*		
Symbol	Date	Examiner
C09K5/06,14,02	01/20/2021	ED
F25B23/00	01/20/2021	ED
C04B35/645	01/20/2021	ED

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
Inventors search conducted on EAST and PALM	01/20/2021	ED
Text search conducted on EAST and IP.COM	01/20/2021, 01/21/2021	ED
Text modified search conducted (see EAST search history)	01/20/2021	ED
Reviewed and considered PCT/EP2017/076203 written opinion	01/20/2021	ED
Updated search conducted (see EAST search history)	06/01/2021, 06/02/2021	ED

/EMMANUEL E DUKE/ Primary Examiner, Art Unit 3763	

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Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/341,618	Moya Raposo et al.
	Examiner	Art Unit
	EMMANUEL E DUKE	3763

Interference Search			
US Class/CPC Symbol	**US Subclass/CPC Group**	**Date**	**Examiner**
EAST	Conducted text search on EAST for Interference	06/02/2021, 06/02/2021	ED
165/C09K	104.170/5/06	06/01/2021	ED

/EMMANUEL E DUKE/ Primary Examiner, Art Unit 3763	

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EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	1	((("Moya") near3 ("Raposo") near3 ("Javier") near3 ("Eduardo"))).INV.	US-PGPUB; USPAT; USOCR	OR	OFF	2021/01/20 07:13
S2	1	((("Avramenko") near3 ("Alexander"))).INV.	US-PGPUB; USPAT; USOCR	OR	OFF	2021/01/20 07:14
S3	0	((("Manosa") near3 ("Carrera") near3 ("LluÃs"))).INV.	US-PGPUB; USPAT; USOCR	OR	OFF	2021/01/20 07:14
S4	0	((("Tamarit") near3 ("Mur") near3 ("Josep") near3 ("LluÃs"))).INV.	US-PGPUB; USPAT; USOCR	OR	OFF	2021/01/20 07:15
S5	0	((("Lloveras") near3 ("MuntanÃ©") near3 ("Pol") near3 ("Marcel"))).INV.	US-PGPUB; USPAT; USOCR	OR	OFF	2021/01/20 07:15
S6	25,693	(C09K5/06 or C09K5/14 or C09K5/02 or F25B23/00 or C04B35/645).cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2021/01/20 07:42
S7	1,233	C09K5/06.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2021/01/20 07:43
S8	7,559	C09K5/14.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	OFF	2021/01/20 07:44

			DERWENT ; IBM_TDB			
S9	368	C09K5/02.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT ; IBM_TDB	OR	OFF	2021/01/20 07:45
S10	887	F25B23/00.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT ; IBM_TDB	OR	OFF	2021/01/20 07:45
S11	15,869	C04B35/645.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT ; IBM_TDB	OR	OFF	2021/01/20 07:46
S12	6	ORGANIC MATERIAL BAROCALORIC COOL$3 HEAT$3 AGENT	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT ; IBM_TDB	AND	OFF	2021/01/20 07:48
S13	6	S6 ORGANIC MATERIAL BAROCALORIC COOL$3 HEAT$3 AGENT	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT ; IBM_TDB	AND	OFF	2021/01/20 07:49
S14	13	S6 BAROCALORIC COOL$3 HEAT$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT ; IBM_TDB	AND	OFF	2021/01/20 07:49

S15	3	ORGANIC MATERIAL BAROCALORIC COOL$3 HEAT$3 ((LIQUID OR PLASTIC) NEAR2 CRYSTAL) PRESSURE (PHASE NEAR2 TRANSITION)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/20 09:46
S16	2,054,195	((LIQUID OR PLASTIC) NEAR2 CRYSTAL)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/20 11:01
S17	6	BAROCALORIC COOL$3 HEAT$3 ((LIQUID OR PLASTIC) NEAR2 CRYSTAL)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/20 11:05
S18	88,935	(ORGANIC NEAR2 MATERIAL) ((LIQUID OR PLASTIC) NEAR2 CRYSTAL)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/20 11:06
S19	19,714	COOL$3 HEAT$3 (ORGANIC NEAR2 MATERIAL) ((LIQUID OR PLASTIC) NEAR2 CRYSTAL)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/20 11:07
S20	6	COOL$3 HEAT$3 (ORGANIC NEAR2 MATERIAL) ((LIQUID OR PLASTIC) NEAR2 CRYSTAL) BAROCALORIC	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/20 11:07
S21	2,218	COOL$3 HEAT$3 (ORGANIC NEAR2 MATERIAL) ((LIQUID OR PLASTIC)	US-PGPUB;	AND	OFF	2021/01/20 11:09

		NEAR2 CRYSTAL) HYDROXYL AMINO NITRO	USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S22	131	COOL$3 HEAT$3 (ORGANIC NEAR2 MATERIAL) ((LIQUID OR PLASTIC) NEAR2 CRYSTAL) HYDROXYL AMINO NITRO ALKYL HALO HYDROXYL OXO	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/20 11:11
S23	8	BAROCALORIC (ORGANIC NEAR2 MATERIAL) COOL$3 HEAT$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/20 11:54
S24	10	BAROCALORIC (ORGANIC NEAR2 MATERIAL)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/20 11:54
S25	121,593	(ORGANIC NEAR2 MATERIAL) COOL$3 HEAT$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/20 11:55
S26	19,714	(ORGANIC NEAR2 MATERIAL) COOL$3 HEAT$3 ((LIQUID OR PLASTIC) NEAR2 CRYSTAL)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/20 11:56
S27	138	(ORGANIC NEAR2 MATERIAL) COOL$3 HEAT$3 ((LIQUID AND PLASTIC) NEAR2 CRYSTAL)	US-PGPUB; USPAT; USOCR;	AND	OFF	2021/01/20 11:56

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
S28	5,809	(ORGANIC NEAR2 MATERIAL) ((COOL$3 OR HEAT$3) NEAR2 AGENT)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/21 05:49
S29	3,441	(ORGANIC NEAR2 MATERIAL) ((COOL$3 OR HEAT$3) NEAR2 AGENT) ((ORGANIC NEAR2 COMPOUND) OR SALT)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/21 05:50
S30	1,054	(ORGANIC NEAR2 MATERIAL) ((COOL$3 OR HEAT$3) NEAR2 AGENT) ((ORGANIC NEAR2 COMPOUND) OR SALT) CARBON HYDROGEN BONDS	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/21 05:52
S31	326	(ORGANIC NEAR2 MATERIAL) ((COOL$3 OR HEAT$3) NEAR2 AGENT) ((ORGANIC NEAR2 COMPOUND) OR SALT) CARBON HYDROGEN BONDS ((LIQUID OR PLACTIC) NEAR2 CRYSTAL)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/21 05:52
S32	2	(ORGANIC NEAR2 MATERIAL) ((COOL$3 OR HEAT$3) NEAR2 AGENT) ((ORGANIC NEAR2 COMPOUND) OR SALT) CARBON HYDROGEN BONDS ((LIQUID OR PLACTIC) NEAR2 CRYSTAL) (ALKYL OR CYCLOALKYL) ADAMANTANTYL	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/21 05:55
S33	197	(ORGANIC NEAR2 MATERIAL) ((COOL$3 OR HEAT$3) NEAR2 AGENT) ((ORGANIC NEAR2 COMPOUND) OR SALT) CARBON HYDROGEN BONDS ((LIQUID OR PLACTIC) NEAR2 CRYSTAL) (ALKYL OR CYCLOALKYL)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	AND	OFF	2021/01/21 05:55

			DERWENT; IBM_TDB			
S34	2	(ORGANIC NEAR2 MATERIAL) ((COOL$3 OR HEAT$3) NEAR2 AGENT) ((ORGANIC NEAR2 COMPOUND) OR SALT) CARBON HYDROGEN BONDS ((LIQUID OR PLACTIC) NEAR2 CRYSTAL) (ALKYL OR CYCLOALKYL) HYDROSTATIC PRESSURE	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/21 05:56
S35	197	(ORGANIC NEAR2 MATERIAL) ((COOL$3 OR HEAT$3) NEAR2 AGENT) ((ORGANIC NEAR2 COMPOUND) OR SALT) CARBON HYDROGEN BONDS ((LIQUID OR PLACTIC) NEAR2 CRYSTAL) (ALKYL OR CYCLOALKYL) TEMPERATURE	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/21 05:57
S36	14	(ORGANIC NEAR2 MATERIAL) ((COOL$3 OR HEAT$3) NEAR2 AGENT) ((ORGANIC NEAR2 COMPOUND) OR SALT) CARBON HYDROGEN BONDS ((LIQUID OR PLACTIC) NEAR2 CRYSTAL) (ALKYL OR CYCLOALKYL) TEMPERATURE (PHASE NEAR2 TRANSITION)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/21 05:58
S37	2	(BAROCALORIC NEAR2 (COOL$3 AND HEAT$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	NEAR	OFF	2021/01/21 06:31
S38	3	(BAROCALORIC NEAR12 (COOL$3 AND HEAT$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	NEAR	OFF	2021/01/21 06:32
S39	3	(BAROCALORIC NEAR20 (COOL$3 AND HEAT$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	NEAR	OFF	2021/01/21 06:34

S40	1,993	((ORGANIC NEAR2 MATERIAL) NEAR20 (COOL$3 AND HEAT$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	NEAR	OFF	2021/01/21 06:34
S41	10	((ORGANIC NEAR2 MATERIAL) NEAR20 (COOL$3 AND HEAT$3)) HYDROSTATIC PRESSURE	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/21 06:43
S43	55,447	(ORGANIC NEAR2 MATERIAL) (COOL$3 OR HEAT$3) ((LIQUID OR PLACTIC) NEAR2 CRYSTAL)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/21 09:03
S44	6,594	((ORGANIC NEAR2 MATERIAL) near12 (COOL$3 OR HEAT$3)) ((LIQUID OR PLACTIC) NEAR2 CRYSTAL)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/21 09:04
S45	2,761	((ORGANIC NEAR2 MATERIAL) near12 (COOL$3 OR HEAT$3)) ((LIQUID OR PLACTIC) NEAR2 CRYSTAL) (cycloalkyi or alkyl)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/21 09:06
S46	2	((ORGANIC NEAR2 MATERIAL) near12 (COOL$3 OR HEAT$3)) ((LIQUID OR PLACTIC) NEAR2 CRYSTAL) (cycloalkyi or alkyl) adamantantyl	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/21 09:08
S47	13	((ORGANIC NEAR2 MATERIAL) near12 (COOL$3 OR HEAT$3)) ((LIQUID OR	US-PGPUB;	AND	OFF	2021/01/21 09:08

		PLACTIC) NEAR2 CRYSTAL) (cycloalkyi or alkyl) alkyl halo hydroxyl oxo	USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S48	10	((ORGANIC NEAR2 MATERIAL) near12 (COOL$3 OR HEAT$3)) ((LIQUID OR PLACTIC) NEAR2 CRYSTAL) (cycloalkyi or alkyl) alkyl halo hydroxyl oxo cycloalkyl aryl	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/21 09:10
S49	2	(ORGANIC NEAR2 MATERIAL) (BAROCALORIC NEAR2 (COOL$3 OR HEAT$3)) ((LIQUID OR PLACTIC) NEAR2 CRYSTAL) (cycloalkyi or alkyl) alkyl halo hydroxyl oxo cycloalkyl aryl	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/21 11:00
S54	26	plastic crystal alkyl cycoalkyl	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 14:52
S57	3	plastic crystal alkyl cycoalkyl halo hydroxyl oxo	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 14:53
S59	2	(plastic near2 crystal) adamantantyl	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 14:55
S60	47	adamantantyl	US-PGPUB; USPAT; USOCR;	AND	OFF	2021/01/22 14:56

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
S61	2	COOL$3 HEAT$3 (ORGANIC NEAR2 MATERIAL) ((LIQUID and PLASTIC) NEAR2 CRYSTAL) HYDROXYL AMINO NITRO ALKYL HALO HYDROXYL OXO	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:04
S62	2	(ORGANIC NEAR2 MATERIAL) ((LIQUID and PLASTIC) NEAR2 CRYSTAL) HYDROXYL AMINO NITRO ALKYL HALO HYDROXYL OXO	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:05
S63	2	((LIQUID and PLASTIC) NEAR2 CRYSTAL) HYDROXYL AMINO NITRO ALKYL HALO HYDROXYL OXO	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:05
S64	405	(ORGANIC NEAR2 MATERIAL) ((LIQUID and PLASTIC) NEAR2 CRYSTAL)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:05
S65	60	(ORGANIC NEAR2 MATERIAL) ((LIQUID and PLASTIC) NEAR2 CRYSTAL) HYDROXYL	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:06
S66	54	(ORGANIC NEAR2 MATERIAL) ((LIQUID and PLASTIC) NEAR2 CRYSTAL) AMINO	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	AND	OFF	2021/01/22 15:07

			DERWENT ; IBM_TDB			
S67	30	(ORGANIC NEAR2 MATERIAL) ((LIQUID and PLASTIC) NEAR2 CRYSTAL) NITRO	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT ; IBM_TDB	AND	OFF	2021/01/22 15:07
S68	101	(ORGANIC NEAR2 MATERIAL) ((LIQUID and PLASTIC) NEAR2 CRYSTAL) ALKYL	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT ; IBM_TDB	AND	OFF	2021/01/22 15:07
S69	32	(ORGANIC NEAR2 MATERIAL) ((LIQUID and PLASTIC) NEAR2 CRYSTAL) HALO	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT ; IBM_TDB	AND	OFF	2021/01/22 15:08
S70	60	(ORGANIC NEAR2 MATERIAL) ((LIQUID and PLASTIC) NEAR2 CRYSTAL) HYDROXYL	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT ; IBM_TDB	AND	OFF	2021/01/22 15:08
S71	6	(ORGANIC NEAR2 MATERIAL) ((LIQUID and PLASTIC) NEAR2 CRYSTAL) cycloalkyl	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT ; IBM_TDB	AND	OFF	2021/01/22 15:09
S72	224	poly(methyl methacrylate) ((LIQUID and PLASTIC) NEAR2 CRYSTAL)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT ; IBM_TDB	AND	OFF	2021/01/22 15:14

S73	28	poly(methyl methacrylate) ((LIQUID and PLASTIC) NEAR2 CRYSTAL) hydroxyl amino nitro	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:15
S75	31	poly(methyl methacrylate) (PLASTIC NEAR2 CRYSTAL) CYCLOALKYL	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:26
S76	1	poly(methyl methacrylate) (PLASTIC NEAR2 CRYSTAL) CYCLOALKYL ALKYL HALO HYDROXYL OXO	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:27
S77	31	poly(methyl methacrylate) (PLASTIC NEAR2 CRYSTAL) CYCLOALKYL	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:28
S78	31	poly(methyl methacrylate) (PLASTIC NEAR2 CRYSTAL) CYCLOALKYL ALKYL	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:28
S79	6	poly(methyl methacrylate) (PLASTIC NEAR2 CRYSTAL) CYCLOALKYL ALKYL HALO	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:28

S80	17	poly(methyl methacrylate) (PLASTIC NEAR2 CRYSTAL) CYCLOALKYL ALKYL HYDROXYL	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:28
S81	7	poly(methyl methacrylate) (PLASTIC NEAR2 CRYSTAL) CYCLOALKYL ALKYL OXO	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:28
S82	604	(PLASTIC NEAR2 CRYSTAL) (ALKYL OR CYCLOALKYL)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:43
S83	391	(PLASTIC NEAR2 CRYSTAL) (ALKYL NEAR2 GROUP)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:44
S84	256	(PLASTIC NEAR2 CRYSTAL) (ALKYL NEAR2 GROUP) CARBON BOND$1	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:45
S85	171	(PLASTIC NEAR2 CRYSTAL) (ALKYL NEAR2 GROUP) CARBON BOND$1 HYDROXYL	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:46

S86	47	(ORGANIC NEAR2 MATERIAL) (PLASTIC NEAR2 CRYSTAL) (ALKYL NEAR2 GROUP) CARBON BOND$1 HYDROXYL	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 16:00
S87	6	((organic material) NEAR10 ((alkyl NEAR2(carboxylic NEAR2 acid)) OR (alkyl (carboxylate salt))))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	NEAR	OFF	2021/01/22 16:37
S90	7	((organic near2 material) near2 (plastic near2 crystal))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	NEAR	OFF	2021/01/23 12:19
S91	211	(organic near2 (plastic near2 crystal))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	NEAR	OFF	2021/01/23 12:22
S92	2	(ORGANIC NEAR2 MATERIAL) (BAROCALORIC NEAR2 ((COOL$3 OR NEAT$3) NEAR2 AGENT))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/01 14:39
S93	2	(BAROCALORIC NEAR2 ((COOL$3 OR NEAT$3) NEAR2 AGENT))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	NEAR	OFF	2021/06/01 14:53
S94	10	(BAROCALORIC NEAR2 (COOL$3 OR NEAT$3))	US-PGPUB;	NEAR	OFF	2021/06/01 14:54

			USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S95	3	(ORGANIC NEAR2 MATERIAL) (BAROCALORIC NEAR2 (MATERIAL OR DEVICE)) (COOL$3 OR NEAT$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/01 15:00
S96	6	(BAROCALORIC NEAR2 (MATERIAL OR DEVICE)) (COOL$3 OR NEAT$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/01 15:01
S97	26,775	(C09K5/06 or C09K5/14 or C09K5/02 or F25B23/00 or C04B35/645).cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2021/06/01 15:03
S98	6	S97 S94	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/01 15:03
S107	0	NEOPENTYL ALCOHOL TRIS(HYDROXYMETHYL)AMINOMETHANE BAROCALORIC AGENT COOLING HEATING HYROSTATIC PRESSURE	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/01 15:28
S108	0	NEOPENTYL ALCOHOL TRIS (HYDROXYMETHYL) AMINOMETHANE BAROCALORIC COOLING HEATING HYROSTATIC PRESSURE	US-PGPUB; USPAT; USOCR;	AND	OFF	2021/06/01 15:28

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
S109	1	NEOPENTYL ALCOHOL TRIS (HYDROXYMETHYL) AMINOMETHANE BAROCALORIC COOLING HEATING	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/01 15:28
S110	1	NEOPENTYL ALCOHOL (HYDROXYMETHYL) BAROCALORIC COOLING HEATING	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/01 15:29
S111	1	NEOPENTYL ALCOHOL TRIS(HYDROXYMETHYL)AMINOMETHANE BAROCALORIC	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/01 15:29
S112	0	BAROCALORIC COOLING HEATING HYROSTATIC PRESSURE	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/01 15:30
S113	19	BAROCALORIC COOLING HEATING	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/01 15:31
S115	7,381	(PLASTIC NEAR2 CRYSTAL)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	AND	OFF	2021/06/01 17:30

			DERWENT; IBM_TDB			
S116	47	(PLASTIC NEAR2 CRYSTAL) HYDROSTATIC PRESSURE	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/01 17:30
S117	2	(PLASTIC NEAR2 CRYSTAL) HYDROSTATIC PRESSURE CYCLOALKYL	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/01 17:32
S118	2	(PLASTIC NEAR2 CRYSTAL) HYDROSTATIC PRESSURE ADAMANTANTYL	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/01 17:32
S119	2	(PLASTIC NEAR2 CRYSTAL) HYDROSTATIC PRESSURE ALKYL	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/01 17:32
S120	2	(PLASTIC NEAR2 CRYSTAL) HYDROSTATIC PRESSURE HYDROXYL	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/01 17:33
S121	2	(PLASTIC NEAR2 CRYSTAL) HYDROSTATIC PRESSURE AMINO	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/01 17:33

S122	2	(PLASTIC NEAR2 CRYSTAL) HYDROSTATIC PRESSURE NITRO	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/01 17:33
S123	2	(PLASTIC NEAR2 CRYSTAL) HYDROSTATIC PRESSURE CARBOXYLIC	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/01 17:34
S124	2	(PLASTIC NEAR2 CRYSTAL) HYDROSTATIC PRESSURE CARBOXYLATE	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/01 17:34
S125	11	(PLASTIC NEAR2 CRYSTAL) HYDROSTATIC PRESSURE PHASE TRANSITION	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/01 17:34
S126	2	(PLASTIC NEAR2 CRYSTAL) CYCLOALKYL ADAMANTANTYL ALKYL HYDROXYL AMINO NITRO CARBOXYLIC CARBOXYLATE PHASE TRANSITION HYDROSTATIC PRESSURE	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/01 17:35
S128	44	ADAMANTANTYL (ALKYL OR HALO OR HYDROXYL OR OXO)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/02 06:13

S129	12	ADAMANTANTYL (ALKYL OR HALO OR HYDROXYL OR OXO) (COOLING OR HEATING)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/02 06:14
S130	26	barocaloric (cooling or heating)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/02 06:21
S131	352,930	(ORGANIC NEAR2 (MATERIAL OR COMPOUND)) (cooling or heating)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/02 06:33
S132	402,976	(ORGANIC NEAR2 (MATERIAL OR (COMPOUND OR SALT))) (cooling or heating)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/02 06:34
S133	9	(ORGANIC NEAR2 (MATERIAL OR (COMPOUND OR SALT))) (cooling or heating) BAROCALORIC	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/02 06:35
S134	437	(ORGANIC NEAR2 (MATERIAL OR (COMPOUND OR SALT))) (cooling or heating) (PLASTIC NEAR2 CRYSTAL)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/02 06:56
S135	2	(ORGANIC NEAR2 (MATERIAL OR (COMPOUND OR SALT))) (cooling or	US-PGPUB;	AND	OFF	2021/06/02 06:56

		heating) (PLASTIC NEAR2 CRYSTAL) ADAMANTANTYL	USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S136	236	(ORGANIC NEAR2 (MATERIAL OR (COMPOUND OR SALT))) (cooling or heating) (PLASTIC NEAR2 CRYSTAL) (ALKYL OR HALO OR HYDROXYL OR OXO)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/02 06:58
S137	32,245	(ORGANIC NEAR2 (MATERIAL OR (COMPOUND OR SALT))) (cooling or heating) ((PLASTIC OR LIQUID) NEAR2 CRYSTAL) (ALKYL OR HALO OR HYDROXYL OR OXO)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/02 06:59
S138	17,983	(ORGANIC NEAR2 (MATERIAL OR (COMPOUND OR SALT))) (cooling or heating) ((PLASTIC OR LIQUID) NEAR2 CRYSTAL) (ALKYL OR HALO OR HYDROXYL OR OXO) HYDROCARBON	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/02 07:05
S139	1,390	(ORGANIC NEAR2 (MATERIAL OR (COMPOUND OR SALT))) (cooling or heating) ((PLASTIC OR LIQUID) NEAR2 CRYSTAL) (ALKYL OR HALO OR HYDROXYL OR OXO) HYDROCARBON (PHASE NEAR2 TRANSITION)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/02 07:06
S141	25	(cooling or heating) ((PLASTIC OR LIQUID) NEAR2 CRYSTAL) (ALKYL OR HALO OR HYDROXYL OR OXO) HYDROCARBON (PHASE NEAR2 TRANSITION) (HYDROSTATIC NEAR2 PRESSURE)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/02 07:21
S143	1	(cooling or heating) ORGANIC (BAROCALORIC NEAR2 TRANSITION)	US-PGPUB; USPAT; USOCR;	AND	OFF	2021/06/02 07:30

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
S145	2	(ORGANIC NEAR2 (MATERIAL OR (COMPOUND OR SALT))) (cooling or heating) ((PLASTIC OR LIQUID) NEAR2 CRYSTAL) (ALKYL OR HALO OR HYDROXYL OR OXO) HYDROCARBON (PHASE NEAR2 TRANSITION) (HYDROSTATIC NEAR2 PRESSURE)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/02 10:56
S146	118,214	(ORGANIC NEAR2 (MATERIAL OR (COMPOUND OR SALT))) ((PLASTIC OR LIQUID) NEAR2 CRYSTAL)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/02 11:03
S147	91,304	(ORGANIC NEAR2 MATERIAL) (LIQUID NEAR2 CRYSTAL)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/02 11:05
S148	6	(ORGANIC NEAR2 MATERIAL) (LIQUID NEAR2 CRYSTAL) Barocaloric	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/02 11:05
S149	56,720	(ORGANIC NEAR2 MATERIAL) (LIQUID NEAR2 CRYSTAL) (Cool$3 or Heat$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/06/02 11:06
S150	411	(ORGANIC NEAR2 MATERIAL) (LIQUID NEAR2 CRYSTAL) (plastic near2 crystal)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	AND	OFF	2021/06/02 11:07

			DERWENT ; IBM_TDB			

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S99	1	(ORGANIC NEAR2 MATERIAL) (BAROCALORIC NEAR2 ((COOL$3 OR NEAT$3) NEAR2 AGENT))	US-PGPUB; USPAT	AND	OFF	2021/06/01 14:42
S100	1	(BAROCALORIC NEAR2 ((COOL$3 OR NEAT$3) NEAR2 AGENT))	US-PGPUB; USPAT	NEAR	OFF	2021/06/01 14:54
S101	4	(BAROCALORIC NEAR2 (COOL$3 OR NEAT$3))	US-PGPUB; USPAT	NEAR	OFF	2021/06/01 14:57
S102	2	(ORGANIC NEAR2 MATERIAL) (BAROCALORIC NEAR2 (MATERIAL OR DEVICE)) (COOL$3 OR NEAT$3)	US-PGPUB; USPAT	AND	OFF	2021/06/01 15:00
S103	3	(BAROCALORIC NEAR2 (MATERIAL OR DEVICE)) (COOL$3 OR NEAT$3)	US-PGPUB; USPAT	AND	OFF	2021/06/01 15:01
S104	231	C09K5/06.cpc.	US-PGPUB; USPAT	OR	OFF	2021/06/01 15:04
S105	13	(ORGANIC NEAR2 MATERIAL) ((COOL$3 OR HEAT$3) NEAR2 AGENT) ((ORGANIC NEAR2 COMPOUND) OR SALT) CARBON HYDROGEN BONDS ((LIQUID OR PLACTIC) NEAR2 CRYSTAL) (ALKYL OR CYCLOALKYL) TEMPERATURE (PHASE NEAR2 TRANSITION)	US-PGPUB; USPAT	AND	OFF	2021/06/01 15:10
S106	1	(ORGANIC NEAR2 MATERIAL) (BAROCALORIC NEAR2 (COOL$3 OR HEAT$3)) ((LIQUID OR PLACTIC) NEAR2 CRYSTAL) (cycloalkyi or alkyl) alkyl halo hydroxyl oxo cycloalkyl aryl	US-PGPUB; USPAT	AND	OFF	2021/06/01 15:12
S114	12	BAROCALORIC COOLING HEATING	US-PGPUB; USPAT	AND	OFF	2021/06/01 15:37
S127	1	(PLASTIC NEAR2 CRYSTAL) CYCLOALKYL ADAMANTANTYL ALKYL HYDROXYL AMINO NITRO CARBOXYLIC CARBOXYLATE PHASE TRANSITION HYDROSTATIC PRESSURE	US-PGPUB; USPAT	AND	OFF	2021/06/01 17:36
S144	1	(ORGANIC NEAR2 (MATERIAL OR (COMPOUND OR SALT))) (cooling or heating) ((PLASTIC OR LIQUID) NEAR2 CRYSTAL) (ALKYL OR HALO OR HYDROXYL OR OXO)	US-PGPUB; USPAT	AND	OFF	2021/06/02 07:07

		HYDROCARBON (PHASE NEAR2 TRANSITION) (HYDROSTATIC NEAR2 PRESSURE)				

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Electronically Filed May 26, 2021

AMENDMENT AND RESPONSE Address to: Mail Stop Amendment Commissioner for Patents P.O. Box 1450 Alexandria, VA 22313-1450	Attorney Docket No.	MEWE-072
	Confirmation No.	1000
	First Named Inventor	Javier Eduardo Moya Raposo
	Application Number	16/341,618
	Filing Date	April 12, 2019
	Group Art Unit	3763
	Examiner Name	Emmanuel E. Duke
	Title: "*Use of Barocaloric Materials and Barocaloric Devices*"	

Commissioner:

This communication is responsive to the Office Action dated January 28, 2021, for which a three-month period for response was given, making this response due by April 28, 2021. In addition, Applicant petitions for a one-month extension of time, making this response due by May 28, 2021. In view of the remarks put forth below, reconsideration and allowance are respectfully requested.

AMENDMENTS TO THE CLAIMS

Claim 1-30. (Cancelled)

31. (**Currently Amended**) **A method comprising employing** ~~The use of~~ an organic material as a barocaloric cooling or heating agent.

32. (**Currently Amended**) The ~~use~~ **method** according to claim 31, wherein the organic material is an organic compound or a salt thereof optionally **wherein at least one of:**

~~wherein~~ the organic material has a molecular weight of at most 2,000**;** ~~, such as at most 1,000; and/or~~

~~wherein~~ the organic material has a molecular weight of at least 50; ~~and/or~~

~~wherein~~ the organic material is an organic compound or a salt thereof, and the organic compound has two or more carbon-carbon bonds; ~~and/or~~

~~wherein~~ the organic material is an organic compound or a salt thereof, and the organic compound has two or more carbon-hydrogen bonds; and~~/or~~

~~wherein~~ the organic material is a liquid crystal or a plastic crystal.

33. (**Currently Amended**) The ~~use~~ **method** according to claim 31, wherein the organic material is a plastic crystal ~~such as a plastic crystal comprising an alkyl group or a cycloalkyl group~~ optionally **wherein:**

~~wherein~~ the plastic crystal comprises a cycloalkyl group, and the cycloalkyl group is an adamantantyl group ~~preferably wherein the adamantantyl group is~~ optionally substituted with one or more groups selected from the group consisting of alkyl, halo, hydroxyl and oxo; or

~~wherein~~ the plastic crystal comprises an alkyl group, and the alkyl group is a $C_{4\text{-}20}$ alkyl group, ~~such as a $C_{4\text{-}5}$ alkyl group preferably wherein the alkyl group is~~ optionally substituted with one or more groups selected from the group consisting of hydroxyl, amino and nitro.

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34. (**Currently Amended**) The ~~use~~ **method** according to claim 31, wherein the organic material is a liquid crystal optionally wherein the liquid crystal comprises one or more groups selected from alkyl, cycloalkyl and aryl~~, such as wherein the liquid crystal has an alkyl group, a cycloalkyl group and an aryl group~~.

35. (**Currently Amended**) The ~~use~~ **method** according to claim 31, wherein the organic material is an alkyl carboxylic acid or an alkyl carboxylate salt optionally wherein the alkyl group has three or more carbon atoms~~, such as 3 or 4 carbon atom preferably~~**; or** ~~wherein~~ the organic material is a hydrocarbon~~, such as an alkane or a cycloalkane~~.

36. (**Currently Amended**) The ~~use~~ **method** according to claim 31, wherein the organic material has a phase transition at a temperature within the range 200 to 450 K, ~~such as 245 to 340 K, such as 245 to 315 K~~ optionally wherein ~~the phase transition of the organic material comprises a first-order phase transition preferably wherein~~ the phase transition of the organic material is a first-order phase transition.

37. (**Currently Amended**) The ~~use~~ **method** according to claim 31, wherein **at least one of:**

the organic material has an entropy change at a phase transition, $|\Delta S_0|$, of at least 10 J K^{-1} kg^{-1}~~, such as at least 50 J K^{-1} kg^{-1}, such as at least 100 J K^{-1} kg^{-1}, such as at least 150 J K^{-1} kg^{-1}, such as at least 250 J K^{-1} kg^{-1}, such as at least 400 J K^{-1} kg^{-1}~~; and~~/or~~

~~wherein~~ a phase transition in the organic material displays a latent heat, $|Q_0|$, that is at least 1 kJ kg^{-1}~~, such as at least 5.0 kJ kg^{-1}, such as at least 10.0 kJ kg^{-1}, such as at least 25 kJ kg^{-1}, such as at least 50 kJ kg^{-1}~~:~~and/or wherein~~**; or** the organic material has a volume change at the phase transition of at least 1.0 mm^3 g^{-1}~~, such as at least 10 mm^3 g^{-1}, such as at least 50 mm^3 g^{-1} and/or wherein~~**; or** the organic material is provided within a pressure-transmitting medium~~, such as a pressure-transmitting fluid or a pressure-transmitting solid~~.

38. (**Currently Amended**) The ~~use~~ **method** according to claim 31, wherein hydrostatic pressure is applied to the organic material at a temperature that is within 50 K~~, such as within 10 K, such as within 5 K, such as within 1 K~~, of a phase transition temperature of the organic material, where the phase transition temperature is the temperature for the phase transition in the absence of the hydrostatic pressure optionally **wherein:**

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~~wherein~~ the applied hydrostatic pressure is at most 1.0 GPa~~, at most 0.5 GPa, at most 0.2 GPa, such as at most 0.1 GPa, such as at most 0.07 GPa preferably~~**; or**
~~wherein~~ the applied hydrostatic pressure is at least 0.1 MPa~~, such as at least 0.5 MPa, such as at least 5.0 MPa~~.

39. (**Currently Amended**) A method of barocaloric cooling or heating, the method comprising the steps of:

(i) applying hydrostatic pressure to an organic material; ~~and~~

(ii) permitting heat flow from or to the organic material[[.]]**;**

(iii) releasing hydrostatic pressure from an organic material that is under applied pressure; and

(iv) permitting heat flow to or from the organic material.

40. (**Currently Amended**) The method according to claim 39, wherein the organic material is an organic compound or a salt thereof optionally **wherein:**

~~wherein~~ the organic material has a molecular weight of at most 2,000**;**~~, such as at most 1,000; and/or~~

~~wherein~~ the organic material has a molecular weight of at least 50; ~~and/or~~

~~wherein~~ the organic material is an organic compound or a salt thereof, and the organic compound has two or more carbon-carbon bonds; ~~and/or~~

~~wherein~~ the organic material is an organic compound or a salt thereof, and the organic compound has two or more carbon-hydrogen bonds; ~~and/~~or

~~wherein~~ the organic material is a liquid crystal or a plastic crystal.

41. (**Currently Amended**) The method according to claim 39, wherein the organic material is a plastic crystal ~~such as a plastic crystal comprising an alkyl group or a cycloalkyl group~~ optionally **wherein:**

~~wherein~~ the plastic crystal comprises a cycloalkyl group, and the cycloalkyl group is an adamantantyl group ~~preferablywherein the adamantantyl group is~~ optionally substituted with one or more groups selected from the group consisting of alkyl, halo, hydroxyl and oxo; or

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~~wherein~~ the plastic crystal comprises an alkyl group, and the alkyl group is a C_{4-20} alkyl group, ~~such as a C_{4-5} alkyl group preferably wherein the alkyl group is~~ optionally substituted with one or more groups selected from the group consisting of hydroxyl, amino and nitro.

42. (**Currently Amended**) The method according to claim 39, wherein the organic material is a liquid crystal optionally wherein the liquid crystal comprises one or more groups selected from alkyl, cycloalkyl and aryl~~, such as wherein the liquid crystal has an alkyl group, a cycloalkyl group and an aryl group~~.

43. (**Currently Amended**) The method according to claim 39, wherein the organic material is an alkyl carboxylic acid or an alkyl carboxylate salt optionally wherein**:**

the alkyl group has three or more carbon atoms**; or**~~, such as 3 or 4 carbon atom preferably wherein~~ the organic material is a hydrocarbon~~, such as an alkane or a cycloalkane~~.

44. (**Currently Amended**) The method according to claim 39, wherein the organic material has a phase transition at a temperature within the range 200 to 450 K~~, such as 245 to 340 K, such as 245 to 315 K~~, optionally wherein ~~the phase transition of the organic material comprises a first-order phase transition, preferably wherein~~ the phase transition of the organic material is a first-order phase transition.

45. (**Currently Amended**) The method according to claim 39, wherein

the organic material has an entropy change at a phase transition, $|\Delta S_0|$, of at least 10 J K^{-1} kg^{-1}~~, such as at least 50 J K^{-1} kg^{-1}, such as at least 100 J K^{-1} kg^{-1}, such as at least 150 J K^{-1} kg^{-1}, such as at least 250 J K^{-1} kg^{-1}, such as at least 400 J K^{-1} kg^{-1}~~; ~~and/~~or

~~wherein~~ a phase transition in the organic material displays a latent heat, $|Q_0|$, that is at least 1 kJ kg^{-1}~~, such as at least 5.0 kJ kg^{-1}, such as at least 10.0 kJ kg^{-1}, such as at least 25 kJ kg^{-1}, such as at least 50 kJ kg^{-1}:and/or wherein~~**; or** the organic material has a volume change at the phase transition of at least 1.0 mm^3 g^{-1}~~, such as at least 10 mm^3 g^{-1}, such as at least 50 mm^3 g^{-1} and/or wherein~~**; or** the organic material is provided within a pressure-transmitting medium~~, such as a pressure-transmitting fluid or a pressure-transmitting solid~~.

46. (**Currently Amended**) The method according to claim 39, wherein hydrostatic pressure is applied to the organic material at a temperature that is within 50 K~~, such as within 10 K, such~~

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~~as within 5 K, such as within 1 K,~~ of a phase transition temperature of the organic material, where the phase transition temperature is the temperature for the phase transition in the absence of the hydrostatic pressure optionally **wherein:**

~~wherein~~ the applied hydrostatic pressure is at most 1.0 GPa~~, at most 0.5 GPa, at most 0.2 GPa, such as at most 0.1 GPa, such as at most 0.07 GPa preferably~~**; or**
~~wherein~~ the applied hydrostatic pressure is at least 0.1 MPa~~, such as at least 0.5 MPa, such as at least 5.0 MPa~~.

47. (**Currently Amended**) A cooling or heating apparatus comprising an organic material as a barocaloric cooling or heating agent **and a means for transferring heat to and from the organic material, wherein the means for transferring heat to and from the organic material is suitable to transfer heat for a barocaloric transition with a latent heat, $|Q_0|$, that is at least 25 kJ kg^{-1}**.

48. (**Currently Amended**) The apparatus according to claim 47, wherein the organic material is an organic compound or a salt thereof optionally **wherein:**

~~wherein~~ the organic material has a molecular weight of at most 2,000**;** ~~, such as at most 1,000; and/or~~

~~wherein~~ the organic material has a molecular weight of at least 50**;** ~~; and/or~~

~~wherein~~ the organic material is an organic compound or a salt thereof, and the organic compound has two or more carbon-carbon bonds; ~~and/or~~

~~wherein~~ the organic material is an organic compound or a salt thereof, and the organic compound has two or more carbon-hydrogen bonds; ~~and/~~or

~~wherein~~ the organic material is a liquid crystal or a plastic crystal.

49. (**Currently Amended**) The apparatus according to claim 47, wherein the organic material is a plastic crystal ~~such as a plastic crystal comprising an alkyl group or a cycloalkyl group~~ optionally **wherein:**

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~~wherein~~ the plastic crystal comprises a cycloalkyl group, and the cycloalkyl group is an adamantantyl group ~~preferably wherein the adamantantyl group is~~ optionally substituted with one or more groups selected from the group consisting of alkyl, halo, hydroxyl and oxo; or

~~wherein~~ the plastic crystal comprises an alkyl group, and the alkyl group is a C_{4-20} alkyl group, ~~such as a C_{4-5} alkyl group preferably wherein the alkyl group is~~ optionally substituted with one or more groups selected from the group consisting of hydroxyl, amino and nitro.

50. (**Currently Amended**) The apparatus according to claim 47, wherein the organic material is a liquid crystal optionally wherein the liquid crystal comprises one or more groups selected from alkyl, cycloalkyl and aryl~~, such as wherein the liquid crystal has an alkyl group, a cycloalkyl group and an aryl group~~.

51. (**Currently Amended**) The apparatus according to claim 47, wherein the organic material is an alkyl carboxylic acid or an alkyl carboxylate salt optionally wherein the alkyl group has three or more carbon atoms~~, such as 3 or 4 carbon atom preferably~~**; or**

~~wherein~~ the organic material is a hydrocarbon~~, such as an alkane or a cycloalkane~~.

52. (**Currently Amended**) The apparatus according to claim 47, wherein the organic material has a phase transition at a temperature within the range 200 to 450 K~~, such as 245 to 340 K, such as 245 to 315 K~~ optionally wherein the phase ~~transition of the organic material comprises a first-order phase transition preferably wherein the phase transition~~ of the organic material is a first-order phase transition.

53. (**Currently Amended**) The apparatus according to claim 47, wherein **at least one of:**

the organic material has an entropy change at a phase transition, $|\Delta S_0|$, of at least 10 J K^{-1} kg^{-1}~~, such as at least 50 J K^{-1} kg^{-1}, such as at least 100 J K^{-1} kg^{-1}, such as at least 150 J K^{-1} kg^{-1}, such as at least 250 J K^{-1} kg^{-1}, such as at least 400 J K^{-1} kg^{-1}~~; ~~and/or~~

~~wherein~~ a phase transition in the organic material displays a latent heat, $|Q_0|$, that is at least 1 kJ kg^{-1}~~, such as at least 5.0 kJ kg^{-1}, such as at least 10.0 kJ kg^{-1}, such as at least 25 kJ kg^{-1}, such as at least 50 kJ kg^{-1}:and/or wherein~~ **; or** the organic material has a volume change at the phase transition of at least 1.0 mm^3 g^{-1}~~, such as at least 10 mm^3 g^{-1}, such as at least 50 mm^3 g^{-1}; and/or~~**; and**

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~~wherein~~ the organic material is provided within a pressure-transmitting medium~~, such as a pressure-transmitting fluid or a pressure-transmitting solid~~.

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REMARKS

In view of the remarks put forth below, the Examiner is requested to withdraw the rejections and allow Claims 31-53, the only claims currently under examination in this application.

FORMAL MATTERS

Claims 31-53 are pending and under examination after entry of the amendments set forth herein.

Support for amendments to Claim 47 is found throughout the specification as filed, for example, at: p. 23, lines 10-14 and p. 17, lines 1-5. Claim 47 is also amended to incorporate subject matter from Claim 53. The remaining claims are amended for clarity, typographical reasons, and to recite particular options.

No new matter is added.

OBJECTIONS TO THE CLAIMS

Claims 31, 37, 39, 45, and 53 have been objected to due to formality reasons.

The Office alleged that Claim 31 lacked antecedent basis for the term “the use”. Claim 31 as amended does not recite “the use” and instead recites “a method”.

The Office alleged that Claims 37, 39, 45, and 53 because they allegedly contain improper punctuation. The claims have been amended for typographical reasons to address punctuation.

Accordingly, Applicant requests that the objections be withdrawn.

REJECTIONS UNDER 35 U.S.C. §101

Claims 31-38 have been rejected under 35 U.S.C. §101 for allegedly being directed to unpatentable subject matter. The Office alleged that “use” type claims do not represent patentable subject matter.

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35 U.S.C. §101 states that "who ever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor".

Claim 31 is amended to recite "A method comprising ….". As such, Applicant submits that the claims are directed to a method that represents patentable subject matter. Applicant requests that the rejection be withdrawn.

REJECTIONS UNDER 35 U.S.C. §112(a)

Claims 31-38

Claims 31-38 have been rejected under 35 U.S.C. §112(a) because the claims allegedly purport to invoke 35 U.S.C. §112(f) but fail to recite a combination of elements required to perform the functions.

Applicant notes that at the time of the rejection Claim 31 recited "The use of an organic material as a barocaloric cooling or heating agent". However, Claim 31 as amended recites "A method comprising employing an organic material as a barocaloric cooling or heating agent". Accordingly, Applicant respectfully submits that Claim 31 as amended comports with 35 U.S.C. §112(a) and requests that the rejection be withdrawn.

Claims 39-46

Claims 39-46 have been rejected under 35 U.S.C. §112(a) for allegedly failing to comply with the enablement requirement. The Office alleged that the application fails to enable the element of "applying hydrostatic pressure" in order to permit heat flow to and from the organic material.

With respect to enablement, courts have held that: "[t]he test of enablement is whether one reasonably skilled in the art could make or use the invention from the disclosures in the patent coupled with information known in the art without undue experimentation." *United States v. Telectronics, Inc.,* 8 USPQ 2d 1217, 1233 (Fed. Cir. 1988), *cert. denied*, 490 U.S. 1046 (1989). See also *Genentech, Inc. v. Novo Nordisk*, 42 USPQ 2d 1001 (Fed. Cir. 1997), *cert.*

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denied, 522 U.S. 963 (1997); *Scripps Clinic and Research Foundation v. Genentech, Inc.*, 18 USPQ 2d 1001 (Fed. Cir. 1991).

Applicant respectfully submits that the application provides enablement for the step of applying hydrostatic pressure in order to permit heat flow to and from an organic material. For example, the specification states that "typically, the organic material is provided with a pressure transmitting medium, such as a pressure transmitting fluid, which is contained within a piston head space (or the piston chamber). The pressure transmitting medium is not essential, and pressure may be applied directly to the organic material, such as a material having a liquid phase, such as liquid crystals" (p. 23, lines 15-20). Thus, the application describes applying pressure through a pressure transmitting medium, such as a **pressure transmitted fluid** within a **piston head space**. An exemplary pressure-transmitting liquid is an alkoxy silane, such as DW-Therm, which is sold by Huber Kaltemaschinenbau GmbH (p. 22, lines 33-35). In some cases, the pressure can be transmitted through a pressure-transmitting solid, such as alumina powder (p. 22, lines 33-35).

The application further states that applying pressure can be performed adiabatically as part of a Brayton cycle, or isothermally as part of an Ericsson cycle (p. 20, lines 24-35). The heating or cooling that is generated can then by delivered to a location by a "radiator or another such heat exchanger" (p. 21, lines 8-20). The heat exchanger can have a heat switch, such as a thermoelectric or electromechanical heat switch, a solid-state thermal diode or a heat pipe (Id.). The amount of hydrostatic pressure can be in some cases at most 1.0 GPa, such as at most 0.5 GPa (p. 21, lines 40-41). The amount of a pressurizing force can in some cases be at least 0.1 MPa, such as at least 0.5 MPa (p. 22, lines 1-5).

Furthermore, in the Examples section of the application, it is described that differential thermal analyzers operating under hydrostatic pressure were used to apply pressure and measure heat transfer, such as through the methods of Manosa et al. (Nat. Mater., 2010, 9., 478) (p. 25, lines 33-40; p. 27, line 17).

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As such, Applicant respectfully submits that the application provides sufficient discussion of the step of applying pressure to the organic material to provide enablement for the present claims. Applicant requests that the rejection be withdrawn.

Claims 47-53

Claims 47-53 have been rejected under 35 U.S.C. §112(a) for allegedly failing to comply with the enablement requirement. The Office alleged that "while being enabling for 'cooling or heating apparatus', does not reasonably provide enablement for the apparatus" (OA, p. 4).

Applicant notes that Claim 47 recites "a cooling or heating apparatus" and therefore, as acknowledged by the Office, the specification provides enablement for the recited "cooling or heating apparatus". In addition, Claims 48-53 recite "the apparatus according to claim 47". As such, even though Claims 48-53 merely recite "the apparatus", it is clear that Claims 48-53 refer to the cooling or heating apparatus of Claim 47, which finds sufficient enablement in the application as filed. In addition, Claim 47 as amended further recites "a means for transferring heat to and from the organic material" wherein the means "is suitable to transfer heat for a barocaloric transition with a latent heat, $|Q_0|$, that is at least 25 kJ kg^{-1}". An ordinarily skilled artisan would recognize that the cooling or heating apparatus recited in the claims, i.e. that includes a barocaloric cooling or heating agent along with the means described above, could be made and used without undue experimentation by an ordinarily skilled artisan in light of the application. As such, the claims comply with the enablement requirement and Applicant requests that the rejection be withdrawn.

REJECTIONS UNDER 35 U.S.C. §112(b)

Claims 31-38 have been rejected under 35 U.S.C. §112(b) for allegedly being indefinite. The Office alleged that the term "the use" rendered the claims indefinite.

Claims 31-38 have been amended to remove the term "the use". As such, Applicant contends that the claims are not indefinite and requests that the rejection be withdrawn.

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Claims 32, 37, 40, 45, 48, and 53 have been rejected under 35 U.S.C. §112(b) for allegedly being indefinite. The Office alleged that the term "and/or" recited in the claims renders the claims indefinite.

Applicant contends that the meaning of the term "and/or" would be sufficiently clear to a skilled artisan in view of the specification. For instance, the specification discusses the term "and/or" by stating that (p. 24, lines 14-17):

> "and/or" where used herein is to be taken as a specific disclosure of each of the two specified features or components with or without the other. For example, "A and/or B" is to be taken as a specific disclosure of each of (i) A, (ii) B and (iii) A and B, just as if each is set out individually herein.

Nevertheless, in the spirit of expediting prosecution, the claims have been amended to remove the term "and/or".

As such, Applicant contends that the claims are not indefinite and requests that the rejections be withdrawn.

REJECTIONS UNDER 35 U.S.C. §102

Claims 31-32, 39-40, and 47-48 have been rejected under 35 U.S.C. §102 for allegedly being anticipated by Lloveras et al. (Nature Communications, 2015, 6:8801, doi:10.1038/ncomms9801; hereinafter Lloveras).

A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference. *Verdegaal Bros. v. Union Oil of California*, 814 F.2d 628, 631 (Fed. Cir. 1987). To anticipate a claim, a prior art reference must disclose every feature of the claimed invention, either explicitly or inherently. *Glaxo v. Novopharm, Ltd.*, 334 U.S.P.Q.2d 1565 (Fed. Cir. 1995).

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The Office alleged that Lloveras teaches using an organic material as a barocaloric cooling or heating agent while citing page 2, column 1, paragraph 2 along with page 3, column 2, and paragraph 2 of Lloveras (OA, p. 11). The Office cited the discussion regarding poly(methyl methacrylate) in Lloveras in making the rejection.

Applicant respectfully disagrees and submits that Lloveras fails to teach using an organic material as a barocaloric cooling or heating agent.

For instance, Lloveras is directed to measuring the barocaloric effect at low pressure in ferrielectric ammonium sulphate (title and abstract). The cited passage on page 3 describes experimental observations regarding ammonium sulfate. However, ammonium sulfate cannot be reasonably interpreted as an organic material, as recited in the claims. The application states that "a barocaloric organic material is a compound, or a salt of that compound, having a carbon atom, and optionally having one or more carbon-carbon bonds and/or one or more carbon-hydrogen bonds" (p. 4, lines 19-21). A skilled artisan would recognize that ammonium sulfate lacks a carbon atom. Thus, the cited passage on page 3 fails to teach using an organic material as a barocaloric cooling or heating agent.

In addition, the cited passage on page 2 of Lloveras discusses poly(methyl methacrylate), which was mentioned by the Office in making the rejection. Lloveras states that "large barocaloric (BC) effects driven by hydrostatic pressure near phase transitions have only been observed in a small number of relatively expensive magnetic materials … large BC effects have also been observed in poly(methyl methacrylate) away from any transition" (p. 2, col. 1, ¶2; emphasis added).

Thus, Lloveras merely describes measuring a particular scientific property of poly(methyl methacrylate), i.e. the barocaloric effect of poly(methyl methacrylate), and does not describe the actual step of employing the compound as a barocaloric cooling or heating agent, as recited in Claims 31 and 47. For instance, the present application states that exemplary cooling applications include "foodstuffs, beverages, medical products and medical samples, electronics, and populated spaces such as offices" (p. 1, lines 24-25). Lloveras fails

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to describe employing the poly(methyl methacrylate) as a barocaloric cooling or heating agent, such as the applications recited in the present application.

In addition, Lloveras fails to describe the particular steps recited in Claim 39 of (i) applying hydrostatic pressure, (ii) permitting heat flow, (iii) releasing hydrostatic pressure, and (iv) permitting heat flow.

Furthermore, Claim 47 is amended to recite that "a means for transferring heat to and from the organic material", and that such a means "is suitable to transfer heat for a barocaloric transition with latent heat, $|Q_0|$, that is at least 25 kJ kg^{-1}". The cited passages in Lloveras fail to describe a means for transferring heat as recited in the claims that can transfer heat for a barocaloric transition with latent heat, $|Q_0|$, that is at least 25 kJ kg^{-1}.

Accordingly, Applicant respectfully contends that the cited art fails to teach all the elements of the claims and requests that the rejection be withdrawn.

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CONCLUSION

Applicant submits that all of the claims are in condition for allowance, which action is requested. If the Examiner finds that a telephone conference would expedite the prosecution of this application, please telephone the undersigned at the number provided.

The Commissioner is hereby authorized to charge any underpayment of fees up to a strict limit of $500.00 beyond that authorized on the credit card, but not more than $500.00 in additional fees due with any communication for the above referenced patent application, including but not limited to any necessary fees for extensions of time, or credit any overpayment of any amount to Deposit Account No. 50-0815, order number MEWE-072.

Respectfully submitted,
BOZICEVIC, FIELD & FRANCIS LLP

Date: May 26, 2021

By: /Michael J. Blessent PhD, Reg. No. 76,489/
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Date: May 26, 2021

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IPR2024-01235

Electronic Patent Application Fee Transmittal

Application Number:	16341618
Filing Date:	12-Apr-2019
Title of Invention:	Use of Barocaloric Materials and Barocaloric Devices
First Named Inventor/Applicant Name:	Javier Eduardo Moya Raposo
Filer:	Bret E. Field/Eri Baker
Attorney Docket Number:	MEWE-072

Filed as Large Entity

Filing Fees for U.S. National Stage under 35 USC 371

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension - 1 month with $0 paid	1251	1	220	220
Miscellaneous:				
			Total in USD ($)	**220**

Electronic Acknowledgement Receipt

EFS ID:	42825622
Application Number:	16341618
International Application Number:	
Confirmation Number:	1000
Title of Invention:	Use of Barocaloric Materials and Barocaloric Devices
First Named Inventor/Applicant Name:	Javier Eduardo Moya Raposo
Customer Number:	93726
Filer:	Bret E. Field/Eri Baker
Filer Authorized By:	Bret E. Field
Attorney Docket Number:	MEWE-072
Receipt Date:	26-MAY-2021
Filing Date:	12-APR-2019
Time Stamp:	16:54:23
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$220
RAM confirmation Number	E20215PG54443899
Deposit Account	
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The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		MEWE-072_Rsp_to_OA_dtd_20 21-1-28.pdf	91763 af05b35b97567c12b62137d7d1485c581b7 e461e	yes	16

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Amendment/Req. Reconsideration-After Non-Final Reject	1	1
	Claims	2	8
	Applicant Arguments/Remarks Made in an Amendment	9	16

Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30675 6fa4a6b0bdffd0fef668c4fbc1ba4d11f04e8 dc3	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	122438		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/341,618	04/12/2019	Javier Eduardo Moya Raposo	MEWE-072	1000

93726 7590 01/28/2021

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EXAMINER
DUKE, EMMANUEL E

ART UNIT	PAPER NUMBER
3763	

NOTIFICATION DATE	DELIVERY MODE
01/28/2021	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

docket@bozpat.com

Office Action Summary	Application No. 16/341,618	Applicant(s) Moya Raposo et al.	
	Examiner EMMANUEL E DUKE	Art Unit 3763	AIA (FITF) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☑ Responsive to communication(s) filed on 04/12/2019.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL.** 2b) ☑ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☑ Claim(s) 31-53 is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6) ☐ Claim(s) _____ is/are allowed.

7) ☑ Claim(s) 31-53 is/are rejected.

8) ☐ Claim(s) _____ is/are objected to.

9) ☐ Claim(s) _____ are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☑ The drawing(s) filed on 04/12/2019 is/are: a)☑ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☑ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☑ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☑ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☑ Notice of References Cited (PTO-892)

2) ☑ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date _____.

4) ☐ Other: _____.

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DETAILED ACTION

Notice of Pre-AIA or AIA Status

The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

In the event the determination of the status of the application as subject to AIA 35 U.S.C. 102 and 103 (or as subject to pre-AIA 35 U.S.C. 102 and 103) is incorrect, any correction of the statutory basis for the rejection will not be considered a new ground of rejection if the prior art relied upon, and the rationale supporting the rejection, would be the same under either status.

Claim Objections

1. Claims 31, 37, 39, 45 and 53 are objected to because of the following informalities:

- In claim 31, line 1; the phrase "The use of an organic material" should be changed to --A use of an organic material-- for proper antecedent basis.
- In claim 37, lines 6-7; the phrase "such as at least 50 kJ kg-1;and/or" should be changed to --such as at least 50 kJ kg-1; and/or-- for proper punctuation.
- In claim 39, line 3; the phrase "the organic material." should be changed to --the organic material,-- for proper punctuation.
- In claim 45, lines 6-7; the phrase "such as at least 50 kJ kg-1;and/or" should be changed to --such as at least 50 kJ kg-1; and/or-- for proper punctuation.
- In claim 53, lines 6-7; the phrase "such as at least 50 kJ kg-1;and/or" should be changed to --such as at least 50 kJ kg-1; and/or-- for proper punctuation.

Appropriate correction is required.

Claim Rejections - 35 USC § 101

2. 35 U.S.C. 101 reads as follows:

> Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.

Claims 31-38 are rejected under 35 U.S.C. 101 because the claimed invention is directed to non-statutory subject matter. The claims do not fall within at least one of the four categories of patent eligible subject matter because "use" claims that do not purport to claim a process, machine, manufacture, or composition of matter fail to comply with 35 U.S.C. 101; In re Moreton, 288 F.2d 708, 709, 129 USPQ 227, 228 (CCPA 1961).

Claim Rejections - 35 USC § 112

3. The following is a quotation of the first paragraph of 35 U.S.C. 112(a):

> (a) IN GENERAL.—The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same, and shall set forth the best mode contemplated by the inventor or joint inventor of carrying out the invention.

The following is a quotation of the first paragraph of pre-AIA 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same, and shall set forth the best mode contemplated by the inventor of carrying out his invention.

Claims 31-38 are rejected under 35 U.S.C. 112(a) or pre-AIA 35 U.S.C. 112, first paragraph, because the claim purports to invoke 35 U.S.C. 112(f) or pre-AIA 35 U.S.C. 112, sixth paragraph, but fails to recite a combination of elements as required by that statutory

provision and thus cannot rely on the specification to provide the structure, material or acts to support the claimed function. As such, the claim recites a function that has no limits and covers every conceivable means for achieving the stated function, while the specification discloses at most only those means known to the inventor. Accordingly, the disclosure is not commensurate with the scope of the claim.

Claims 39-46 are rejected under 35 U.S.C. 112(a) or 35 U.S.C. 112 (pre-AIA), first paragraph, because the specification, while being enabling for "applying hydrostatic pressure", does not reasonably provide enablement for means that would facilitate the application of the hydrostatic pressure and means permitting heat flow from or to the organic material. The specification does not enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention commensurate in scope with these claims.

Claims 47-53 are rejected under 35 U.S.C. 112(a) or 35 U.S.C. 112 (pre-AIA), first paragraph, because the specification, while being enabling for "Cooling or heating apparatus", does not reasonably provide enablement for the apparatus. The specification does not enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention commensurate in scope with these claims.

The following is a quotation of 35 U.S.C. 112(b):

> (b) CONCLUSION.—The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the inventor or a joint inventor regards as the invention.

The following is a quotation of 35 U.S.C. 112 (pre-AIA), second paragraph:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 31-38 are rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor (or for applications subject to pre-AIA 35 U.S.C. 112, the applicant), regards as the invention. In claims 31-38 the "use" claims that do not purport to claim a process, machine, manufacture, or composition of matter fail to comply with 35 U.S.C. 101; In re Moreton, 288 F.2d 708, 709, 129 USPQ 227, 228 (CCPA 1961); generally raises an issue of indefiniteness under 35 U.S.C. 112(b), second paragraph.

Claims 32, 37, 40, 45, 48 and 53 are rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor (or for applications subject to pre-AIA 35 U.S.C. 112, the applicant), regards as the invention.

Claim 32, calls for the limitation of "and/or" in line 4. It is unclear which of these limitations is applicable; the organic material has a molecular weight of at most 2,000, such as at most 1,000 and the organic material has a molecular weight of at least 50; or the organic material has a molecular weight of at most 2,000, such as at most 1,000 or the organic material has a molecular weight of at least 50. As best understood, for the purposes of examination, the limitation “and/or” has been interpreted as “or”.

Claim 32, calls for the limitation of "and/or" in line 5. It is unclear which of these limitations is applicable; the organic material has a molecular weight of at least 50 and the organic material is an organic compound; or the organic material has a molecular weight of at

least 50 or the organic material is an organic compound. As best understood, for the purposes of examination, the limitation “and/or” has been interpreted as “or”.

Claim 32, calls for the limitation of "and/or" in line 7. It is unclear which of these limitations is applicable; the organic compound has two or more carbon-carbon bonds and the organic material is an organic compound or a salt thereof; or the organic compound has two or more carbon-carbon bonds or the organic material is an organic compound or a salt thereof. As best understood, for the purposes of examination, the limitation “and/or” has been interpreted as “or”.

Claim 32, calls for the limitation of "and/or" in line 9. It is unclear which of these limitations is applicable; the organic compound has two or more carbon-carbon bonds and the organic material is a liquid crystal or a plastic crystal; or the organic compound has two or more carbon-carbon bonds or the organic material is a liquid crystal or a plastic crystal. As best understood, for the purposes of examination, the limitation “and/or” has been interpreted as “or”.

Claim 37, calls for the limitation of "and/or" in line 4. It is unclear which of these limitations is applicable; such as at least 400 J K^{-1} $kg^{1}$and a phase transition in the organic material displays a latent heat; or such as at least 400 J K^{-1} $kg^{1}$and a phase transition in the organic material displays a latent heat or a phase transition in the organic material displays a latent heat. As best understood, for the purposes of examination, the limitation “and/or” has been interpreted as “or”.

Claim 37, calls for the limitation of "and/or" in line 7. It is unclear which of these limitations is applicable; such as at least 25 kJ kg^{1}, such as at least 50 kJ $kg^{-1}$and the organic material has a volume change at the phase transition of at least 1.0 mm^{3} g^{-1}; or such as at least 25 kJ kg^{1}, such as at least 50 kJ kg^{-1}or the organic material has a volume change at the phase

transition of at least 1.0 mm^3 g^{-1}. As best understood, for the purposes of examination, the limitation “and/or” has been interpreted as “or”.

Claim 37, calls for the limitation of "and/or" in line 8. It is unclear which of these limitations is applicable; such as at least 50 mm^3 g^{-1} and the organic material is provided within a pressure-transmitting medium; or such as at least 50 kJ kg^{-1}or the organic material is provided within a pressure-transmitting medium. As best understood, for the purposes of examination, the limitation “and/or” has been interpreted as “or”.

Claim 40, calls for the limitation of "and/or" in line 4. It is unclear which of these limitations is applicable; the organic material has a molecular weight of at most 2,000, such as at most 1,000 and the organic material has a molecular weight of at least 50; or the organic material has a molecular weight of at most 2,000, such as at most 1,000 or the organic material has a molecular weight of at least 50. As best understood, for the purposes of examination, the limitation “and/or” has been interpreted as “or”.

Claim 40, calls for the limitation of "and/or" in line 5. It is unclear which of these limitations is applicable; the organic material has a molecular weight of at least 50 and the organic material is an organic compound; or the organic material has a molecular weight of at least 50 or the organic material is an organic compound. As best understood, for the purposes of examination, the limitation “and/or” has been interpreted as “or”.

Claim 40, calls for the limitation of "and/or" in line 7. It is unclear which of these limitations is applicable; the organic compound has two or more carbon-carbon bonds and the organic material is an organic compound or a salt thereof; or the organic compound has two or more carbon-carbon bonds or the organic material is an organic compound or a salt thereof. As

best understood, for the purposes of examination, the limitation “and/or” has been interpreted as “or”.

Claim 40, calls for the limitation of "and/or" in line 9. It is unclear which of these limitations is applicable; the organic compound has two or more carbon-carbon bonds and the organic material is a liquid crystal or a plastic crystal; or the organic compound has two or more carbon-carbon bonds or the organic material is a liquid crystal or a plastic crystal. As best understood, for the purposes of examination, the limitation “and/or” has been interpreted as “or”.

Claim 45, calls for the limitation of "and/or" in line 4. It is unclear which of these limitations is applicable; such as at least 400 J K^{-1} $kg^{1}$and a phase transition in the organic material displays a latent heat; or such as at least 400 J K^{-1} $kg^{1}$and a phase transition in the organic material displays a latent heat or a phase transition in the organic material displays a latent heat. As best understood, for the purposes of examination, the limitation “and/or” has been interpreted as “or”.

Claim 45, calls for the limitation of "and/or" in line 7. It is unclear which of these limitations is applicable; such as at least 25 kJ kg^{1}, such as at least 50 kJ $kg^{-1}$and the organic material has a volume change at the phase transition of at least 1.0 mm^3 g^{-1}; or such as at least 25 kJ kg^{1}, such as at least 50 kJ kg^{-1}or the organic material has a volume change at the phase transition of at least 1.0 mm^3 g^{-1}. As best understood, for the purposes of examination, the limitation “and/or” has been interpreted as “or”.

Claim 45, calls for the limitation of "and/or" in line 8. It is unclear which of these limitations is applicable; such as at least 50 mm^3 g^{-1} and the organic material is provided within a pressure-transmitting medium; or such as at least 50 kJ kg^{-1}or the organic material is provided

within a pressure-transmitting medium. As best understood, for the purposes of examination, the limitation “and/or” has been interpreted as “or”.

Claim 48, calls for the limitation of "and/or" in line 4. It is unclear which of these limitations is applicable; the organic material has a molecular weight of at most 2,000, such as at most 1,000 and the organic material has a molecular weight of at least 50; or the organic material has a molecular weight of at most 2,000, such as at most 1,000 or the organic material has a molecular weight of at least 50. As best understood, for the purposes of examination, the limitation “and/or” has been interpreted as “or”.

Claim 48, calls for the limitation of "and/or" in line 5. It is unclear which of these limitations is applicable; the organic material has a molecular weight of at least 50 and the organic material is an organic compound; or the organic material has a molecular weight of at least 50 or the organic material is an organic compound. As best understood, for the purposes of examination, the limitation “and/or” has been interpreted as “or”.

Claim 48, calls for the limitation of "and/or" in line 7. It is unclear which of these limitations is applicable; the organic compound has two or more carbon-carbon bonds and the organic material is an organic compound or a salt thereof; or the organic compound has two or more carbon-carbon bonds or the organic material is an organic compound or a salt thereof. As best understood, for the purposes of examination, the limitation “and/or” has been interpreted as “or”.

Claim 48, calls for the limitation of "and/or" in line 9. It is unclear which of these limitations is applicable; the organic compound has two or more carbon-carbon bonds and the organic material is a liquid crystal or a plastic crystal; or the organic compound has two or more

carbon-carbon bonds or the organic material is a liquid crystal or a plastic crystal. As best understood, for the purposes of examination, the limitation “and/or” has been interpreted as “or”.

Claim 53, calls for the limitation of "and/or" in line 4. It is unclear which of these limitations is applicable; such as at least 400 J K^{-1} $kg^{1}$and a phase transition in the organic material displays a latent heat; or such as at least 400 J K^{-1} $kg^{1}$and a phase transition in the organic material displays a latent heat or a phase transition in the organic material displays a latent heat. As best understood, for the purposes of examination, the limitation “and/or” has been interpreted as “or”.

Claim 53, calls for the limitation of "and/or" in line 7. It is unclear which of these limitations is applicable; such as at least 25 kJ kg^{1}, such as at least 50 kJ $kg^{-1}$and the organic material has a volume change at the phase transition of at least 1.0 mm^3 g^{-1}; or such as at least 25 kJ kg^{1}, such as at least 50 kJ kg^{-1}or the organic material has a volume change at the phase transition of at least 1.0 mm^3 g^{-1}. As best understood, for the purposes of examination, the limitation “and/or” has been interpreted as “or”.

Claim 53, calls for the limitation of "and/or" in line 8. It is unclear which of these limitations is applicable; such as at least 50 mm^3 g^{-1} and the organic material is provided within a pressure-transmitting medium; or such as at least 50 kJ kg^{-1}or the organic material is provided within a pressure-transmitting medium. As best understood, for the purposes of examination, the limitation “and/or” has been interpreted as “or”.

Claim Rejections - 35 USC § 102

4. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(a)(1) the claimed invention was patented, described in a printed publication, or in public use, on sale or otherwise available to the public before the effective filing date of the claimed invention.

Claims 31, 32, 39, 40, 47 and 48 *are rejected under 35 U.S.C. 102(a)(1) as being anticipated by Lloveras et al. (**Giant Barocaloric Effects at Low Pressure in Ferrielectric Ammonium Sulphate**), hereinafter referred to as Lloveras et al.*

Regarding claim 31, Lloveras et al. disclose a use of an organic material as a barocaloric cooling or heating agent {see page 2, Col. 1, paragraph 2 and page 3, Col 2, paragraph 2: wherein poly(methyl methacrylate) constitutes an organic material}.

Regarding claim 32, Lloveras et al. disclose the use, according to claim 31, wherein the organic material is an organic compound or a salt thereof optionally wherein the organic material has a molecular weight of at most 2,000, such as at most 1,000 {see page 2, Col. 1, paragraph 2 and page 3, Col 2, paragraph 2: wherein poly(methyl methacrylate) constitutes an organic compound or a salt with a molecular weight of at most 2,000}; and/or wherein the organic material has a molecular weight of at least 50 {see page 2, Col. 1, paragraph 2: wherein poly(methyl methacrylate) constitutes an organic material with a molecular weight of at least 50}; and/or wherein the organic material is an organic compound or a salt thereof, and the organic compound has two or more carbon-carbon bonds; and/or wherein the organic material is an organic compound or a salt thereof, and the organic compound has two or more carbon-hydrogen bonds {see page 2, Col. 1, paragraph 2: wherein poly(methyl methacrylate ($C_5H_8O_2)_n$)) constitutes an organic compound or a salt thereof, and the organic compound has two or more carbon-hydrogen bonds}; and/or wherein the organic material is a liquid crystal or a plastic crystal {see page 2, Col. 1, paragraph 2: wherein poly(methyl methacrylate) is of a plastic crystal}.

Regarding claim 39, Lloveras et al. disclose a method of barocaloric cooling or heating, the method comprising the steps of: (i) applying hydrostatic pressure to an organic material (see page 2, Col. 1, paragraph 2 and page 3, Col 2, paragraph 2: wherein poly(methyl methacrylate)

constitutes an organic material); and (ii) permitting heat flow from or to the organic material. (iii) releasing hydrostatic pressure from an organic material that is under applied pressure; and (iv) permitting heat flow to or from the organic material {as shown in Figs. 3a-3c: page 3, Col 2, paragraph 2}.

Regarding claim 40, Lloveras et al. disclose the method according to claim 39, wherein the organic material is an organic compound or a salt thereof optionally wherein the organic material has a molecular weight of at most 2,000, such as at most 1,000 {see page 2, Col. 1, paragraph 2 and page 3, Col 2, paragraph 2: wherein poly(methyl methacrylate) constitutes an organic compound or a salt with a molecular weight of at most 2,000}; and/or wherein the organic material has a molecular weight of at least 50{see page 2, Col. 1, paragraph 2: wherein poly(methyl methacrylate) constitutes an organic material with a molecular weight of at least 50}; and/or wherein the organic material is an organic compound or a salt thereof, and the organic compound has two or more carbon-carbon bonds {see page 2, Col. 1, paragraph 2: wherein poly(methyl methacrylate $(C_5H_8O_2)_n$)) constitutes an organic compound or a salt thereof, and the organic compound has two or more carbon-hydrogen bonds}; and/or wherein the organic material is an organic compound or a salt thereof, and the organic compound has two or more carbon-hydrogen bonds {see page 2, Col. 1, paragraph 2: wherein poly(methyl methacrylate $(C_5H_8O_2)_n$)) constitutes an organic compound or a salt thereof, and the organic compound has two or more carbon-hydrogen bonds}; and/or wherein the organic material is a liquid crystal or a plastic crystal {see page 2, Col. 1, paragraph 2: wherein poly(methyl methacrylate) is of a plastic crystal}.

Regarding claim 47, Lloveras et al. disclose a cooling or heating apparatus comprising an organic material as a barocaloric cooling or heating agent {see page 2, Col. 1, paragraph 2 and page 3, Col 2, paragraph 2: wherein poly(methyl methacrylate) constitutes an organic material}.

Regarding claim 48, Lloveras et al. disclose the apparatus according to claim 47, wherein the organic material is an organic compound or a salt thereof optionally wherein the organic material has a molecular weight of at most 2,000, such as at most 1,000 {see page 2, Col. 1, paragraph 2 and page 3, Col 2, paragraph 2: wherein poly(methyl methacrylate) constitutes an

organic compound or a salt with a molecular weight of at most 2,000}; and/or wherein the organic material has a molecular weight of at least 50 {see page 2, Col. 1, paragraph 2: wherein poly(methyl methacrylate) constitutes an organic material with a molecular weight of at least 50}: and/or wherein the organic material is an organic compound or a salt thereof, and the organic compound has two or more carbon-carbon bonds{see page 2, Col. 1, paragraph 2: wherein poly(methyl methacrylate $(C_5H_8O_2)_n$)) constitutes an organic compound or a salt thereof, and the organic compound has two or more carbon-hydrogen bonds}; and/or wherein the organic material is an organic compound or a salt thereof, and the organic compound has two or more carbon-hydrogen bonds {see page 2, Col. 1, paragraph 2: wherein poly(methyl methacrylate $(C_5H_8O_2)_n$)) constitutes an organic compound or a salt thereof, and the organic compound has two or more carbon-hydrogen bonds}; and/or wherein the organic material is a liquid crystal or a plastic crystal {see page 2, Col. 1, paragraph 2: wherein poly(methyl methacrylate) is of a plastic crystal}.

Conclusion

5. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

- U.S. 2007/0099249A1 to Abbott, Nicholas et al.
- U.S. 20100060844A1 to Sawatari; Naoko et al.
- U.S. 3,920,414A to Steere; David E. et al.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to EMMANUEL E DUKE,EMMANUEL E DUKE whose telephone number is (571)270-5290. The examiner can normally be reached on Monday thru Friday; 6:00 AM to 2:00 PM Monday thru Friday; 6:00 AM to 2:00 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, FRANTZ JULES can be reached on (571)272-6681(571)272-6681. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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/EMMANUEL E DUKE/

Primary Examiner, Art Unit 3763

01/23/2021

Notice of References Cited	Application/Control No. 16/341,618	Applicant(s)/Patent Under Reexamination Moya Raposo et al.	
	Examiner EMMANUEL E DUKE	Art Unit 3763	Page 1 of 1

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*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
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*	B	US-20100060844-A1	03-2010	Sawatari; Naoko	G02F1/1341	349/187
*	C	US-3920414-A	11-1975	Steere; David E.	C10L1/143	44/331
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NON-PATENT DOCUMENTS

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*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/341,618	Moya Raposo et al.
	Examiner	Art Unit
	EMMANUEL E DUKE	3763

CPC - Searched*		
Symbol	Date	Examiner
C09K5/06,14,02	01/20/2021	ED
F25B23/00	01/20/2021	ED
C04B35/645	01/20/2021	ED

CPC Combination Sets - Searched*		
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US Classification - Searched*			
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Search Notes		
Search Notes	Date	Examiner
Inventors search conducted on EAST and PALM	01/20/2021	ED
Text search conducted on EAST and IP.COM	01/20/2021, 01/21/2021	ED
Text modified search conducted (see EAST search history)	01/20/2021	ED
Reviewed and considered PCT/EP2017/076203 written opinion	01/20/2021	ED

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner

Pascal Technologies, Ex. 1002, page 139
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IPR2024-01235

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/341,618	Moya Raposo et al.
	Examiner	Art Unit
	EMMANUEL E DUKE	3763

Pascal Technologies, Ex. 1002, page 140
Pascal Technologies v. Cambridge Enterprise Limited, Universitat De Barcelona, and Universitat Politècnica De Catalunya
IPR2024-01235

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/341,618	Moya Raposo et al.
	Examiner	Art Unit
	EMMANUEL E DUKE	3763

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	01/21/2021								
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IPR2024-01235

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	16/341,618	Moya Raposo et al.
	Examiner	**Art Unit**
	EMMANUEL E DUKE	3763

CLAIM		DATE								
Final	Original	01/21/2021								
13	43	✓								
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19	49	✓								
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21	51	✓								
22	52	✓								
23	53	✓								

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(Not for submission under 37 CFR 1.99)

Application Number	16/341618
Filing Date	04/12/2019
First Named Inventor	Javier Eduardo Moya Raposo
Art Unit	3763
Examiner Name	Emmanuel Duke
Attorney Docket Number	MEWE-072

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	Art Unit	3763
	Examiner Name	Emmanuel Duke
	Attorney Docket Number	MEWE-072

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Filing Date	04/12/2019
First Named Inventor	Javier Eduardo Moya Raposo
Art Unit	3763
Examiner Name	Emmanuel Duke
Attorney Docket Number	MEWE-072

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Bret E. Field, Reg. No. 37,620/	Date (YYYY-MM-DD)	2019-04-12
Name/Print	Bret E. Field	Registration Number	37,620

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Bibliographic Data

Application No: 16/341,618

Foreign Priority claimed: (●) Yes ( ) No

35 USC 119 (a-d) conditions met: [✓] Yes [ ] No [ ] Met After Allowance

Verified and Acknowledged: /EMMANUEL E DUKE/ Examiner's Signature | Initials

Title: Use of Barocaloric Materials and Barocaloric Devices

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
04/12/2019	165	3763	MEWE-072
RULE			

APPLICANTS

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Universitat de Barcelona, Barcelona, SPAIN

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Josep Lluís Tamarit Mur, Barcelona, SPAIN

Pol Marcel Lloveras Muntané, Barcelona, SPAIN

CONTINUING DATA

This application is a 371 of PCT/EP2017/076203 10/13/2017

FOREIGN APPLICATIONS

UNITED KINGDOM GB1617508.5 10/14/2016

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01/12/2020

STATE OR COUNTRY

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UNITED STATES

FILING FEE RECEIVED

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Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (02-18)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16341618
Filing Date	2019-04-12
First Named Inventor	Javier Eduardo Moya Raposo
Art Unit	~~N/A~~ 3763
Examiner Name	~~N/A~~ Emmanuel Duke
Attorney Docket Number	MEWE-072

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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /E.E.D/

Receipt date: 05/17/2019

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16341618
	Filing Date	2019-04-12
	First Named Inventor	Javier Eduardo Moya Raposo
	Art Unit	~~N/A~~ 3763
	Examiner Name	~~N/A~~ Emmanuel Duke
	Attorney Docket Number	MEWE-072

	1	ALONSO, Efectes barocalòrics en la transició plàstica del 1-Bromadamantà, June 2017, with a machine translation.	X
	2	CATALÁ, Efectes barocalòrics en cristalls plàstics, Escola Tècnica Superior d'Enginyeria Industrial de Barcelona, June 2016, with a machine translation.	☒
	3	GOMEZ et al., Efectes barocalòrics colossals en cristalls plàstics derivats del neopentà, Gener 2016, with a machine translation.	☒

If you wish to add additional non-patent literature document citation information please click the Add button Add

EXAMINER SIGNATURE

Examiner Signature	/EMMANUEL E DUKE/	Date Considered	01/21/2021

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

Receipt date: 05/17/2019

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(Not for submission under 37 CFR 1.99)

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Filing Date	2019-04-12
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Examiner Name	N/A Emmanuel Duke
Attorney Docket Number	MEWE-072

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

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OR

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Signature	/Bret E. Field, Reg. No. 37,620/	Date (YYYY-MM-DD)	2019-05-17
Name/Print	Bret E. Field	Registration Number	37,620

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EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	1	((("Moya") near3 ("Raposo") near3 ("Javier") near3 ("Eduardo"))).INV.	US-PGPUB; USPAT; USOCR	OR	OFF	2021/01/20 07:13
S2	1	((("Avramenko") near3 ("Alexander"))).INV.	US-PGPUB; USPAT; USOCR	OR	OFF	2021/01/20 07:14
S3	0	((("Manosa") near3 ("Carrera") near3 ("LluÃs"))).INV.	US-PGPUB; USPAT; USOCR	OR	OFF	2021/01/20 07:14
S4	0	((("Tamarit") near3 ("Mur") near3 ("Josep") near3 ("LluÃs"))).INV.	US-PGPUB; USPAT; USOCR	OR	OFF	2021/01/20 07:15
S5	0	((("Lloveras") near3 ("MuntanÃ©") near3 ("Pol") near3 ("Marcel"))).INV.	US-PGPUB; USPAT; USOCR	OR	OFF	2021/01/20 07:15
S6	25,693	(C09K5/06 or C09K5/14 or C09K5/02 or F25B23/00 or C04B35/645).cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2021/01/20 07:42
S7	1,233	C09K5/06.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2021/01/20 07:43
S8	7,559	C09K5/14.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2021/01/20 07:44
S9	368	C09K5/02.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2021/01/20 07:45
S10	887	F25B23/00.cpc.	US-PGPUB; USPAT; USOCR; FPRS;	OR	OFF	2021/01/20 07:45

			EPO; JPO; DERWENT; IBM_TDB			
S11	15,869	C04B35/645.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2021/01/20 07:46
S12	6	ORGANIC MATERIAL BAROCALORIC COOL$3 HEAT$3 AGENT	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/20 07:48
S13	6	S6 ORGANIC MATERIAL BAROCALORIC COOL$3 HEAT$3 AGENT	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/20 07:49
S14	13	S6 BAROCALORIC COOL$3 HEAT$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/20 07:49
S15	3	ORGANIC MATERIAL BAROCALORIC COOL$3 HEAT$3 ((LIQUID OR PLASTIC) NEAR2 CRYSTAL) PRESSURE (PHASE NEAR2 TRANSITION)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/20 09:46
S16	2,054,195	((LIQUID OR PLASTIC) NEAR2 CRYSTAL)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/20 11:01
S17	6	BAROCALORIC COOL$3 HEAT$3 ((LIQUID OR PLASTIC) NEAR2 CRYSTAL)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/20 11:05
S18	88,935	(ORGANIC NEAR2 MATERIAL) ((LIQUID OR PLASTIC) NEAR2 CRYSTAL)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	AND	OFF	2021/01/20 11:06

			DERWENT; IBM_TDB			
S19	19,714	COOL$3 HEAT$3 (ORGANIC NEAR2 MATERIAL) ((LIQUID OR PLASTIC) NEAR2 CRYSTAL)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/20 11:07
S20	6	COOL$3 HEAT$3 (ORGANIC NEAR2 MATERIAL) ((LIQUID OR PLASTIC) NEAR2 CRYSTAL) BAROCALORIC	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/20 11:07
S21	2,218	COOL$3 HEAT$3 (ORGANIC NEAR2 MATERIAL) ((LIQUID OR PLASTIC) NEAR2 CRYSTAL) HYDROXYL AMINO NITRO	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/20 11:09
S22	131	COOL$3 HEAT$3 (ORGANIC NEAR2 MATERIAL) ((LIQUID OR PLASTIC) NEAR2 CRYSTAL) HYDROXYL AMINO NITRO ALKYL HALO HYDROXYL OXO	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/20 11:11
S23	8	BAROCALORIC (ORGANIC NEAR2 MATERIAL) COOL$3 HEAT$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/20 11:54
S24	10	BAROCALORIC (ORGANIC NEAR2 MATERIAL)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/20 11:54
S25	121,593	(ORGANIC NEAR2 MATERIAL) COOL$3 HEAT$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/20 11:55
S26	19,714	(ORGANIC NEAR2 MATERIAL) COOL$3 HEAT$3 ((LIQUID OR PLASTIC) NEAR2 CRYSTAL)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	AND	OFF	2021/01/20 11:56

			DERWENT; IBM_TDB			
S27	138	(ORGANIC NEAR2 MATERIAL) COOL$3 HEAT$3 ((LIQUID AND PLASTIC) NEAR2 CRYSTAL)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/20 11:56
S28	5,809	(ORGANIC NEAR2 MATERIAL) ((COOL$3 OR HEAT$3) NEAR2 AGENT)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/21 05:49
S29	3,441	(ORGANIC NEAR2 MATERIAL) ((COOL$3 OR HEAT$3) NEAR2 AGENT) ((ORGANIC NEAR2 COMPOUND) OR SALT)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/21 05:50
S30	1,054	(ORGANIC NEAR2 MATERIAL) ((COOL$3 OR HEAT$3) NEAR2 AGENT) ((ORGANIC NEAR2 COMPOUND) OR SALT) CARBON HYDROGEN BONDS	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/21 05:52
S31	326	(ORGANIC NEAR2 MATERIAL) ((COOL$3 OR HEAT$3) NEAR2 AGENT) ((ORGANIC NEAR2 COMPOUND) OR SALT) CARBON HYDROGEN BONDS ((LIQUID OR PLACTIC) NEAR2 CRYSTAL)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/21 05:52
S32	2	(ORGANIC NEAR2 MATERIAL) ((COOL$3 OR HEAT$3) NEAR2 AGENT) ((ORGANIC NEAR2 COMPOUND) OR SALT) CARBON HYDROGEN BONDS ((LIQUID OR PLACTIC) NEAR2 CRYSTAL) (ALKYL OR CYCLOALKYL) ADAMANTANTYL	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/21 05:55
S33	197	(ORGANIC NEAR2 MATERIAL) ((COOL$3 OR HEAT$3) NEAR2 AGENT) ((ORGANIC NEAR2 COMPOUND) OR SALT) CARBON HYDROGEN BONDS ((LIQUID OR PLACTIC) NEAR2 CRYSTAL) (ALKYL OR CYCLOALKYL)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/21 05:55
S34	2	(ORGANIC NEAR2 MATERIAL) ((COOL$3 OR HEAT$3) NEAR2 AGENT) ((ORGANIC NEAR2	US-PGPUB; USPAT; USOCR; FPRS;	AND	OFF	2021/01/21 05:56

		COMPOUND) OR SALT) CARBON HYDROGEN BONDS ((LIQUID OR PLACTIC) NEAR2 CRYSTAL) (ALKYL OR CYCLOALKYL) HYDROSTATIC PRESSURE	EPO; JPO; DERWENT; IBM_TDB			
S35	197	(ORGANIC NEAR2 MATERIAL) ((COOL$3 OR HEAT$3) NEAR2 AGENT) ((ORGANIC NEAR2 COMPOUND) OR SALT) CARBON HYDROGEN BONDS ((LIQUID OR PLACTIC) NEAR2 CRYSTAL) (ALKYL OR CYCLOALKYL) TEMPERATURE	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/21 05:57
S36	14	(ORGANIC NEAR2 MATERIAL) ((COOL$3 OR HEAT$3) NEAR2 AGENT) ((ORGANIC NEAR2 COMPOUND) OR SALT) CARBON HYDROGEN BONDS ((LIQUID OR PLACTIC) NEAR2 CRYSTAL) (ALKYL OR CYCLOALKYL) TEMPERATURE (PHASE NEAR2 TRANSITION)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/21 05:58
S37	2	(BAROCALORIC NEAR2 (COOL$3 AND HEAT$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	NEAR	OFF	2021/01/21 06:31
S38	3	(BAROCALORIC NEAR12 (COOL$3 AND HEAT$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	NEAR	OFF	2021/01/21 06:32
S39	3	(BAROCALORIC NEAR20 (COOL$3 AND HEAT$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	NEAR	OFF	2021/01/21 06:34
S40	1,993	((ORGANIC NEAR2 MATERIAL) NEAR20 (COOL$3 AND HEAT$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	NEAR	OFF	2021/01/21 06:34
S41	10	((ORGANIC NEAR2 MATERIAL) NEAR20 (COOL$3 AND HEAT$3)) HYDROSTATIC PRESSURE	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/21 06:43

S43	55,447	(ORGANIC NEAR2 MATERIAL) (COOL$3 OR HEAT$3) ((LIQUID OR PLACTIC) NEAR2 CRYSTAL)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/21 09:03
S44	6,594	((ORGANIC NEAR2 MATERIAL) near12 (COOL$3 OR HEAT$3)) ((LIQUID OR PLACTIC) NEAR2 CRYSTAL)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/21 09:04
S45	2,761	((ORGANIC NEAR2 MATERIAL) near12 (COOL$3 OR HEAT$3)) ((LIQUID OR PLACTIC) NEAR2 CRYSTAL) (cycloalkyi or alkyl)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/21 09:06
S46	2	((ORGANIC NEAR2 MATERIAL) near12 (COOL$3 OR HEAT$3)) ((LIQUID OR PLACTIC) NEAR2 CRYSTAL) (cycloalkyi or alkyl) adamantantyl	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/21 09:08
S47	13	((ORGANIC NEAR2 MATERIAL) near12 (COOL$3 OR HEAT$3)) ((LIQUID OR PLACTIC) NEAR2 CRYSTAL) (cycloalkyi or alkyl) alkyl halo hydroxyl oxo	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/21 09:08
S48	10	((ORGANIC NEAR2 MATERIAL) near12 (COOL$3 OR HEAT$3)) ((LIQUID OR PLACTIC) NEAR2 CRYSTAL) (cycloalkyi or alkyl) alkyl halo hydroxyl oxo cycloalkyl aryl	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/21 09:10
S49	2	(ORGANIC NEAR2 MATERIAL) (BAROCALORIC NEAR2 (COOL$3 OR HEAT$3)) ((LIQUID OR PLACTIC) NEAR2 CRYSTAL) (cycloalkyi or alkyl) alkyl halo hydroxyl oxo cycloalkyl aryl	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/21 11:00
S54	26	plastic crystal alkyl cycoalkyl	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 14:52

S57	3	plastic crystal alkyl cycoalkyl halo hydroxyl oxo	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 14:53
S59	2	(plastic near2 crystal) adamantantyl	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 14:55
S60	47	adamantantyl	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 14:56
S61	2	COOL$3 HEAT$3 (ORGANIC NEAR2 MATERIAL) ((LIQUID and PLASTIC) NEAR2 CRYSTAL) HYDROXYL AMINO NITRO ALKYL HALO HYDROXYL OXO	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:04
S62	2	(ORGANIC NEAR2 MATERIAL) ((LIQUID and PLASTIC) NEAR2 CRYSTAL) HYDROXYL AMINO NITRO ALKYL HALO HYDROXYL OXO	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:05
S63	2	((LIQUID and PLASTIC) NEAR2 CRYSTAL) HYDROXYL AMINO NITRO ALKYL HALO HYDROXYL OXO	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:05
S64	405	(ORGANIC NEAR2 MATERIAL) ((LIQUID and PLASTIC) NEAR2 CRYSTAL)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:05
S65	60	(ORGANIC NEAR2 MATERIAL) ((LIQUID and PLASTIC) NEAR2 CRYSTAL) HYDROXYL	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:06

S66	54	(ORGANIC NEAR2 MATERIAL) ((LIQUID and PLASTIC) NEAR2 CRYSTAL) AMINO	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:07
S67	30	(ORGANIC NEAR2 MATERIAL) ((LIQUID and PLASTIC) NEAR2 CRYSTAL) NITRO	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:07
S68	101	(ORGANIC NEAR2 MATERIAL) ((LIQUID and PLASTIC) NEAR2 CRYSTAL) ALKYL	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:07
S69	32	(ORGANIC NEAR2 MATERIAL) ((LIQUID and PLASTIC) NEAR2 CRYSTAL) HALO	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:08
S70	60	(ORGANIC NEAR2 MATERIAL) ((LIQUID and PLASTIC) NEAR2 CRYSTAL) HYDROXYL	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:08
S71	6	(ORGANIC NEAR2 MATERIAL) ((LIQUID and PLASTIC) NEAR2 CRYSTAL) cycloalkyl	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:09
S72	224	poly(methyl methacrylate) ((LIQUID and PLASTIC) NEAR2 CRYSTAL)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:14
S73	28	poly(methyl methacrylate) ((LIQUID and PLASTIC) NEAR2 CRYSTAL) hydroxyl amino nitro	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:15

S75	31	poly(methyl methacrylate) (PLASTIC NEAR2 CRYSTAL) CYCLOALKYL	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:26
S76	1	poly(methyl methacrylate) (PLASTIC NEAR2 CRYSTAL) CYCLOALKYL ALKYL HALO HYDROXYL OXO	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:27
S77	31	poly(methyl methacrylate) (PLASTIC NEAR2 CRYSTAL) CYCLOALKYL	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:28
S78	31	poly(methyl methacrylate) (PLASTIC NEAR2 CRYSTAL) CYCLOALKYL ALKYL	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:28
S79	6	poly(methyl methacrylate) (PLASTIC NEAR2 CRYSTAL) CYCLOALKYL ALKYL HALO	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:28
S80	17	poly(methyl methacrylate) (PLASTIC NEAR2 CRYSTAL) CYCLOALKYL ALKYL HYDROXYL	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:28
S81	7	poly(methyl methacrylate) (PLASTIC NEAR2 CRYSTAL) CYCLOALKYL ALKYL OXO	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:28
S82	604	(PLASTIC NEAR2 CRYSTAL) (ALKYL OR CYCLOALKYL)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:43

S83	391	(PLASTIC NEAR2 CRYSTAL) (ALKYL NEAR2 GROUP)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:44
S84	256	(PLASTIC NEAR2 CRYSTAL) (ALKYL NEAR2 GROUP) CARBON BOND$1	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:45
S85	171	(PLASTIC NEAR2 CRYSTAL) (ALKYL NEAR2 GROUP) CARBON BOND$1 HYDROXYL	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 15:46
S86	47	(ORGANIC NEAR2 MATERIAL) (PLASTIC NEAR2 CRYSTAL) (ALKYL NEAR2 GROUP) CARBON BOND$1 HYDROXYL	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	OFF	2021/01/22 16:00
S87	6	((organic material) NEAR10 ((alkyl NEAR2(carboxylic NEAR2 acid)) OR (alkyl (carboxylate salt))))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	NEAR	OFF	2021/01/22 16:37
S90	7	((organic near2 material) near2 (plastic near2 crystal))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	NEAR	OFF	2021/01/23 12:19
S91	211	(organic near2 (plastic near2 crystal))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	NEAR	OFF	2021/01/23 12:22

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/341,618	04/12/2019	Javier Eduardo Moya Raposo	MEWE-072

CONFIRMATION NO. 1000

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PUBLICATION NOTICE

OC000000116471641

Title: Use of Barocaloric Materials and Barocaloric Devices

Publication No.US-2020-0123426-A1
Publication Date:04/23/2020

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The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

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IPR2024-01235

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U.S. APPLICATION NO.	FIRST NAMED INVENTOR	ATTY. DOCKET NO.
16/341,618	Javier Eduardo Moya Raposo	MEWE-072

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INTERNATIONAL APPLICATION NO.	
PCT/EP2017/076203	
I.A. FILING DATE	PRIORITY DATE
10/13/2017	10/14/2016

CONFIRMATION NO. 1000
371 ACCEPTANCE LETTER

OC00000011389977O

Date Mailed: 01/14/2020

NOTICE OF ACCEPTANCE OF APPLICATION UNDER 35 U.S.C 371 AND 37 CFR 1.495

The applicant is hereby advised that the United States Patent and Trademark Office, in its capacity as a Designated / Elected Office (37 CFR 1.495), has ACCEPTED the above identified international application for national patentability examination in the United States Patent and Trademark Office.

The United States Application Number assigned to the application is shown above. A Filing Receipt will be issued for the present application in due course. **THE DATE APPEARING ON THE FILING RECEIPT AS THE "FILING DATE or 371(c) DATE" IS THE DATE ON WHICH THE LAST OF THE 35 U.S.C. 371 (c)(1) and (c)(2) REQUIREMENTS HAS BEEN RECEIVED IN THE OFFICE. THIS DATE IS SHOWN BELOW.** The filing date of the above identified application is the international filing date of the international application (Article 11(3) and 35 U.S.C. 363)

04/12/2019
DATE OF RECEIPT OF 35 U.S.C.
371(c)(1) and (c)(2) REQUIREMENTS

The following items have been received:

- Copy of the International Application filed on 04/12/2019
- Copy of the International Search Report filed on 04/12/2019
- Preliminary Amendments filed on 04/12/2019
- Information Disclosure Statements filed on 05/17/2019
- Inventor's Oath or Declaration filed on 07/08/2019
- Request for Immediate Examination filed on 04/12/2019
- U.S. Basic National Fees filed on 04/12/2019
- Priority Documents filed on 04/12/2019
- Power of Attorney filed on 04/12/2019
- Specification filed on 04/12/2019
- Claims filed on 04/12/2019
- Abstracts filed on 04/12/2019
- Drawings filed on 04/12/2019
- Application Data Sheet (37 CFR 1.76) filed on 07/08/2019

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Pascal Technologies v. Cambridge Enterprise Limited, Universitat De Barcelona, and Universitat Politècnica De Catalunya
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Pascal Technologies v. Cambridge Enterprise Limited, Universitat De Barcelona, and Universitat Politècnica De Catalunya
IPR2024-01235

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
16/341,618	04/12/2019		2020	MEWE-072	23	3

CONFIRMATION NO. 1000

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REDWOOD CITY, CA 94065

FILING RECEIPT

OC000000113899789

Date Mailed: 01/14/2020

Receipt is acknowledged of this non-provisional utility patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF FIRST INVENTOR, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection.

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Universitat de Barcelona, Barcelona, SPAIN

Power of Attorney: The patent practitioners associated with Customer Number 93726

Domestic Priority data as claimed by applicant

This application is a 371 of PCT/EP2017/076203 10/13/2017

Foreign Applications (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.)
UNITED KINGDOM 1617508.5 10/14/2016

Permission to Access Application via Priority Document Exchange: No

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IPR2024-01235

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The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 16/341,618**
Projected Publication Date: 04/23/2020
Non-Publication Request: No
Early Publication Request: No
Title

Use of Barocaloric Materials and Barocaloric Devices

Preliminary Class

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

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IPR2024-01235

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Title 37, Code of Federal Regulations, 5.11 & 5.15

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IPR2024-01235

MULTIPLE DEPENDENT CLAIM FEE CALCULATION SHEET

Substitute for Form PTO-1360
(For use with Form PTO/SB/06)

Application Number	Filing Date
16341618	

Applicant(s) Javier Moya Raposo

* May be used for additional claims or amendments

CLAIMS	AS FILED		AFTER FIRST AMENDMENT		AFTER SECOND AMENDMENT	
	Indep	Depend	Indep	Depend	Indep	Depend
1	1		---	---		
2	1		---	---		
3	1		---	---		
4		3	---	---		
5		3	---	---		
6		(1)	---	---		
7		(1)	---	---		
8		(1)	---	---		
9		(1)	---	---		
10		(1)	---	---		
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27		(1)	---	---		
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29		2	---	---		
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45				1		
46				1		
47			1			
48				1		
49				1		
50				1		
Total Indep	3		3		0	
Total Depend	33	↵	20	↵	0	↵
Total Claims	36		23		0	

	*		*		*	
	Indep	Depend	Indep	Depend	Indep	Depend
51				1		
52				1		
53				1		
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PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 16/341,618

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	300
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	520
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	760
TOTAL CLAIMS (37 CFR 1.16(i))	23 minus 20 =	* 3			OR	x 100 =	300
INDEPENDENT CLAIMS (37 CFR 1.16(h))	3 minus 3 =	*				x 460 =	0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	1880

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

PTO/AIA/01 (08-12)
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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	Use of Barocaloric Materials and Barocaloric Devices

As the below named inventor, I hereby declare that:

This declaration is directed to:

☐ The attached application, or

☒ United States application or PCT international application number PCT/EP2017/076203 filed on October 13, 2017.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

LEGAL NAME OF INVENTOR

Inventor: Javier Eduardo Moya Raposo Date (Optional): 5-6-2019

Signature: _____

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 1 minute to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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LEGAL NAME OF INVENTOR

Inventor: Alexander Avramenko Date (Optional): 05.06.2019

Signature: 

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

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LEGAL NAME OF INVENTOR

Inventor: Lluis Manosa Carrera Date (Optional): 24/09/2019

Signature: 

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

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filed on October 13, 2017

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

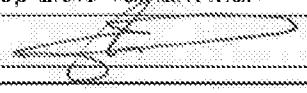
I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

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LEGAL NAME OF INVENTOR

Inventor: Josep Lluís Tamarit Mur Date (Optional): April 26th 2019

Signature: 

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

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This declaration is directed to:

☐ The attached application, or

☒ United States application or PCT international application number PCT/EP2017/076203 filed on October 13, 2017.

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LEGAL NAME OF INVENTOR

Inventor: Pol Marcel Lloveras Muntané Date (Optional): _____

Signature: _____

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 1 minute to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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Electronic Acknowledgement Receipt

EFS ID:	37193107
Application Number:	16341618
International Application Number:	
Confirmation Number:	1000
Title of Invention:	Use of Barocaloric Materials and Barocaloric Devices
First Named Inventor/Applicant Name:	Javier Eduardo Moya Raposo
Customer Number:	93726
Filer:	Bret E. Field/Samantha Dewees
Filer Authorized By:	Bret E. Field
Attorney Docket Number:	MEWE-072
Receipt Date:	20-SEP-2019
Filing Date:	
Time Stamp:	13:55:51
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Oath or Declaration filed	MEWE-072_Declaration.pdf	3212298 a228b7abc98abcb201a378018d7ff1c92384ee23	no	5

Warnings:

Pascal Technologies, Ex. 1002, page 179
Pascal Technologies v. Cambridge Enterprise Limited, Universitat De Barcelona, and Universitat Politècnica De Catalunya
IPR2024-01235

Information:	
Total Files Size (in bytes):	3212298

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Doc Code: R48.REQ
Document Description: Request under Rule 48 correcting inventorship

PTO/AIA/40 (04-15)
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REQUEST FOR CORRECTION IN A PATENT APPLICATION RELATING TO INVENTORSHIP OR AN INVENTOR NAME, OR ORDER OF NAMES, OTHER THAN IN A REISSUE APPLICATION (37 CFR 1.48)

Application Number	16/341,618
Filing Date	April 12, 2019
First Named Inventor	Javier Eduardo Moya Raposo
Art Unit	To be assigned
Examiner Name	To be assigned
Practitioner Docket Number	MEWE-072

To: Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Applicant hereby **requests that the inventorship be corrected or changed, or that the name of the inventor or a joint inventor, or the order of the names of joint inventors, be changed,** in the above-identified application. **Note**: 37 CFR 1.48 applies to any request to correct inventorship filed on or after September 16, 2012, regardless of the application filing date. **Do not submit this form after payment of the issue fee or if the application has been patented.** See 37 CFR 1.324 for correction of inventorship in a patent.

Please check the applicable box(es) below.

For a nonprovisional application:

☐ 1. This request is to correct or change the inventorship in a **nonprovisional** application (**under 37 CFR 1.48(a)**) and includes:

☐ An application data sheet (ADS) in accordance with 37 CFR 1.76(c) with the corrected or updated information shown with markings (*e.g.*, underlining for insertions, strikethrough for deletions). See the Manual of Patent Examining Procedure (MPEP) section 601.05(a) for information about filing an ADS in an application filed on/after September 16, 2012. For information about filing a Supplemental ADS in an application filed before September 16, 2012, see MPEP 601.05(b).

☐ The processing fee set forth in 37 CFR 1.17(i). $ _____

☐ An inventor is being added. An inventor's oath or declaration by any actual inventor who has not yet executed an oath or declaration is required (see 37 CFR 1.48(b)). See MPEP 602.01(a) for information about an inventor's oath or declaration for an application filed on/after September 16, 2012 (*e.g.*, form **PTO/AIA/01**). For information about an inventor's oath or declaration for an application filed before September 16, 2012 (*e.g.*, form **PTO/SB/01**), see MPEP 602.01(b).

☐ This request is being filed after the first Office action on the merits has been given or mailed (see 37 CFR 1.48(c) and 1.17(d)). Check one of the following:

☐ This request to correct or change the inventorship is due solely to the cancellation of claims in the application.

OR

☐ The fee set forth in 37 CFR 1.17(d) is due (in addition to the fee set forth in 37 CFR 1.17(i)). $ _____

This collection of information is required by 37 CFR 1.48. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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U.S. Patent and Trademark Office, U.S. DEPARTMENT OF COMMERCE
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REQUEST FOR CORRECTION IN A PATENT APPLICATION RELATING TO INVENTORSHIP OR AN INVENTOR NAME, OR ORDER OF NAMES, OTHER THAN IN A REISSUE APPLICATION (37 CFR 1.48)

☒ 2. This request is to correct or update the name of the inventor or a joint inventor, or the order of names of joint inventors, in a **nonprovisional** application (**under 37 CFR 1.48(f)**) and includes:

☒ An application data sheet in accordance with 37 CFR 1.76(c) identifying the complete inventive entity, including the corrected or updated name of the inventor, or the new order of names shown with markings (*e.g.*, underlining for insertions, strikethrough for deletions). See the MPEP 601.05(a) for information about filing an ADS in an application filed on/after September 16, 2012. For information about filing a Supplemental ADS in an application filed before September 16, 2012, see MPEP 601.05(b).

☒ The processing fee set forth in 37 CFR 1.17(i). $ 140.00

For a provisional application:

☐ This request is to change or correct the inventorship, or correct or update the name of the inventor or a joint inventor, in a **provisional** application (**under 37 CFR 1.48(d)**) and includes:

☐ **Attached hereto** is a request, signed by a party set forth in 37 CFR 1.33(b), that identifies each inventor by his or her legal name, in the preferred order.

☐ The processing fee set forth in 37 CFR 1.17(q). $ _____

Fee Payment Information:

☐ Applicant asserts small entity status. See 37 CFR 1.27.

☐ Applicant certifies micro entity status. See 37 CFR 1.29.
Form PTO/SB/15A or B or equivalent must either be enclosed or have been submitted previously

☐ A check in the amount of the fee is enclosed.

☐ Payment by credit card. Form PTO-2038 is attached.

☒ The Director is hereby authorized to charge any fees which may be required, or credit any overpayment to Deposit Account No. 50-0815.

☒ Payment made via EFS-Web.

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

I am the

☐ Applicant*

☒ attorney or agent of record
Registration number 37,620

☐ attorney or agent acting under 37 CFR 1.34
Registration number _____

Signature /Bret E. Field, Reg. No. 37,620/

Typed or printed name Bret E. Field

Date July 8, 2019

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. *Juristic entities must be represented by a patent practitioner (See 37 CFR 1.31, applicable to any paper filed on or after September 16, 2012 that is presented on behalf of a juristic entity, regardless of application filing date). Submit multiple forms if more than one signature is required, see below**.

☒ ** Total of 1 forms are submitted.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

PTO/AIA/14 (02-18)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	MEWE-072
	Application Number	16/341,618
Title of Invention	Use of Barocaloric Materials and Barocaloric Devices	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2:

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Javier	Eduardo	Moya Raposo	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	Cambridge, Cambridgeshire	Country of Residence [i]	GB

Mailing Address of Inventor:

Address 1	Dept. of Matl. Sci. & Met., Univ. of Cambridge		
Address 2	27 Charles Babbage Road		
City	Cambridge, Cambridgeshire	State/Province	
Postal Code	CB3 0FS	Country [i]	GB

Inventor 2 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	~~Alexandrovich~~ Alexander		Avramenko	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	Cambridge, Cambridgeshire	Country of Residence [i]	GB

Mailing Address of Inventor:

Address 1	Dept. of Matl. Sci. & Met., Univ. of Cambridge		
Address 2	27 Charles Babbage Road		
City	Cambridge, Cambridgeshire	State/Province	
Postal Code	CB3 0FS	Country [i]	GB

Inventor 3 Remove

Legal Name

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	MEWE-072
	Application Number	16/341,618
Title of Invention	Use of Barocaloric Materials and Barocaloric Devices	

Prefix	Given Name	Middle Name	Family Name	Suffix
	Lluís		Manosa Carrera	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	Barcelona	Country of Residence [i]	ES

Mailing Address of Inventor:

Address 1	Univ. de Barcelona, Centre de Patents de la UB		
Address 2	Baldiri Reixac, 4 - Torre D		
City	Barcelona	State/Province	
Postal Code	08028	Country [i]	ES

Inventor 4 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Josep	Lluís	Tamarit Mur	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	Barcelona	Country of Residence [i]	ES

Mailing Address of Inventor:

Address 1	Univ. Politècnica de Catalunya		
Address 2	C/Jordi Girona 31		
City	Barcelona	State/Province	
Postal Code	08034	Country [i]	ES

Inventor 5 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Pol	Marcel	Lloveras Muntané	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	Barcelona	Country of Residence [i]	ES

Mailing Address of Inventor:

Address 1	Univ. Politècnica de Catalunya		
Address 2	C/Jordi Girona 31		
City	Barcelona	State/Province	
Postal Code	08034	Country [i]	ES

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	MEWE-072
	Application Number	16/341,618
Title of Invention	Use of Barocaloric Materials and Barocaloric Devices	

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below. For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	93726		
Email Address	docket@bozpat.com	Add Email	Remove Email

Application Information:

Title of the Invention	Use of Barocaloric Materials and Barocaloric Devices		
Attorney Docket Number	MEWE-072	**Small Entity Status Claimed**	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	3	**Suggested Figure for Publication (if any)**	1

Filing By Reference:

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	MEWE-072
	Application Number	16/341,618
Title of Invention	Use of Barocaloric Materials and Barocaloric Devices	

Please Select One:	(●) Customer Number	( ) US Patent Practitioner	( ) Limited Recognition (37 CFR 11.9)
Customer Number	93726		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing benefit claim information in the Application Data Sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.
When referring to the current application, please leave the "Application Number" field blank.

Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
16341618	a 371 of international	PCT/EP2017/076203	2017-10-13

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button.

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)[i] the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

			Remove
Application Number	Country[i]	Filing Date (YYYY-MM-DD)	Access Code[i] (if applicable)
1617508.5	GB	2016-10-14	

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button.

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	MEWE-072
	Application Number	16/341,618
Title of Invention	Use of Barocaloric Materials and Barocaloric Devices	

Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

NOTE: This section of the Application Data Sheet is **ONLY** reviewed and processed with the **INITIAL** filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

A. Priority Document Exchange (PDX) - Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

B. Search Results from U.S. Application to EPO - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

2. Opt-Out of Authorizations to Permit Access by a Foreign Intellectual Property Office(s)

☐ A. Applicant **DOES NOT** authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.

☐ B. Applicant **DOES NOT** authorize the USPTO to transmit to the EPO any search results from the instant patent application. If this box is checked, the USPTO will not be providing the EPO with search results from the instant application.

NOTE: Once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	MEWE-072
	Application Number	16/341,618
Title of Invention	Use of Barocaloric Materials and Barocaloric Devices	

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant 1

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

○ Assignee	○ Legal Representative under 35 U.S.C. 117	○ Joint Inventor
◉ Person to whom the inventor is obligated to assign.	○ Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor:

If the Applicant is an Organization check here. ☒

Organization Name	Cambridge Enterprise Limited

Mailing Address Information For Applicant:

Address 1	The Old Schools, Trinity Lane		
Address 2			
City	Cambridge, Cambridgeshire	**State/Province**	
Country GB		Postal Code	CB2 1TN
Phone Number		Fax Number	
Email Address			

Additional Applicant Data may be generated within this form by selecting the Add button.

PTO/AIA/14 (02-18)
Approved for use through 11/30/2020. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	MEWE-072
	Application Number	16/341,618
Title of Invention	Use of Barocaloric Materials and Barocaloric Devices	

Applicant 2

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

○ Assignee	○ Legal Representative under 35 U.S.C. 117	○ Joint Inventor
◉ Person to whom the inventor is obligated to assign.	○ Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor:	

If the Applicant is an Organization check here. ☒

Organization Name	Universitat Politècnica de Catalunya

Mailing Address Information For Applicant:

Address 1	C/Jordi Girona 31		
Address 2			
City	Barcelona	**State/Province**	
Country	ES	Postal Code	08034
Phone Number		Fax Number	
Email Address			

Additional Applicant Data may be generated within this form by selecting the Add button.

Applicant 3

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

○ Assignee	○ Legal Representative under 35 U.S.C. 117	○ Joint Inventor
◉ Person to whom the inventor is obligated to assign.	○ Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor:	

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	MEWE-072
	Application Number	16/341,618
Title of Invention	Use of Barocaloric Materials and Barocaloric Devices	

If the Applicant is an Organization check here. ☒			
Organization Name	Universitat de Barcelona		
Mailing Address Information For Applicant:			
Address 1	Centre de Patents de la UB		
Address 2	Baldiri Reixac, 4 - Torre D		
City	Barcelona	**State/Province**	
Country	ES	Postal Code	08028
Phone Number		Fax Number	
Email Address			

Additional Applicant Data may be generated within this form by selecting the Add button.

Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Assignee 1

Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.

If the Assignee or Non-Applicant Assignee is an Organization check here. ☐

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	MEWE-072
	Application Number	16/341,618
Title of Invention	Use of Barocaloric Materials and Barocaloric Devices	

Mailing Address Information For Assignee including Non-Applicant Assignee:			
Address 1			
Address 2			
City		**State/Province**	
Country i		Postal Code	
Phone Number		Fax Number	
Email Address			

Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button.

Signature:

NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). **However, if this Application Data Sheet is submitted with the INITIAL filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).**

This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	/Bret E. Field, Reg. No. 37,620/			Date (YYYY-MM-DD)	2019-07-08
First Name	Bret	Last Name	Field	Registration Number	37,620

Additional Signature may be generated within this form by selecting the Add button.

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent CooperationTreaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

PTO/AIA/01 (08-12)
Approved for use through 11/30/2020. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	Use of Barocaloric Materials and Barocaloric Devices

As the below named inventor, I hereby declare that:

This declaration is directed to:

- ☐ The attached application, or
- ☒ United States application or PCT international application number PCT/EP2017/076203 filed on October 13, 2017.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

LEGAL NAME OF INVENTOR

Inventor: Javier Eduardo Moya Raposo Date (Optional): 5-6-2019

Signature: _____

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 1 minute to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	Use of Barocaloric Materials and Barocaloric Devices

As the below named inventor, I hereby declare that:

This declaration is directed to:

☐ The attached application, or

☒ United States application or PCT international application number PCT/EP2017/076203 filed on October 13, 2017.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

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LEGAL NAME OF INVENTOR

Inventor: Alexander Avramenko Date (Optional): 05.06.2019

Signature: 

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

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LEGAL NAME OF INVENTOR

Inventor: Lluís Manosa Carrera Date (Optional): 24/09/2019

Signature: 

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

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filed on October 13, 2017

The above-identified application was made or authorized to be made by me.

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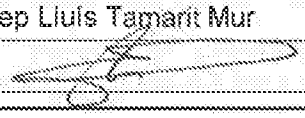
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LEGAL NAME OF INVENTOR

Inventor: Josep Lluis Tamarit Mur Date (Optional): April 26th 2019

Signature: 

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

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☒ United States application or PCT international application number PCT/EP2017/076203 filed on October 13, 2017.

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LEGAL NAME OF INVENTOR

Inventor: Pol Marcel Lloveras Muntané Date (Optional): _____

Signature: _____

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

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Electronic Patent Application Fee Transmittal

Application Number:	16341618
Filing Date:	
Title of Invention:	Use of Barocaloric Materials and Barocaloric Devices
First Named Inventor/Applicant Name:	Javier Eduardo Moya Raposo
Filer:	Bret E. Field/Eri Baker
Attorney Docket Number:	MEWE-072

Filed as Large Entity

Filing Fees for U.S. National Stage under 35 USC 371

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
PROCESSING FEE, EXCEPT PROV. APPLS.	1830	1	140	140
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**140**

Electronic Acknowledgement Receipt

EFS ID:	36496054
Application Number:	16341618
International Application Number:	
Confirmation Number:	1000
Title of Invention:	Use of Barocaloric Materials and Barocaloric Devices
First Named Inventor/Applicant Name:	Javier Eduardo Moya Raposo
Customer Number:	93726
Filer:	Bret E. Field/Eri Baker
Filer Authorized By:	Bret E. Field
Attorney Docket Number:	MEWE-072
Receipt Date:	08-JUL-2019
Filing Date:	
Time Stamp:	15:09:56
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$140
RAM confirmation Number	070919INTEFSW15102800
Deposit Account	
Authorized User	

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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Request under Rule 48 correcting inventorship	MEWE-072_Request_Correction_Inventorship-.pdf	155342 dfa8bdab08d94cc7845c328d77023cee032d8cc4	no	3
Warnings:					
Information:					
2	Application Data Sheet	MEWE-072_Corrected_ADS.pdf	132656 c8e1d212e86ea8fb6d3623728a6dd7f30882ba23	no	10
Warnings:					
Information:					
This is not an USPTO supplied ADS fillable form					
3	Oath or Declaration filed	MEWE-072_Declaration.pdf	3216363 759046b3ee3bc9045898da6905c7a7a6a86ad3cb	no	5
Warnings:					
Information:					
4	Fee Worksheet (SB06)	fee-info.pdf	30575 87d9eaddbbc3e7237316e5aefb89fb5380438afe	no	2
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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/08a (02-18)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	16341618
Filing Date	2019-04-12
First Named Inventor	Javier Eduardo Moya Raposo
Art Unit	N/A
Examiner Name	N/A
Attorney Docket Number	MEWE-072

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16341618
	Filing Date	2019-04-12
	First Named Inventor	Javier Eduardo Moya Raposo
	Art Unit	N/A
	Examiner Name	N/A
	Attorney Docket Number	MEWE-072

	1	ALONSO, Efectes barocalòrics en la transició plàstica del 1-Bromadamantà, June 2017, with a machine translation.	X
	2	CATALÁ, Efectes barocalòrics en cristalls plàstics, Escola Tècnica Superior d'Enginyeria Industrial de Barcelona, June 2016, with a machine translation.	☒
	3	GOMEZ et al., Efectes barocalòrics colossals en cristalls plàstics derivats del neopentà, Gener 2016, with a machine translation.	☒

If you wish to add additional non-patent literature document citation information please click the Add button Add

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	16341618
	Filing Date	2019-04-12
	First Named Inventor	Javier Eduardo Moya Raposo
	Art Unit	N/A
	Examiner Name	N/A
	Attorney Docket Number	MEWE-072

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Bret E. Field, Reg. No. 37,620/	Date (YYYY-MM-DD)	2019-05-17
Name/Print	Bret E. Field	Registration Number	37,620

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Acknowledgement Receipt

EFS ID:	36037765
Application Number:	16341618
International Application Number:	
Confirmation Number:	1000
Title of Invention:	Use of Barocaloric Materials and Barocaloric Devices
First Named Inventor/Applicant Name:	Javier Eduardo Moya Raposo
Customer Number:	93726
Filer:	Bret E. Field/Eri Baker
Filer Authorized By:	Bret E. Field
Attorney Docket Number:	MEWE-072
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Application number GB 1617508.5

1.	Your reference	**AJW/CP7205966**
2.	Full name, address and postcode of the applicant or of each applicant	**Cambridge Enterprise Limited** **The Old Schools** **Trinity Lane** **Cambridge CB2 1TN** **Cambridgeshire** **United Kingdom**
	Patents ADP number *(if you know it)*	
	Full name, address and postcode of the applicant or of each applicant	**Universitat Politècnica de Catalunya** **C/Jordi Girona 31** **Barcelona 08034** **Spain**
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	Full name, address and postcode of the applicant or of each applicant	**Universitat de Barcelona** **Centre de Patents de la UB** **Baldiri Reixac, 4 - Torre D** **Barcelona 08028** **Spain**
	Patents ADP number *(if you know it)*	
3.	Title of the invention	**USE OF BAROCALORIC MATERIALS AND BAROCALORIC DEVICES**
4.	Name of your agent *(if you have one)*	**MEWBURN ELLIS LLP**
	"Address for service" to which all correspondence should be sent. This may be in the European Economic area or Channel Islands (see warning note below) *(including the postcode)*	**MEWBURN ELLIS LLP** **City Tower** **40 Basinghall Street** **London EC2V 5DE** **Greater London** **United Kingdom**
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12. Name, e-mail address, telephone, fax and/or mobile number, if any, of a contact point for the applicant

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USE OF BAROCALORIC MATERIALS AND BAROCALORIC DEVICES

The project leading to this application has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (grant agreement No 680032).

Field of the Invention

The present invention provides the use of organic materials in methods of barocaloric cooling. The invention also provides for the use of the organic materials to achieve a barocaloric cooling effect, such as in a method of cooling. Also provided is a cooling device comprising an organic material for use as a barocaloric cooling agent.

Background

Foodstuffs, beverages, medical products and medical samples, electronics, and populated spaces such as offices, all require cooling. Current refrigeration and air-conditioning units rely primarily on the compression and expansion of environmentally harmful fluids, and there is strong interest in developing cooling systems that avoid such fluids. Recent developments in the field have looked at solid materials that display magnetically, electrically and mechanically driven phase transitions near room temperature. These materials will only gain commercial acceptance if they are shown to be inexpensive and capable of exhibiting large reversible thermal changes driven by applied fields that are easy to generate.

Caloric effects are currently under intense study due to the prospect of environmentally-friendly cooling applications. To date the work in this area has focussed on developing large magnetocaloric effects and large electrocaloric effects, but the former require large magnetic fields that are challenging to generate economically and the latter require large electric fields that can typically be applied without breakdown only in thin samples. For these reasons recent work has turned to mechanocaloric effects, such as elastocaloric effects, where the effects are driven by applied uniaxial stress, and barocaloric effects, which are driven by isotropic stress (hydrostatic pressure). These effects are attractive for the reason that mechanical stress is easy to generate and large mechanocaloric effects have been observed at relatively low applied stresses. However, the use of elastocaloric materials is limited, as these materials exhibit plastic flow which develops in the MPa range for metallic materials. For barocaloric materials there are no energy losses or mechanical breakdown associated with plastic deformation.

Large barocaloric effects (also referred to as BC effects) driven by hydrostatic pressure near phase transitions have been observed, but generally only in a small number of relatively expensive magnetic materials. Here, changes of magnetization are accompanied by changes in volume, with or without changes in crystal symmetry.

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It is known that first-order phase transitions release or absorb latent heat. This latent heat may be released or absorbed by the application of a specific field, which in the case of barocaloric materials is the application of a mechanical stress, and more accurately, the application of hydrostatic pressure. Large barocaloric effects are observed near the phase transition temperature when the first-order phase transition is induced by the applied isotropic stress.

For example, Matsunami *et al.* have described large barocaloric effects enhanced by the frustration of the antiferromagnetic phase in Mn_3GaN. Here, the large barocaloric effects are caused by an enhancement of the ratio of volume change against the pressure coefficient of the Néel temperature. The phase transition occurs around 290 K. The material shows a pressure-driven isothermal entropy change of around 21 J K^{-1} kg^{-1} due to a change in hydrostatic pressure of 0.09 GPa (with respect to ambient pressure), providing a barocaloric strength of 232 J K^{-1} kg^{-1} GPa^{-1} ($|\Delta S|/|\Delta p|$ which is maximized with the smallest $|\Delta p|$ compatible with maximizing $|\Delta S|$), and a refrigerant capacity of 125 J kg^{-1}.

Recently the present inventors have described larger barocaloric effects at low pressures in ferrielectric ammonium sulfate (see Lloveras *et al.*). Here ammonium sulfate undergoes a transition between a centrosymmetric orthorhombic structure and an orthorhombic polar structure at around 220 K. The large barocaloric effects are connected with pressure-driven changes in ionic ordering, which contrast with the smaller effects observed in magnetic materials, which are linked to pressure-driven changes in the density of electronic states near the Fermi level.

Ammonium sulfate shows a pressure-driven isothermal entropy change of around 60 J K^{-1} kg^{-1} due to changes in hydrostatic pressure of 0.10 GPa (with respect to ambient pressure), providing a barocaloric strength of 600 J K^{-1} kg^{-1} GPa^{-1}, and a refrigerant capacity of 276 J kg^{-1}.

There is a desire to identify materials exhibiting large barocaloric effects, and most particularly it is desirable to identify materials displaying a large isothermal entropy change at relatively low pressure. It is helpful to identify those materials exhibiting a large adiabatic temperature change in response to an applied isotropic stress, as well as those materials having a relative large latent heat. There is also the practical need to identify materials where a phase transition occurs near ambient temperatures.

Summary of the Invention

In a general aspect the invention provides for the use of an organic material, such as an organic material having a molecular weight of 2,000 or less, as a barocaloric cooling agent, for example where the organic material is used near a non-isochoric phase transition. The

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methods that permit the use of the organic material as a cooling agent may be adapted for use of the organic material as a heating agent.

Until now the materials known to provide barocaloric effects have been generally limited to inorganic materials, such as Mn_3GaN and ammonium sulfate. The inventors have found that organic materials that display volume changes due to first-order phase transitions may be used to provide a barocaloric effect. These organic materials typically display a very large pressure-driven shift in the phase transition temperature. Indeed, small changes in hydrostatic pressure are seen to drive giant barocaloric effects at or near phase transition in these materials.

The barocaloric effects for the organic materials are comparable to or exceed those previously observed for inorganic materials, such as magnetic, ferroelectric and ferrielectric inorganic materials. The organic materials are therefore suitable for use in barocaloric cooling methods and cooling devices. For example, the pressure-driven isothermal entropy change values for the organic materials, such as plastic crystals, may be comparable to or exceed those reported for Mn_3GaN or ammonium sulfate. The latent heat values and adiabatic temperature changes for the organic materials, such as plastic crystals, may be comparable to or exceed those reported for Mn_3GaN or ammonium sulfate. Furthermore, the phase transition temperatures for the organic materials may lie closer to ambient temperatures compared with a material such as ammonium sulfate.

The pressures required to drive the phase transition in the organic materials may also be small compared with the pressures required for the inorganic materials. The phase transitions in organic materials also have latent heat values that are comparable to those reported for the materials currently used in refrigerators and air-conditioning units.

The organic materials are attractive for the reason that they are widely available, and many materials can be obtained on a large scale, at low cost, and the materials have low toxicity, and can be easily and readily disposed of after use. In these respects the use of organic materials has an advantage over the previously reported barocaloric methods which use magnetic materials.

In one aspect of the invention there is provided the use of an organic material as a barocaloric cooling agent. Here, a barocaloric effect, which is typically a large barocaloric effect, may be developed from a relatively low applied hydrostatic pressure.

In a second aspect of the invention there is provided a method of cooling, such as a barocaloric cooling method, the method comprising the steps of:

(i) applying hydrostatic pressure to an organic material; and

(ii) permitting heat flow from or to the organic material, such as from or to the organic material;

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(iii) releasing hydrostatic pressure from an organic material that is under applied pressure; and

(iv) permitting heat flow to or from the organic material, such as to or from the organic material.

The method of the invention may comprise repeating steps (i) to (iv), for example to provide sustained cooling. The steps may be repeated as often as is required to provide the desired cooling effect.

A barocaloric organic material is a compound, or a salt of that compound, having a carbon atom, and optionally having one or more carbon-carbon bonds and/or one or more carbon-hydrogen bonds.
The barocaloric organic material may have a molecular weight of 2,000 or less, such as 1,000 or less. Here, the organic material is not a polymer.
The barocaloric organic material may be a plastic crystal.
The barocaloric organic material may be a liquid crystal.
The barocaloric organic material may be an alkyl carboxylate salt.

In the methods of the invention, the hydrostatic pressure is applied near the transition temperature of the organic material, such as a temperature near and above the transition temperature (for conventional barocaloric materials) or near and below the transition temperature (for inverse barocaloric materials). It is here that large barocaloric effects are observed. For example, the hydrostatic pressure is applied at a temperature that is within 50 K, such as within 20 K, such as within 15 K, such as within 10 K, such as within 5 K, such as within 2 K, such as within 1 K, such as within 0.5 K of the transition temperature, which is the transition temperature of the organic material absent the applied hydrostatic pressure (for example, the transition temperature under ambient pressure).

In the methods of the invention, the hydrostatic pressure may be applied at a level sufficient to induce the phase transition.

In another aspect of the invention there is provided a cooling apparatus, the apparatus comprising an organic material as a barocaloric cooling agent.

The apparatus may also comprise means for applying hydrostatic pressure to the organic material.
The apparatus may also comprise means for transferring heat to and from the organic material.
The organic material may be provided in a pressure-transfer medium, such as a pressure transfer fluid.

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These and other aspects and embodiment of the invention are described in further detail below.

Summary of the Figures

Figure 1 shows the change in entropy (J K^{-1} kg^{-1}) with change in temperature (K) for barium dicalcium propionate (BDP) with the application and release of hydrostatic pressure on the organic material, where the lower portion of the graph (negative entropy change) shows the application of pressure from no applied pressure to the specified applied pressure (GPa), and the upper portion of the graph (positive entropy change) shows the release of pressure from the specified applied pressure (GPa) to no applied pressure.

Figure 2 shows the change in entropy (J K^{-1} kg^{-1}) with change in temperature (K) for barium dicalcium butyrate (BDB) with the application and release of pressure on the organic material, where the lower portion of the graph (negative entropy change) shows the application of pressure from no applied pressure to the specified applied pressure (GPa), and the upper portion of the graph (positive entropy change) shows the release of pressure from the specified applied pressure (GPa) to no applied pressure.

Figure 3 shows the change in entropy (J K^{-1} kg^{-1}) with change in temperature (K) for the liquid crystal 4-(trans-4-pentylcyclohexyl) benzonitrile (PCH5) with the application and release of pressure on the organic material, where the lower portion of the graph shows data for the application of pressure from no applied pressure to the specified applied pressure (GPa), and the upper portion of the graph shows data for the release of pressure from the specified applied pressure (GPa) to no applied pressure.

Figure 4 shows the change in entropy (J K^{-1} kg^{-1}) with change in temperature (K) for a plastic crystal neopentyl glycol (NPG) with the application and release of pressure on the organic material, where the lower portion of the graph shows data for the application of pressure from no applied pressure to the specified applied pressure (GPa), and the upper portion of the graph shows data for the release of pressure from the specified applied pressure (GPa) to no applied pressure.

Figure 5 shows the change in refrigerant capacity, RC, (J kg^{-1}) with the change in hydrostatic pressure $|\Delta p|$ for the organic materials PCH5, NPG, BDP, and BDB (from top to bottom). The solid lines are linear fits to the data.

Detailed Description of the Invention

As noted previously, large barocaloric effects driven by hydrostatic pressure near phase transitions have been experimentally observed in a small number of relatively expensive

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magnetic materials, where changes of magnetization are accompanied by changes in volume, with or without changes in crystal symmetry.

Recent experimental work from the present inventors has shown that large barocaloric effects are observed in ammonium sulfate near the ferrielectric phase transition of this inorganic material.

The present inventors have now established that organic materials, such as those that display non-isochoric phase transitions, can provide large barocaloric effects. These organic materials may be used as alternatives to the inorganic materials that have previously been described for use in barocaloric cooling.

Rodriguez *et al.* have described the barocaloric temperature changes of poly(methyl methacrylate) under high applied hydrostatic pressure. However, the hydrostatic pressure is not apparently applied at a temperature close to a first-order phase transition of the polymer.

Patel *et al.* have described the elastocaloric and barocaloric effects in the polyvinylidene difluoride (PVDF) polymer PVDF-TrFE-CTFE (polyvinylidene difluoride-trifluoroethylene-chlorotrifluoroethylene). The authors estimate the barocaloric response of a ferroelectric polymer near its ferroelectric phase transition. The estimation is based on volume versus temperature data originally reported by Roland *et al.*

Mencke *et al.* have described the response of dihexadecylphosphatidylethanolamine (DHPE) in excess water to large hydrostatic pressure jumps. The authors observe a transition of the phospholipid from a lamellar liquid crystal to a lamellar gel when the material is subjected to a pressure jump from 200 to 600 bar (20 to 60 MPa). The work here is intended to exemplify a new apparatus for time-resolved X-ray diffraction studies using static and oscillating pressures and pressure jumps. There is no suggestion in this paper that organic materials would be generally useful in providing barocaloric cooling within a cooling apparatus.

The organic materials for use in the present case are also preferably lower molecular weight compounds and the salts thereof. Furthermore, the methods of the invention apply pressure at close to, such as within 50 K of, such as within 10 K of, the phase transition temperature of the organic material.

Organic Material

The organic material for use in the present invention may be an organic compound or a salt thereof. References to the organic compound may include a reference to the ionic form of the compound, as appropriate. Generally, the organic material has a molecular weight that

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is 2,000 or less. Thus, the organic materials for use in the present case are preferably small molecular weight compounds, and the salts thereof.

The organic compound, or the ionic form of the compound, has one or more carbon atoms, and most typically two or more carbon atoms. The organic compound will usually possess one or more carbon-carbon bonds, such as two or more carbon-carbon bonds. The organic material may therefore be contrasted with an inorganic material, which does not contain a carbon atom.

The organic compound, or the ionic form of the compound, will typically also contain hydrogen, and the material will usually have one or more carbon-hydrogen bonds, such as two or more carbon-hydrogen bonds.

The organic compound may additionally contain heteroatoms, such as nitrogen, oxygen, sulfur and/or fluorine atoms. The organic compound may therefore contain one or more carbon-heteroatom bonds, such as carbon-oxygen bonds.

The organic compound may contain one or more groups selected from alkyl, alkenyl, alkynyl, cycloalkyl, heterocyclyl, aryl including carboaryl and heteroaryl.

Multiple groups of the same type may be present in the organic compound. For example, an organic material may contain a plurality of cycloalkyl, heterocyclyl, or aryl groups.

Where the organic compound contains ring systems, such as cycloalkyl, heterocyclyl, or aryl groups, these groups may include fused ring systems. For example, an organic material exemplified herein is adamantane, which may be regarded as having fused cycloalkyl groups.

In addition the organic compound may contain one or more groups selected from halo, hydroxyl, carboxyl, oxo such as keto and acyl, ester, carbonate, amino, amido, carbamate, carbamide (urea), cyano, nitrile and nitro.

The carboxyl group may be in ionic form as a carboxylate together with an appropriate counter cation.
The amino group may be in ionic form as a quaternary amine together with an appropriate counter anion.

The organic compound may contain an alkyl group, such as a C_{1-12} alkyl group.
The organic compound may itself be a hydrocarbon. The organic compound may be an alkane, including linear and branched alkanes, or a cycloalkane, such as those having fused carbocyclic rings, such as an alkane or cycloalkane having 4 or more, such as 5 or more,

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such as 10 or more, carbon atoms. For example, 1,3-dimethyladamantane may be used as an organic material in the methods of the present case.
The organic compound may contain an aryl group, such as a carboaryl or a heteroaryl group. The carboaryl group may be phenyl or naphthyl.

In one embodiment, the organic compound is not a salt.
In one embodiment, the organic material is a salt of an organic compound. Here, the counter ion to the ionic form of the organic compound may be a metal ion or an organic ion. Although a metal counter ion may be present, the material may nevertheless be referred to as an organic material owing to the organic character of the ionic form of the organic compound.

A metal ion may be a mixed metal ion. For example, in the worked examples of the present case a mixed Ba and Ca counter ion is present in a propionate salt and a butyrate salt, and a mixed strontium and calcium counter ion is present in a propionate salt.

In one embodiment, the organic material does not contain a metal.
In one embodiment, the organic material does not contain a metal selected from the group consisting of Group 3 to 16 metals, such as Group 3 to 12 metals.

In other embodiments, the organic material does contain a metal. Typically, where a metal is present it is a counter ion to an ionic form of the organic compound. Thus, the metal is typically a cationic species. Where a metal is present it may be a Group 1 and/or a Group 2 metal. The examples in the present case include anionic forms of organic compounds together with Group 2 metal cations, such as barium, calcium and strontium cations.

In one embodiment, the organic material is an alkyl carboxylic acid or an alkyl carboxylate salt, and preferably an alkyl carboxylate. The alkyl group may have three or more carbon atoms, such as 3 or 4 carbon atoms (including the carbon atom provided by the acid group). The worked examples in the present case show barocaloric effects provided by propionate and butyrate salts.

In one embodiment, the organic material may be an alkyl carboxylic acid or an alkyl carboxylate salt where one or more, such as one or two, hydrogen atoms may be substituted with fluorine. The present inventors have found that alkyl carboxylates may be used in the methods of the present invention and fluorinated versions of the alkyl carboxylates are known to have a number of phase transitions at around ambient temperature and below. For example, Yano *et al.* describe the phase transitions of alkyl carboxylates and fluorinated alkyl carboxylates.

In one embodiment, the organic material is a soft matter material, such as a plastic crystal or a liquid crystal.

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A plastic crystal typically has long-range translational order, which may be seen, for example, in the X-ray diffraction pattern for the material, where sharp Bragg peaks are visible, but there is no orientational order.

A liquid crystal has little or no long-range translational order, but orientational order is present. Thus, Bragg peaks are not visible in the X-ray diffraction pattern of the material. Further, plastic crystals have globular motifs, whereas liquids crystals have non-globular motifs.

An organic material having a plastic crystal phase, where there is no orientational order of the crystals, may be converted to or from a phase where there is orientational order, for example with a change in the temperature. Such a phase transition may be used in the methods of the invention.

A description of organic materials having plastic crystal character is provided by Timmermans, the contents of which are hereby incorporated by reference. A description of organic materials having plastic crystal or liquid crystal character is provided by Wunderlich *et al.*, the contents of which are hereby incorporated by reference.

The worked examples in the present case describe the use of organic materials having a plastic crystal character. Examples include neopentane and adamantane derivatives, such as 1-adamantanol.

The plastic crystal may comprise an alkyl group or a cycloalkyl group.

The cycloalkyl group may be an adamantyl group. The adamantyl group may be optionally substituted with one or more groups selected from the group consisting of alkyl, halo, hydroxyl and oxo.

The alkyl group may be a C_{4-20} alkyl group, such as a C_{4-5} alkyl group. The alkyl group is optionally substituted with one or more groups selected from the group consisting of hydroxyl, amino and nitro.

The worked examples in the present case describe the use of an organic material having a liquid crystal character. An example includes the liquid crystal PCH5.

The liquid crystal may comprise one or more groups selected from alkyl, cycloalkyl and aryl, such as wherein the liquid crystal has an alkyl group, a cycloalkyl group and an aryl group.

In one embodiment, the organic material is not lyotropic. Thus, the organic material may not be a phospholipid. Typically, the organic material is not provided, such as dispersed, within a solvent, such as water.

An organic material may contain one or more different organic compounds or salts thereof, and each of these compounds or salts may be as described herein. The individual compounds or their salts may have different transition temperatures. Such composites can

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be operated in a parallel or a cascade mode in order to enhance the temperature span of operation.

The organic materials for use in the present case are typically small molecular weight compounds.

The organic material may have a molecular weight that is at least 50, at least 65, at least 70, at least 100, or at least 150.

The organic material may have a molecular weight that is at most 500, at most 700, at most 1,000, at most 2,000, at most 5,000 or at most 10,000.

The organic material may have a molecular weight that is in a range selected from the lower and upper limits given above. For example, the organic material may have a molecular weight that is in the range 50 to 1,000, such as 100 to 500.

Typically, the organic compound is not a high molecular weight compound, such as a polymer.

It is noted that the work of Patel *et al.* uses a PVDF having a molecular weight of 530,000. The molecular weight of the PVDF-TrFE-CTFE polymer used by the authors is not reported. Rodriquez *et al.* study thermoelastic changes in poly(methyl methacrylate). The authors admit that they did not determine the molecular weight of the polymer or its size distribution.

The organic material may not be poly(methyl methacrylate), a polyvinylidene difluoride-containing polymer, such as polyvinylidene difluoride (PVDF) or PVDF-TrFE-CTFE, or a phospholipid, such as dihexadecylphosphatidylethanolamine (DHPE).

Where the organic material is a salt, the molecular weight may be the molecular weight of the ionic form of the organic compound, or the molecular weight of the ionic form of the organic compound together with its counter ion.

The organic material is usually provided within a pressure transmitting medium, which may be a fluid or a solid material, and such are described in further detail below in the detailed description of the methods of the invention. The organic material is typically not provided in water.

The organic material exhibits certain thermodynamic properties, and these are described below.

Organic Material Properties

The organic materials for use in the present case display barocaloric effects under applied isotropic stress. A reference to organic materials displaying conventional barocaloric effects is also a reference to organic materials displaying inverse barocaloric effects.

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Organic materials are generally expected to display conventional barocaloric effects under applied isotropic stress, where the material has a reduced volume at lower temperatures across the phase transition. However, inverse barocaloric effects may be observed in organic materials and such materials are equally useful in the methods of the invention. References to the properties of the organic materials are generally made with respect to those displaying conventional barocaloric effects. However, these references may be construed as references to materials displaying inverse effects, with the skilled person understanding the behaviour of those materials being opposite to those of conventional materials.

The organic material is a solid or it may have the characteristics of a mesophase, for example the organic compound may be a liquid crystal or plastic crystal, such as determined at ambient temperature, such as 270, 280 or 300 K, or at a lower temperature, such as 100, 150, 200, or 250 K, and at ambient pressure, such as at 101.3 kPa.

An organic material for use in the present invention may be a material having a reversible phase transition at a temperature lying in the range 100 to 450 K, such as 200 to 450 K, such as at ambient pressure, such as at 101.3 kPa.

A phase transition may be a transition between solid, plastic and liquid crystal phases. A phase transition may also be a transition between solid phases, or a transition between liquid crystal phases, or a transition between plastic crystal phases, or a transition between liquid and solid phases. In the present case the methods of cooling based on the barocaloric effect make use of these transitions occurring within the range 100 to 450 K, such as within the range 200 to 450 K, and most preferably the methods of the invention make use of transitions between or within solid and plastic crystal phases.

The inventors have previously found that ammonium sulfate undergoes a transition between a centrosymmetric orthorhombic structure and an orthorhombic polar structure at around 220 K.

An organic material may undergo a displacive or order-disorder phase transition.

The organic materials for use in the present case include alkyl carboxylate salts, such as BDP and BDB. The phase transition observed with these materials is a structural phase transition from cubic symmetry to orthorhombic symmetry, which leads to large changes in the volume of the organic material.

In other embodiments of the invention, organic materials having a plastic crystal phase are provided. The phase transition in these materials may be between the plastic crystal phase and the solid phase. For example, the phase transition, such as on cooling, may be

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between an orientationally disordered crystal phase and an orientationally ordered crystal phase.

In other embodiments of the invention, organic materials having a liquid crystal phase are provided. The phase transition in these materials, such as on cooling, may be between an orientationally disordered liquid phase and an orientationally ordered liquid phase.

Other types of phase transition may be utilised in the methods of the invention.

Examples of other types of transition include a phase transition between solid and liquid phases. Such transitions may be utilised with alkane compounds, for example.

The organic material typically does not exist in the gas phase in the temperature range 100 to 450 K, such as within the range 200 to 450 K, such as at ambient pressure, such as at 101.3 kPa. The methods of the invention do not make use of transitions to or from the gas phase.

For example, the organic material has a reversible phase transition that may lie at a temperature of at least 100, at least 150, at least 200, at least 210, at least 220, at least 230, at least 240, at least 245, at least 250, at least 260, at least 270, or at least 280 K.
For example, the reversible phase transition may lie at a temperature of at most 310, at most 315, at most 320, at most 330, at most 340, at most 350, at most 360, at most 370, at most 380, at most 390, at most 400, or at most 450 K.
In one embodiment, the organic material has a reversible phase transition lying in a temperature range selected from the minimum and maximum temperatures given above.
For example, the organic material has a reversible phase transition lying in the temperature range 245 to 340 K, such as 245 to 315 K or 280 to 330 K.

Most preferably the phase transition lies at a temperature that is close to, or at, ambient temperatures. Thus, as noted above, the reversible phase transition may lie at a temperature in the range 245 to 340 K, such as 245 to 315 K or 280 to 330 K.

More preferably, the phase transition for a material exhibiting conventional barocaloric effects lies at a temperature that is below ambient temperature, such as below 250 K. When hydrostatic pressure is applied to the organic material the transition temperature may be shifted to a temperature that lies within the ambient range or above, such as within the range 250 to 340 K, such as 270 to 340 K, such as 280 to 330 K.

More preferably, the phase transition for a material exhibiting inverse barocaloric effects lies at a temperature that is above ambient temperature, such as above 350 K. When hydrostatic pressure is applied to the organic material the transition temperature may be

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shifted to a temperature that lies within the ambient range or below, such as within the range 250 to 340 K, such as 270 to 340 K, such as 280 to 330 K.

The temperature given for the transition temperature may refer to the starting temperature for the transition, which may refer to the onset of the transition in a cooling or heating cycle at a constant rate of temperature change.

Many of the organic materials for use in the present invention have a reversible phase transition that lies in the preferred temperature ranges. For example BDB has a phase transition near 320 K, and BDP has a phase transition near 265 K. Ammonium sulfate has a reversible phase transition near 220 K, although it is noted that this material displays inverse barocaloric effects, whilst the organic materials exemplified in the present case display conventional barocaloric effects.

An organic material may have a plurality of reversible phase transitions and one or each phase transition may occur at a temperature within the limits given above. Where an organic material has a plurality of reversible phase transitions, the methods of the invention may make use of one or more of these transitions, and typically one of these transitions. The methods of the invention may make use of the transition that lies closest to ambient temperature, such as closest to 270, 280 or 300 K.

The presence of a phase transition in the organic material may be established from the analysis of the heat flow performance of the material across a temperature range including the temperatures mentioned above. For example, the measurements of heat flow may be made by differential scanning calorimetry, such as using a temperature scan rate of 10 K min^{-1}. Lloveras *et al.*, for example, describe a typical experiment for determining the transition temperature at atmospheric pressure (see the *Methods* section, *Calorimetry at Atmospheric Pressure* at page 5, together with Figure 1(b)).

The phase transition temperature may be expressed as the transition temperature observed on heating, cooling, or as the average of the heating and cooling transitions.

An organic material may exhibit an endothermic transition upon heating through the transition point (thus the latent heat Q_0 is > 0). It follows then that the organic materials will exhibit an exothermic transition upon cooling through the transition point (thus Q_0 is < 0).

The entropy change at the transition, $|\Delta S_0|$, may be at least 10, at least 20, at least 50, at least 60, at least 70, at least 80, at least 90, at least 100, at least 110, at least 120 or at least 130 J K^{-1} kg^{-1}, which is the magnitude of the change and this change may be positive or negative as appropriate during heating and cooling through the transition.

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However, many of the organic materials tested by the present inventors have a considerably greater entropy change $|\Delta S_0|$ associated with phase transitions. Thus, the entropy change at the transition may be at least 150, at least 200, at least 250, at least 300 or at least 350, at least 400, or at least 450 J K^{-1} kg^{-1}, which is the magnitude of the change and this change may be negative or positive as appropriate during cooling and heating through the transition. These entropy changes are considerably larger than those recorded for ammonium sulfate in the work of Lloveras *et al.* and also considerably larger than the values reported for metallic alloys (see Table 1 of Lloveras *et al.*, for example).

The entropy change may refer to the entropy change for the entire transition. Alternatively, where a transition includes a first-order transition optionally with other order transitions, the entropy change may refer to the entropy change for the first-order transition only. Where there is a first-order transition which is a part of the entire transition, the entropy change for the first-order transition may be at least 30%, at least 40% or at least 50% of the entropy change of the entire transition.

The entropy change may be expressed as the entropy change observed on heating, cooling, or as the average of the heating and cooling transitions.

The entropy change at the transition may be determined by differential scanning calorimetry, as noted above.

The phase transition is accompanied by a change in the unit cell volume of the material, for example the unit cell volume may increase on heating through the phase transition. This is the change observed for conventional barocaloric materials. A decrease in the unit cell volume may be observed for inverse barocaloric materials.

The volume change at the transition may be at least 1.0, at least 5.0, at least 10, at least 15, at least 20, at least 25, at least 30, at least 40 or at least 50 mm^3g^{-1}.
The volume change at the transition may be a change of at least 0.1%, at least 0.2%, at least 0.5%, or at least 1.0%.
The figures given above relate to the magnitude of the change, and this change may be positive or negative as appropriate during heating and cooling through the transition. For example, the volume change may refer to an increase (positive) change in the volume, as such might be observed on heating through the phase transition.

The volume change may refer to the volume change for the entire transition. Alternatively, where a transition includes a first-order transition optionally with other order transitions, the volume change may refer to the volume change for the first-order transition only. Where there is a first-order transition which is a part of the entire transition, the change in volume for the first-order transition may be at least 30%, at least 40% or at least 50% of the volume change for the entire transition.

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The change in the volume at the transition may be determined from X-ray diffraction analysis of the organic material during a temperature sweep across the phase transition (where the transition typically occurs across a temperature range). Lloveras *et al.*, for example, describe a typical experiment for determining the volume change at atmospheric pressure (see the *Methods* section, *X-Ray Diffraction* at page 5, together with Figure 1(d)). X-Ray diffraction measurements were used to determine the change in volume for the BDP and BDB organic materials described in the present case. The change in the volume at the transition may be determined from volumetric thermal expansion measurements, or from volumetric isothermal compressibility measurements at various temperatures.

The phase transition in the organic material may display a latent heat, $|Q_0|$, that is at least 1.0, at least 2.0 at least 3.0, at least 4.0, at least 5.0, at least 7.0, at least 9.0 or at least 10.0 kJ kg^{-1}.

Some organic materials, such as plastic crystals, have a phase transition that displays a latent heat, $|Q_0|$,that is very high. Thus, in some embodiments, the organic material may have a latent heat, $|Q_0|$, that is at least 25, at least 50, at least 75, at least 100, at least 150 or at least 200 kJ kg^{-1}.

The inorganic materials that have previously been used in the art for barocaloric cooling typically have latent heats in the range 2.0 to 13.2 kJ kg^{-1} (see Table 1 of Lloveras *et al.*, for example).

The latent heat values may be determined from the differential scanning calorimetry analysis of the material.

The organic materials display large barocaloric effects under applied pressure. In particular, the organic materials display a strong pressure-induced shift in the phase transition temperature.

The shift in transition temperature with applied pressure dT_0/dp, is relatively high for the organic components used herein. Thus, small or moderate pressures may be used to drive relatively large temperature changes.

In one embodiment, the change in transition temperature is at least 1 K, at least 2 K, at least 3 K, at least 4 K, at least 5 K, or at least 10 K, for example as measured for a change in applied pressure of 0.15 GPa. The figures given here relate to the magnitude of the change, which may be a positive change (for materials displaying conventional barocaloric effects) or a negative change (for materials displaying inverse barocaloric effects). In the worked examples of the present case, the organic materials are conventional and therefore they show a positive change in transition temperature. It will be understood that alternative materials may be used where a negative change in transition temperature is required.

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In one embodiment, the temperature change is an increase in the transition temperature under the applied pressure.

The temperature change refers to the adiabatic temperature change. The temperature change may be the temperature change derived from $-c\Delta T$ approximating to $T\Delta S = Q$ using the zero-pressure specific heat capacity c, the isothermal entropy change ΔS and the temperature of operation, T (Q is isothermal heat). It is appreciated that a large change in transition temperature with pressure does not always correspond to a large adiabatic temperature change, however in some instances it may do so.

The adiabatic temperature change can be calculated using the values of isothermal entropy change and heat capacity, which is a fundamental quantity known for most materials. The adiabatic temperature change may also be measured experimentally, for examples using the experimental set up described by Rodriquez *et al.*

In one embodiment, the change in transition temperature as a function of change in applied pressure, dT_0/dp, is at least 50, at least 100, at least 150, at least 200, at least 250, at least 400 or at least 500 K GPa^{-1}. The figures given here relate to the magnitude of the change, which may be positive, for example. The change in transition temperature as a function of change in applied pressure may be determined in heat flow experiments, during a heating step or a cooling step, for example at constant pressure. In the liquid crystal experiment described in the present case, the value of dT_0/dp is 210 K GPa^{-1}.

The organic materials typically have a large refrigerant capacity, RC.
In one embodiment, the refrigerant capacity, RC, is at least 100, at least, 150, at least 200, or at least 250 J kg^{-1}. The RC values may be the value determined at an applied hydrostatic pressure of 0.1, 0.2 or 0.3 GPa. The RC values may be the value determined at an applied hydrostatic pressure of 0.075, 0.01, 0.03 or 0.1 GPa.
Refrigerant capacity may be determined from the product of the maximum values of isothermal entropy change with the full width at half maximum (FWHM) of the isothermal entropy peak with temperature, as the absolute value. Thus, the value of RC may be determined as the product of the maximum isothermal entropy change with the full width at half maximum of the peak in $\Delta S(T)$, thus $RC = |\Delta S \times (FWHM \text{ of } \Delta S(T))|$.

In the present case, BDP has an RC value of 77.6 J kg^{-1} at 0.0075 GPa, BDB has an RC value of 560 J kg^{-1} at 0.1029 GPa, and PCH5 has an RC value of 8,765 J kg^{-1} at 0.104 GPa.

Methods and Uses

The present invention provides a method of cooling which uses the barocaloric effects of the organic materials described herein. Thus, the organic materials find use as cooling agents,

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for example within a cooling apparatus. The organic material may be referred to as a refrigerant.

The methods of the invention make use of the change in the thermal behaviour of an organic material under an applied pressure. The application of hydrostatic pressure to the organic material induces a change in the transition temperature. The barocaloric effect may be advantageously used within a heat pump cycle or a refrigeration cycle to provide heating or cooling respectively.

The methods of the invention allow for the use of organic materials displaying conventional barocaloric effects and inverse barocaloric effects.

The methods of the invention include the step of applying hydrostatic pressure to the organic material or releasing hydrostatic pressure from an organic material. Hydrostatic pressure refers to isotropic stress. This is to be contrasted with the uniaxial stresses that are applied to materials for use in elastocaloric cooling. Barocaloric materials have the advantage over elastocaloric materials in that they are not limited by the onset of plastic flow, which typically occurs at high applied pressures (typically hundreds of MPa).

The method of the invention may be performed in an environment at ambient temperature, such as a temperature from 0 to 35°C, such as 5 to 35°C, such as 10 to 30°C (corresponding to 273.15 to 308.15 K, such as 278.15 to 308.15 K, such as 283.15 to 303.15 K). The methods of the invention allow for the generation of cooler and warmer localised regions within the environment as part of the barocaloric cooling process. For example, the organic material may become warmer or cooler than the ambient environment in the methods of the invention.

The methods of the invention include the step of applying a pressurizing force to the organic material, thereby to cause a change in the phase transition temperature, such as to increase the transition temperature (as shown in the worked examples of the present case). Organic materials exhibiting inverse barocaloric effects will exhibit a decrease in the transition temperature under the application of pressure.

In one embodiment, a sufficient pressuring force is applied to move the transition temperature to a temperature that is in an ambient temperature, such as a temperature from 0 to 35°C, such as 5 to 35°C, such as 10 to 30°C (corresponding to 273.15 to 308.15 K, such as 278.15 to 308.15 K, such as 283.15 to 303.15 K).

The organic materials for use in the present case provide large changes in transition temperature with relatively small applied pressures. Thus, the value of dT_0/dp is relatively high compared with many of the inorganic materials described previously.

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The methods of the invention may use the organic material within conventional heating and cooling cycles in place of conventional materials, where the heating and cooling cycle is adapted to exploit the barocaloric effects of the organic materials.

Thus, the organic materials may be used within, for example, a Brayton cycle, an Ericsson cycle or a Carnot cycle to provide heating or cooling as required. The organic materials may also be used in alternative thermodynamic cycles to provide heating or cooling for a particular environment.

A method of the invention may comprise the steps of:

(i) applying hydrostatic pressure to an organic material; and

(ii) permitting heat flow from or to the organic material.

Where an organic material displays a conventional barocaloric effect upon application of hydrostatic pressure, step (ii) provides for the heat flow from the organic material. Where an organic material displays an inverse barocaloric effect, step (ii) provides for heat flow to the organic material.

A method of the invention may comprise the steps of:

(iii) releasing hydrostatic pressure from an organic material that is under applied pressure; and

(iv) permitting heat flow to or from the organic material.

Step (iii) may be referred to as a depressurisation step.

Where an organic material displays a conventional barocaloric effect upon release of hydrostatic pressure, step (iv) provides for the heat flow to the organic material. Where an organic material displays an inverse barocaloric effect, step (iv) provides for heat flow from the organic material.

The method of the invention may additionally comprise all of steps (i) to (iv) in a complete heat and cool cycle. Typically steps (i) and (ii) are undertaken prior to steps (iii) and (iv). The method may be a cooling method.

Where the method is a part of the Brayton cycle, for example, the pressure may be applied adiabatically, with, for example, a consequential heating of the organic material. In step (ii) there is a subsequent heat flow, for example from the organic material, which allows the organic material to return to its original temperature. In a further part of the cycle step, pressure may be released adiabatically with, for example, a consequential cooling of the organic material. In step (iv) there is a subsequent heat flow, for example to the organic material, which allows the organic material to return to its original temperature.

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Where the method is a part of the Ericsson cycle, for example, the pressurisation and depressurisation steps are performed isothermally. Thus, the organic material is maintained at a substantially constant temperature, with heat transfer occurring, and not subsequent to, the pressurisation and depressurisation steps.

The methods of the invention allow heat flow to and from the organic material with changes in applied pressure. The ability of the organic material to absorb heat from the environment, in response to a pressure-induced phase transition, thereby cooling the environment, allows the organic material to be used as a cooling agent in a cooling apparatus.

In the methods of the invention the organic material may be used with a heat transfer fluid to and from which heat may be transferred. The heat transfer fluid is typically a liquid.

The heat transfer fluid may transfer heat to the organic material, thereby resulting in the relative cooling of the heat transfer fluid. The cooled heat transfer fluid may then be taken from the organic material and delivered to a location where cooling is desired.

The heat transfer fluid may accept heat transfer from the organic material, thereby resulting in the relative cooling of the organic material. The heated heat transfer fluid may then be taken from the organic material and delivered to a location for cooling, such as a radiator or another such heat exchanger, for example for cooling to ambient temperature.

It is not necessary for the heat transfer fluid to directly contact the organic material, and the heat transfer may occur *via* a heat exchanger.

A heat exchanger may use a heat switch, such as a thermoelectric heat switch, an electromechanical heat switch, a solid-state thermal diode or a heat pipe. The use of compact switches of these types may improve the design of the cooling devices, and enhance their energy efficiency.

The organic material may also be used together with a regenerator in order to alter or increase the temperature range of operation. The organic material may itself be used as a regenerator.

The barocaloric effects observed with the organic materials can be achieved at relatively low pressures. Accordingly, the pressurizing force applied to the organic material may be relatively low in the methods of the invention.

In the methods of the invention, the hydrostatic pressure is applied in step (i) near the transition temperature of the organic material. It is here that large barocaloric effects are observed. For example, the hydrostatic pressure is applied at a temperature that is within 50 K, within 20 K, within 15 K, within 10 K, such as within 5 K, such as within 2 K, such as

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within 1 K, such as within 0.5 K of the transition temperature, which is the transition temperature of the organic material absent the applied hydrostatic pressure (for example, the transition temperature under ambient pressure).

In the methods of the invention, the hydrostatic pressure may be applied at a level sufficient to induce the phase transition.

When a hydrostatic pressurizing force is applied, the pressure may be at most 1.0 GPa, at most 0.5 GPa, at most 0.2 GPa, at most 0.15 GPa, at most 0.10 GPa, at most 0.09 GPa, at most 0.07 GPa, at most 0.06 GPa, at most 0.05 GPa, at most 0.04 GPa, at most 0.03 GPa, at most 0.02 GPa or at most 0.01 GPa.
When a pressurizing force is applied, the pressure may be at least 0.1 MPa, at least 0.5 MPa, at least 1.0 MPa, or at least 5.0 MPa.
The pressure applied may be a hydrostatic pressure in a range with the lower and upper limits selected from the values given above. For example, the hydrostatic pressure may be a pressure in the range 1.0 MPa to 0.1 GPa.

The pressurizing force is the change in pressure applied to the organic material. Typically the change in pressure is to or from ambient (atmospheric) pressure, such as to or from about 101 kPa.

Where the hydrostatic pressure is applied in step (i), there may be a rapid increase in pressure. Where the hydrostatic pressure is released in step (iii), the pressure may be a rapid release. This is preferred for systems operating as part of or whole of a Brayton cycle, in order to achieve adiabatic conditions.

Where the hydrostatic pressure is applied in step (i), there may be a slow increase in pressure. Where the hydrostatic pressure is released in step (iii), the pressure may be a slow release. This is preferred for systems operating as part of or whole of an Ericsson cycle, in order to achieve isothermal conditions.

The values of the transition temperature under a constant applied pressure (constant hydrostatic pressure) may be determined, for example using a differential thermal analyser operating under hydrostatic pressure at a heating or cooling rate of 1-2 k min^{-1}.

The application of hydrostatic pressure may be achieved by applying pressure to the organic material contained provided within a pressure-transmitting medium. Pressure-transmitting media are well known in the art and include liquid and solid materials. Typically, the pressure-transmitting medium is not water.

An example of a pressure-transmitting liquid includes alkoxy silane materials, such as DW-Therm, available from Huber Kältemaschinenbau GmbH.

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An example of a pressure-transmitting solid is alumina powder.

The methods of the invention may be for use in cooling foodstuffs or beverages.
The methods of the invention may be for use in cooling medicines.
The methods of the invention may be for use in cooling biological samples, such as tissues.
The methods of the invention may be for use in cooling electronic devices, such as devices for analytical measurements.
The methods of the invention may be used to cool air, such as air within building and vehicles.

Cooling Apparatus

The present invention provides a cooling apparatus containing an organic material as described herein, where the cooling apparatus is adapted to provide barocaloric cooling using the organic material.

The cooling apparatus comprises the organic material. The cooling apparatus may be provided with means for applying pressure to the organic component. The cooling apparatus may also be provided with means for transferring heat to and from the organic material.

Typically, the organic material is provided within a pressure transmitting medium, such as a pressure transmitting fluid, which is contained within a piston head space (or the piston chamber). The pressure transmitting medium is not essential, and pressure may be applied directly to the organic material, such as a material having a liquid phase, such as liquid crystals.

Thus, in one aspect the present invention provides a piston comprising the organic material within the head space.

The cooling apparatus may be for use in cooling foodstuffs and beverages, thus the cooling apparatus may be a component of a refrigerator or a freezer.
The cooling apparatus may find general use in cooling air, thus the cooling apparatus may be a component of an air-conditioning unit.

In other aspects of the invention there is more generally provided a heat engine for the transfer of heat between environments, where the heat engine has an organic material as a barocaloric working agent. Whilst the predominant use of refrigerants is in refrigerators and air-conditioning units, the principles underlying the mechanism of cooling an environment may also be used to heat an indoor environment, for example within an air-source heat pump.

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Here, a cool organic material in a first phase may be warmed by the outside ambient environment (including indirectly *via* a heat transfer fluid). The warmed organic material may then be taken isothermally to a second phase, with an associated heat transfer from the environment to the organic material (including indirectly *via* a heat transfer fluid). The organic material is then returned to the indoor environment, where it is permitted to return to the second phase, with an associated heat transfer from the organic material to the indoor environment.

The broad aspects of the invention encompass methods of heat transfer to and from an organic material using barocaloric effects. Thus, the methods of the invention relate to methods of cooling and methods of heating.

Other Preferences

Each and every compatible combination of the embodiments described above is explicitly disclosed herein, as if each and every combination was individually and explicitly recited.

Various further aspects and embodiments of the present invention will be apparent to those skilled in the art in view of the present disclosure.

"and/or" where used herein is to be taken as specific disclosure of each of the two specified features or components with or without the other. For example "A and/or B" is to be taken as specific disclosure of each of (i) A, (ii) B and (iii) A and B, just as if each is set out individually herein.

Unless context dictates otherwise, the descriptions and definitions of the features set out above are not limited to any particular aspect or embodiment of the invention and apply equally to all aspects and embodiments which are described.

Certain aspects and embodiments of the invention will now be illustrated by way of example and with reference to the figures described above.

Experimental Details and Results

The analysis of the organic materials described in the present case follows that of the work described by some of the present inventors in Lloveras *et al.* and Stern-Taulats *et al.*, the contents of both of which are hereby incorporated by reference in their entirety.

Materials

BDP and BDB were prepared, as needed, using standard techniques. An example preparation for BDP is set out below.

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Propionic acid (1 L), 100 g of barium carbonate (100 g) and 100 g of calcium carbonate (100 g) were purchased from Sigma Aldrich. Their respective purities were 99%, 99.8% and 99.98%, and the reagents were used directly without further purification.

BDP (around 10 g yield) was synthesized from propionic acid (10 mL), barium carbonate (3 g) and of calcium carbonate (3 g).

Barium carbonate or calcium carbonate, when combined with propionic acid in aqueous solution generates the corresponding propionate hydrate salt. The molar mass of barium carbonate and calcium carbonate could not be immediately established as the two carbonates absorb moisture from the air. For this reason, the barium propionate and calcium propionate were initially made separately. The mass of propionate hydrates is unaffected by humidity. The two propionate hydrates were combined together, to form BDP, keeping a reproducible molar ratio.

The plastic crystal and liquid crystal, NPG and PCH5, were purchased from commercial suppliers.

Measurements

Table 1 sets out the values for T_0, $|Q_0|$, $|\Delta S_0|$, dT_0/dp, and $|\Delta V_0|$, determined from the analysis of the organic materials BDP and BDB.

Table 2 sets out the values for T_0, $|Q_0|$, $|\Delta S_0|$, dT_0/dp, and $|\Delta V_0|$, determined from the analysis of various plastic crystals.

Table 3 sets out the values for T_0, $|Q_0|$, $|\Delta S_0|$, dT_0/dp, and $|\Delta V_0|$, determined from the analysis of the liquid crystal PCH5.

The results are shown in Figures 1 to 4.

T_0, $|\Delta S_0|$ and $|Q_0|$ were determined via differential scanning calorimetry at ambient pressure. dT_0/dp was determined *via* differential thermal analysis under applied hydrostatic pressure. $|\Delta V_0|$ was determined, for example, from temperature-dependent X-ray diffraction analysis at ambient pressure.

Barocaloric quantities were determined via quasi-direct methods, using differential thermal analysers that operate under hydrostatic pressure, with Peltier modules or thermocouples heat sensors, as for example described in Lloveras *et al.* (see *BC Effects in AS* at page 3, together with reported results in Figure 3, and the *Methods* section at page 5).

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Differential thermal analysis under hydrostatic pressure was performed as described by Mañosa *et al*. The data is shown in Figures 2 and 4 for BDB and PCH5.

Table 1 - Properties of Representative Organic Materials

Organic Material	T_0 (K)	$\|Q_0\|$ (J g^{-1})	$\|\Delta S_0\|$ (J K^{-1} kg^{-1})	dT_0/dp (K/GPa)	$\|\Delta V_0\|$ (mm^3 g^{-1})
BDP $Ba^{2+}Ca^{2+}{}_2[C_2H_5COO^-]_6$	267	10.7	42	332	17.5
BDB $Ba^{2+}Ca^{2+}{}_2[C_3H_7COO^-]_6$	325	4.72	14.5	500	10.1

The table shows transition temperature T_0, latent heat $|Q_0|$, entropy change $|\Delta S_0|$, shift of transition temperature with applied pressure dT_0/dp, and volume change across the transition $|\Delta V_0|$. The organic materials are barium and calcium salts of the organic compounds butyric acid and propionic acid.

Table 2 - Properties of Representative Plastic Crystal Organic Materials

Organic Material	T_0 (K)	$\|Q_0\|$ (J g^{-1})	$\|\Delta S_0\|$ (J K^{-1} kg^{-1})	dT_0/dp (K/GPa)	$\|\Delta V_0\|$ (mm^3 g^{-1})
PG	357.5	177.3	495.2	103.0	51.0
NPG	314.6	122.9	389.8	119.6	46.7
NPA	236.5	45.38	191.7	237.0	45.5
MN	260.1	51.15	196.5	130.7	25.7
MNP	312.0	140.0	449.1	81.0	36.4
AMP	352.6	221.6	629.7	76.0	48.1
TRIS	406.8	280.7	691.0	60.6	41.8
2-Br-Adamantane	277.9	56.20	202.2	243.0	52.8
2-O-Adamantane	221.0	52.79	239.0	181.0	43.5
1-Adamantanol	359.0	85.40	236.5	178.0	42.0
2-Adamantanol	389.3	52.42	134.6	64.3	4.60
1,3-Dimethyladamantane	367.5	46.56	210.7	288.0	60.7

The table shows transition temperature $|T_0|$, latent heat $|Q_0|$, entropy change $|\Delta S_0|$, shift of transition temperature with applied pressure dT_0/dp, and volume change across the transition $|\Delta V_0|$. PG = pentaglycerine; 2-(hydroxymethyl)-2-methylpropane-1,3-diol. NPG = neopentylglycol; 2,2-dimethyl-1,3-propanediol. NPA = neopentyl alcohol; 2,2-dimethyl-1-propanol. MN = 2-methyl-2-nitropropane. MNP = 2-methyl-2-nitro-1-propanol. AMP = 2-amino-2-methyl-1,3-propanediol. TRIS = Tris(hydroxymethyl)aminomethane.

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Table 3 - Properties of a Representative Liquid Crystal Organic Material

Organic Material	T_0 (K)	$\|Q_0\|$ (J g^{-1})	$\|\Delta S_0\|$ (J K^{-1} kg^{-1})	dT_0/dp (K/kbar)	$\|\Delta V_0\|$ (mm^3 g^{-1})
PCH5 *4-(trans*-4-pentylcyclohexyl) benzonitrile	303	87.6	290	210	60.8

The table shows transition temperature T_0, latent heat $|Q_0|$, entropy change $|\Delta S_0|$, shift of transition temperature with applied pressure dT_0/dp, and volume change across the transition $|\Delta V_0|$.

Figure 5 shows the refrigerant capacity, RC, values for the organic materials, BDP, BDB and PCH5, at different applied hydrostatic pressures.

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All documents mentioned in this specification are incorporated herein by reference in their entirety.

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Claims:

1. The use of an organic material as a barocaloric cooling or heating agent.

2. A method of barocaloric cooling or heating, the method comprising the steps of:
(i) applying hydrostatic pressure to an organic material; and
(ii) permitting heat flow from or to the organic material.
(iii) releasing hydrostatic pressure from an organic material that is under applied pressure; and
(iv) permitting heat flow to or from the organic material.

3. A cooling or heating apparatus comprising an organic material as a barocaloric cooling or heating agent.

4. The use, method or apparatus according to any one of claims 1 to 3, wherein the organic material is an organic compound or a salt thereof.

5. The use, method or apparatus according to any one of claims 1 to 3, wherein the organic material has a molecular weight of at most 2,000, such as at most 1,000.

6. The use, method or apparatus according to any one of claims 1 to 5, wherein the organic material has a molecular weight of at least 50.

7. The use, method or apparatus according to any one of claims 1 to 6, wherein the organic material is an organic compound or a salt thereof, and the organic compound has two or more carbon-carbon bonds.

8. The use, method or apparatus according to any one of claims 1 to 7, wherein the organic material is an organic compound or a salt thereof, and the organic compound has two or more carbon-hydrogen bonds.

9. The use, method or apparatus according to any one of claims 1 to 7, wherein the organic material is a liquid crystal or a plastic crystal.

10. The use, method or apparatus according to claim 9, wherein the organic material is a plastic crystal.

11. The use, method or apparatus according to claim 10, wherein the plastic crystal comprises an alkyl group or a cycloalkyl group.

12. The use, method or apparatus according to claim 11, wherein the plastic crystal comprises a cycloalkyl group, and the cycloalkyl group is an adamantantyl group.

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13. The use, method or apparatus according to claim 11, wherein the adamantantyl group is optionally substituted with one or more groups selected from the group consisting of alkyl, halo, hydroxyl and oxo.

14. The use, method or apparatus according to claim 11, wherein the plastic crystal comprises an alkyl group, and the alkyl group is a C_{4-20} alkyl group, such as a C_{4-5} alkyl group.

15. The use, method or apparatus according to claim 14, wherein the alkyl group is optionally substituted with one or more groups selected from the group consisting of hydroxyl, amino and nitro.

16. The use, method or apparatus according to claim 9, wherein the organic material is a liquid crystal.

17. The use, method or apparatus according to claim 9, wherein the liquid crystal comprises one or more groups selected from alkyl, cycloalkyl and aryl, such as wherein the liquid crystal has an alkyl group, a cycloalkyl group and an aryl group.

18. The use, method or apparatus according to any one of claims 1 to 8, wherein the organic material is an alkyl carboxylic acid or an alkyl carboxylate salt.

19. The use, method or apparatus according to claim 18, wherein the alkyl group has three or more carbon atoms, such as 3 or 4 carbon atoms.

20. The use, method or apparatus according to any one of claims 1 to 8, wherein the organic material is a hydrocarbon, such as an alkane or a cycloalkane.

21. The use, method or apparatus according to any one of claims 1 to 20, wherein the organic material has a phase transition at a temperature within the range 200 to 450 K, such as 245 to 340 K, such as 245 to 315 K.

22. The use, method or apparatus according to any one of claims 1 to 20, wherein the organic material has an entropy change at a phase transition, $|\Delta S_0|$, of at least 10 J K^{-1} kg^{-1}, such as at least 50 J K^{-1} kg^{-1}, such as at least 100 J K^{-1} kg^{-1}, such as at least 150 J K^{-1} kg^{-1}, such as at least 250 J K^{-1} kg^{-1}, such as at least 400 J K^{-1} kg^{-1}.

23. The use, method or apparatus according to any one of claims 1 to 22, wherein a phase transition in the organic material displays a latent heat, $|Q_0|$, that is at least 1 kJ kg^{-1}, such as at least 5.0 kJ kg^{-1}, such as at least 10.0 kJ kg^{-1}, such as at least 25 kJ kg^{-1}, such as at least 50 kJ kg^{-1}.

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24. The use, method or apparatus according to any one of claims 1 to 23, wherein the organic material has a volume change at the phase transition of at least 1.0 mm^3g^{-1}, such as at least 10 mm^3g^{-1}, such as at least 50 mm^3g^{-1}.

25. The use, method or apparatus according to any one of claims 1 to 24, wherein the organic material is provided within a pressure-transmitting medium, such as a pressure-transmitting fluid or a pressure-transmitting solid.

26. The use or method according to claim 1 or claim 2, wherein hydrostatic pressure is applied to the organic material at a temperature that is within 50 K, such as within 10 K, such as within 5 K, such as within 1 K, of a phase transition temperature of the organic material, where the phase transition temperature is the temperature for the phase transition in the absence of the hydrostatic pressure.

27. The use or method according to claim 26, wherein the applied hydrostatic pressure is at most 1.0 GPa, at most 0.5 GPa, at most 0.2 GPa, such as at most 0.1 GPa, such as at most 0.07 GPa.

28. The use or method according to claim 26 or claim 27, wherein the applied hydrostatic pressure is at least 0.1 MPa, such as at least 0.5 MPa, such as at least 5.0 MPa.

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Fig. 1

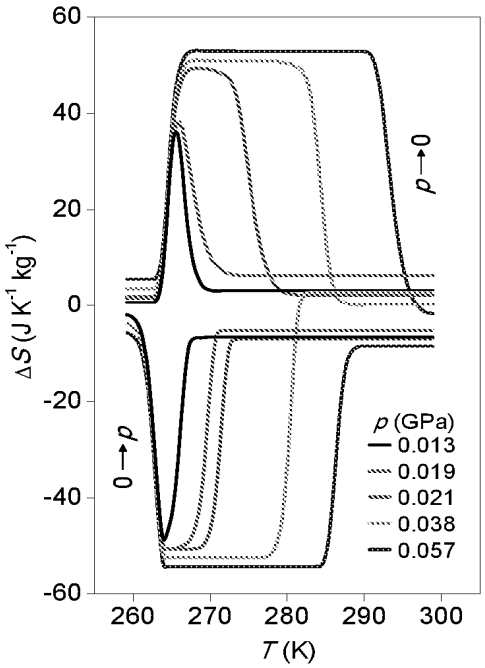
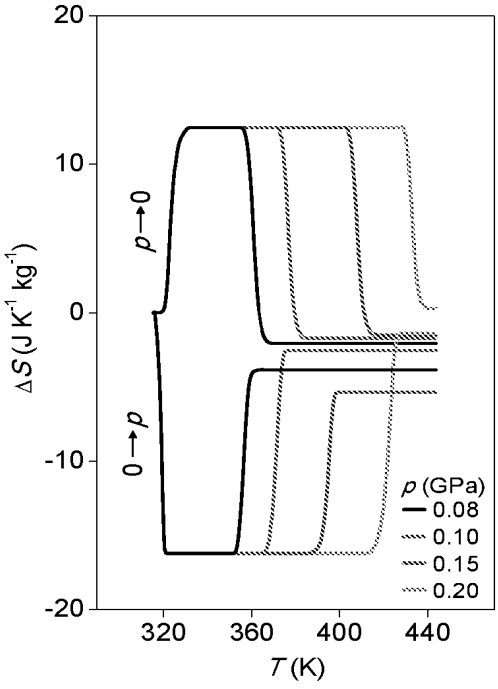


Fig. 2



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Fig. 3

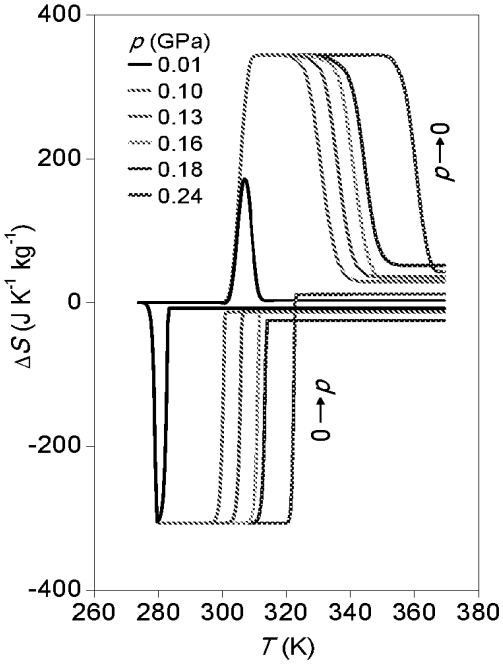
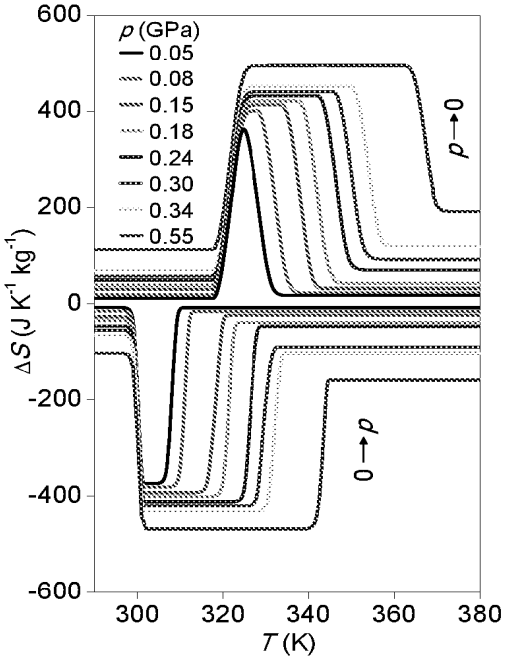
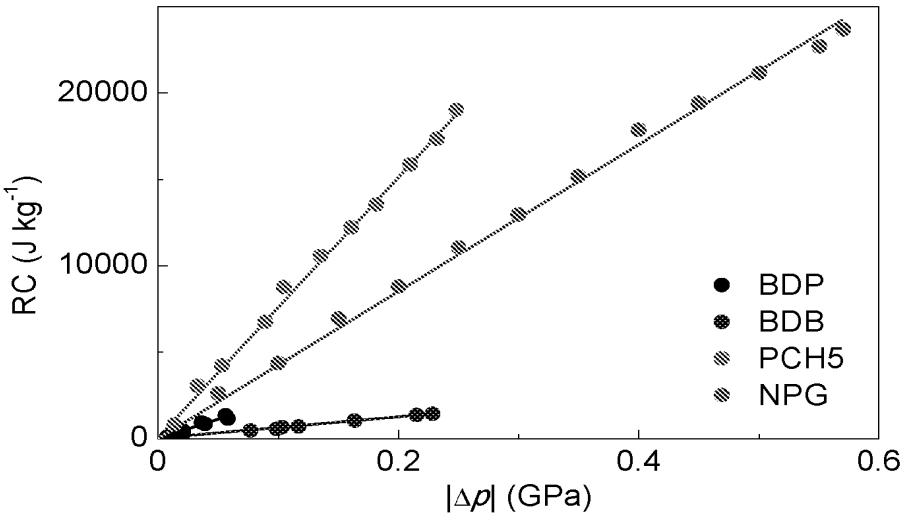


Fig. 4



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Fig. 5



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The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

PTO/AIA/14 (02-18)
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Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	MEWE-072
	Application Number	
Title of Invention	Use of Barocaloric Materials and Barocaloric Devices	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2:

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Javier	Eduardo	Moya Raposo	

Residence Information (Select One) US Residency ● Non US Residency Active US Military Service

City	Cambridge, Cambridgeshire	Country of Residence i	GB

Mailing Address of Inventor:

Address 1	Dept. of Matl. Sci. & Met., Univ. of Cambridge
Address 2	27 Charles Babbage Road
City	Cambridge, Cambridgeshire
State/Province	
Postal Code	CB3 0FS
Country i	GB

Inventor 2 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Alexandrovich		Avramenko	

Residence Information (Select One) US Residency ◉ Non US Residency Active US Military Service

City	Cambridge, Cambridgeshire	Country of Residence i	GB

Mailing Address of Inventor:

Address 1	Dept. of Matl. Sci. & Met., Univ. of Cambridge
Address 2	27 Charles Babbage Road
City	Cambridge, Cambridgeshire
State/Province	
Postal Code	CB3 0FS
Country i	GB

Inventor 3 Remove

Legal Name

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	MEWE-072
	Application Number	
Title of Invention	Use of Barocaloric Materials and Barocaloric Devices	

Prefix	Given Name	Middle Name	Family Name	Suffix
	Lluís		Manosa Carrera	

Residence Information (Select One) US Residency ◉ Non US Residency Active US Military Service

City	Barcelona	Country of Residence [i]	ES

Mailing Address of Inventor:

Address 1	Univ. de Barcelona, Centre de Patents de la UB		
Address 2	Baldiri Reixac, 4 - Torre D		
City	Barcelona	State/Province	
Postal Code	08028	Country [i]	ES

Inventor 4 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Josep	Lluís	Tamarit Mur	

Residence Information (Select One) US Residency ◉ Non US Residency Active US Military Service

City	Barcelona	Country of Residence [i]	ES

Mailing Address of Inventor:

Address 1	Univ. Politècnica de Catalunya		
Address 2	C/Jordi Girona 31		
City	Barcelona	State/Province	
Postal Code	08034	Country [i]	ES

Inventor 5 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Pol	Marcel	Lloveras Muntané	

Residence Information (Select One) US Residency ◉ Non US Residency Active US Military Service

City	Barcelona	Country of Residence [i]	ES

Mailing Address of Inventor:

Address 1	Univ. Politècnica de Catalunya		
Address 2	C/Jordi Girona 31		
City	Barcelona	State/Province	
Postal Code	08034	Country [i]	ES

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	MEWE-072
	Application Number	
Title of Invention	Use of Barocaloric Materials and Barocaloric Devices	

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below. For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	93726		
Email Address	docket@bozpat.com	Add Email	Remove Email

Application Information:

Title of the Invention	Use of Barocaloric Materials and Barocaloric Devices		
Attorney Docket Number	MEWE-072	**Small Entity Status Claimed**	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	3	**Suggested Figure for Publication (if any)**	1

Filing By Reference:

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	MEWE-072
	Application Number	
Title of Invention	Use of Barocaloric Materials and Barocaloric Devices	

Please Select One:	● Customer Number	US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)
Customer Number	93726		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing benefit claim information in the Application Data Sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.
When referring to the current application, please leave the "Application Number" field blank.

Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
	a 371 of international	PCT/EP2017/076203	2017-10-13

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button. Add

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)[i] the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Remove

Application Number	Country[i]	Filing Date (YYYY-MM-DD)	Access Code[i] (if applicable)
1617508.5	GB	2016-10-14	

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button. Add

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	MEWE-072
	Application Number	
Title of Invention	Use of Barocaloric Materials and Barocaloric Devices	

Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

NOTE: This section of the Application Data Sheet is **ONLY** reviewed and processed with the **INITIAL** filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

A. Priority Document Exchange (PDX) - Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

B. Search Results from U.S. Application to EPO - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

2. Opt-Out of Authorizations to Permit Access by a Foreign Intellectual Property Office(s)

☐ A. Applicant **DOES NOT** authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.

☐ B. Applicant **DOES NOT** authorize the USPTO to transmit to the EPO any search results from the instant patent application. If this box is checked, the USPTO will not be providing the EPO with search results from the instant application.

NOTE: Once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	MEWE-072
	Application Number	
Title of Invention	Use of Barocaloric Materials and Barocaloric Devices	

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant 1 Remove

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

Assignee	Legal Representative under 35 U.S.C. 117	Joint Inventor

● Person to whom the inventor is obligated to assign. | Person who shows sufficient proprietary interest

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor:

If the Applicant is an Organization check here. ☒

Organization Name	Cambridge Enterprise Limited		
Mailing Address Information For Applicant:			
Address 1	The Old Schools, Trinity Lane		
Address 2			
City	Cambridge, Cambridgeshire	**State/Province**	
Country	GB	Postal Code	CB2 1TN
Phone Number		Fax Number	
Email Address			

Additional Applicant Data may be generated within this form by selecting the Add button. Add

PTO/AIA/14 (02-18)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	MEWE-072
	Application Number	
Title of Invention	Use of Barocaloric Materials and Barocaloric Devices	

Applicant 2 Remove

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

Assignee	Legal Representative under 35 U.S.C. 117	Joint Inventor

(◉) Person to whom the inventor is obligated to assign. | Person who shows sufficient proprietary interest

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor:

If the Applicant is an Organization check here. ☒

Organization Name	Universitat Politècnica de Catalunya		
Mailing Address Information For Applicant:			
Address 1	C/Jordi Girona 31		
Address 2			
City	Barcelona	**State/Province**	
Country	ES	Postal Code	08034
Phone Number		Fax Number	
Email Address			

Additional Applicant Data may be generated within this form by selecting the Add button. Add

Applicant 3 Remove

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

Assignee	Legal Representative under 35 U.S.C. 117	Joint Inventor

(◉) Person to whom the inventor is obligated to assign. | Person who shows sufficient proprietary interest

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor:

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	MEWE-072
	Application Number	
Title of Invention	Use of Barocaloric Materials and Barocaloric Devices	

If the Applicant is an Organization check here. ☒			
Organization Name	Universitat de Barcelona		
Mailing Address Information For Applicant:			
Address 1	Centre de Patents de la UB		
Address 2	Baldiri Reixac, 4 - Torre D		
City	Barcelona	**State/Province**	
Country	ES	Postal Code	08028
Phone Number		Fax Number	
Email Address			

Additional Applicant Data may be generated within this form by selecting the Add button. Add

Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Assignee 1

Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.

Remove

If the Assignee or Non-Applicant Assignee is an Organization check here. ☐

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix

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Approved for use through 11/30/2020. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	MEWE-072
	Application Number	
Title of Invention	Use of Barocaloric Materials and Barocaloric Devices	

Mailing Address Information For Assignee including Non-Applicant Assignee:

Address 1			
Address 2			
City		**State/Province**	
Country i		Postal Code	
Phone Number		Fax Number	
Email Address			

Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button. Add

Signature:

Remove

NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). **However, if this Application Data Sheet is submitted with the INITIAL filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).**

This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	/Bret E. Field, Reg. No. 37,620/			Date (YYYY-MM-DD)	2019-04-12
First Name	Bret	Last Name	Field	Registration Number	37,620

Additional Signature may be generated within this form by selecting the Add button. Add

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1 The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3 A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent CooperationTreaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

ADVANCE E-MAIL

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF THE RECORDING OF A CHANGE

(PCT Rule 92*bis*.1 and Administrative Instructions, Section 422)

To:

MACIVER, Eleanor
Mewburn Ellis LLP
City Tower
40 Basinghall Street
London Greater London EC2V 5DE
ROYAUME-UNI

Date of mailing *(day/month/year)*
03 November 2017 (03.11.2017)

Applicant's or agent's file reference
EEMCP7304009

IMPORTANT NOTIFICATION

International application No.
PCT/EP2017/076203

International filing date *(day/month/year)*
13 October 2017 (13.10.2017)

1. The following indications appeared on record concerning:

☐ the applicant ☒ the inventor ☐ the agent ☐ the common representative

Name and Address
MOYA, Xavier
Department of Materials Science & Metallurgy
University of Cambridge
27 Charles Babbage Road
Cambridge Cambridgeshire CB3 0FS
United Kingdom

State of Nationality | State of Residence

Telephone No.

Facsimile No.

E-mail address

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

☐ the person ☒ the name ☐ the address ☐ the nationality ☐ the residence

Name and Address
MOYA RAPOSO , Javier Eduardo
Department of Materials Science & Metallurgy
University of Cambridge
27 Charles Babbage Road
Cambridge Cambridgeshire CB3 0FS
United Kingdom

State of Nationality | State of Residence

Telephone No.

Facsimile No.

E-mail address
☐ Notifications by e-mail authorized

3. Further observations, if necessary:

4. A copy of this notification has been sent to:

☒ the receiving Office
☒ the International Searching Authority
☐ the Authority(ies) specified for supplementary search
☐ the International Preliminary Examining Authority
☐ the designated Offices concerned
☐ the elected Offices concerned
☐ other:

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No. +41 22 338 89 75

Authorized officer
Hoehtker Christoph
e-mail pct.team5@wipo.int
Telephone No. +41 22 338 74 05

Pascal Technologies, Ex. 1002, page 263
Pascal Technologies v. Cambridge Enterprise Limited, Universitat De Barcelona, and Universitat Politècnica De Catalunya
IPR2024-01235

ADVANCE E-MAIL

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF THE RECORDING OF A CHANGE

(PCT Rule 92*bis*.1 and Administrative Instructions, Section 422)

To:

MACIVER, Eleanor
Mewburn Ellis LLP
City Tower
40 Basinghall Street
London Greater London EC2V 5DE
ROYAUME-UNI

Date of mailing *(day/month/year)*
03 November 2017 (03.11.2017)

Applicant's or agent's file reference
EEMCP7304009

IMPORTANT NOTIFICATION

International application No.
PCT/EP2017/076203

International filing date *(day/month/year)*
13 October 2017 (13.10.2017)

1. The following indications appeared on record concerning:

☐ the applicant ☒ the inventor ☐ the agent ☐ the common representative

Name and Address
CARRERA, Lluís Mañosa
Universitat de Barcelona
Centre de Patents de la UB
Baldiri Reixac, 4 - Torre D
08028 Barcelona
Spain

State of Nationality | State of Residence

Telephone No.

Facsimile No.

E-mail address

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

☐ the person ☒ the name ☐ the address ☐ the nationality ☐ the residence

Name and Address
MAÑOSA CARRERA, Lluís
Universitat de Barcelona
Centre de Patents de la UB
Baldiri Reixac, 4 - Torre D
08028 Barcelona
Spain

State of Nationality | State of Residence

Telephone No.

Facsimile No.

E-mail address
☐ Notifications by e-mail authorized

3. Further observations, if necessary:

4. A copy of this notification has been sent to:

☒ the receiving Office
☒ the International Searching Authority
☐ the Authority(ies) specified for supplementary search
☐ the International Preliminary Examining Authority
☐ the designated Offices concerned
☐ the elected Offices concerned
☐ other:

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No. +41 22 338 89 75

Authorized officer
Hoehtker Christoph
e-mail pct.team5@wipo.int
Telephone No. +41 22 338 74 05

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NOTIFICATION OF THE RECORDING OF A CHANGE

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International application No.
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International filing date *(day/month/year)*
13 October 2017 (13.10.2017)

1. The following indications appeared on record concerning:

☐ the applicant ☒ the inventor ☐ the agent ☐ the common representative

Name and Address
MUR, Josep Lluís Tamarit
Universitat Politècnica de Catalunya
C/Jordi Girona 31
08034 Barcelona
Spain

State of Nationality | State of Residence

Telephone No.

Facsimile No.

E-mail address

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

☐ the person ☒ the name ☐ the address ☐ the nationality ☐ the residence

Name and Address
TAMARIT MUR, Josep Lluís
Universitat Politècnica de Catalunya
C/Jordi Girona 31
08034 Barcelona
Spain

State of Nationality | State of Residence

Telephone No.

Facsimile No.

E-mail address
☐ Notifications by e-mail authorized

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☐ the designated Offices concerned
☐ the elected Offices concerned
☐ other:

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No. +41 22 338 89 75

Authorized officer
Hoehtker Christoph
e-mail pct.team5@wipo.int
Telephone No. +41 22 338 74 05

Pascal Technologies, Ex. 1002, page 265
Pascal Technologies v. Cambridge Enterprise Limited, Universitat De Barcelona, and Universitat Politècnica De Catalunya
IPR2024-01235

ADVANCE E-MAIL

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NOTIFICATION OF THE RECORDING OF A CHANGE

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ROYAUME-UNI

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03 November 2017 (03.11.2017)

Applicant's or agent's file reference
EEMCP7304009

IMPORTANT NOTIFICATION

International application No.
PCT/EP2017/076203

International filing date *(day/month/year)*
13 October 2017 (13.10.2017)

1. The following indications appeared on record concerning:

☐ the applicant ☒ the inventor ☐ the agent ☐ the common representative

Name and Address
MUNTANÉ, Pol Marcel Lloveras
Universitat Politècnica de Catalunya
C/Jordi Girona 31
08034 Barcelona
Spain

State of Nationality | State of Residence

Telephone No.

Facsimile No.

E-mail address

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

☐ the person ☒ the name ☐ the address ☐ the nationality ☐ the residence

Name and Address
LLOVERAS MUNTANÉ, Pol Marcel
Universitat Politècnica de Catalunya
C/Jordi Girona 31
08034 Barcelona
Spain

State of Nationality | State of Residence

Telephone No.

Facsimile No.

E-mail address
☐ Notifications by e-mail authorized

3. Further observations, if necessary:

4. A copy of this notification has been sent to:

☒ the receiving Office
☒ the International Searching Authority
☐ the Authority(ies) specified for supplementary search
☐ the International Preliminary Examining Authority
☐ the designated Offices concerned
☐ the elected Offices concerned
☐ other:

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No. +41 22 338 89 75

Authorized officer
Hoehtker Christoph
e-mail pct.team5@wipo.int
Telephone No. +41 22 338 74 05

Pascal Technologies, Ex. 1003, page 266
Pascal Technologies v. Cambridge Enterprise Limited, Universitat De Barcelona, and Universitat Politècnica De Catalunya
IPR2024-01235

Doc Code: PA..
Document Description: Power of Attorney

PTO/AIA/82A (07-13)
Approved for use through 01/31/2018. OMB 0651-0035
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

TRANSMITTAL FOR POWER OF ATTORNEY TO ONE OR MORE REGISTERED PRACTITIONERS

NOTE: This form is to be submitted with the Power of Attorney by Applicant form (PTO/AIA/82B) to identify the application to which the Power of Attorney is directed, in accordance with 37 CFR 1.5, unless the application number and filing date are identified in the Power of Attorney by Applicant form. If neither form PTO/AIA/82A nor form PTO/AIA82B identifies the application to which the Power of Attorney is directed, the Power of Attorney will not be recognized in the application.

Application Number	Filed herewtih
Filing Date	
First Named Inventor	Javier Eduardo Moya Raposo
Title	Use of Barocaloric Materials and Barocaloric Devices
Art Unit	
Examiner Name	
Attorney Docket Number	MEWE-072

SIGNATURE of Applicant or Patent Practitioner

Signature	/Bret E. Field, Reg. No. 37,620/	Date (Optional)	April 12, 2019
Name	Bret E. Field	Registration Number	37,620
Title (if Applicant is a juristic entity)			
Applicant Name (if Applicant is a juristic entity)			

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. If more than one applicant, use multiple forms.

☑ *Total of 3 forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Pascal Technologies v. Cambridge Enterprise Limited, Universitat De Barcelona, and Universitat Politècnica De Catalunya
IPR2024-01235

Doc Code: PA..
Document Description: Power of Attorney

PTO/AIA/82B (07-13)
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Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number

POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in either the attached transmittal letter or the boxes below.

Application Number	Filing Date
PCT/EP2017/076203	October 13, 2017

(Note: The boxes above may be left blank if information is provided on form PTO/AIA/82A.)

☑ I hereby appoint the Patent Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above: 93726

OR

☐ I hereby appoint Practitioner(s) named in the attached list (form PTO/AIA/82C) as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the patent application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above. (Note: Complete form PTO/AIA/82C.)

Please recognize or change the correspondence address for the application identified in the attached transmittal letter or the boxes above to:

☐ The address associated with the above-mentioned Customer Number

OR

☑ The address associated with Customer Number: 93726

OR

☐ Firm or Individual Name					
Address					
City		State		Zip	
Country					
Telephone		Email			

I am the Applicant (if the Applicant is a juristic entity, list the Applicant name in the box):

Cambridge Enterprise Limited

☐ Inventor or Joint Inventor (title not required below)

☐ Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)

☑ Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)

☐ Person Who Otherwise Shows Sufficient Proprietary Interest (e.g., a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document) (provide signer's title if applicant is a juristic entity)

SIGNATURE of Applicant for Patent

The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

Signature	B Bouquenaux	Date (Optional)	25 March 2019
Name	BORIS BOUQUENIAUX		
Title	HEAD OF SUPPORT SERVICES		

NOTE: Signature - This form must be signed by the applicant in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. If more than one applicant, use multiple forms.

☐ Total of forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Doc Code: PA..
Document Description: Power of Attorney

PTO/AIA/82B (07-13)
Approved for use through 01/31/2018. OMB 0651-0035
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in either the attached transmittal letter or the boxes below.

Application Number	Filing Date
PCT/EP2017/076203	October 13, 2017

(Note: The boxes above may be left blank if information is provided on form PTO/AIA/82A.)

☑ I hereby appoint the Patent Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above: 93726

OR

☐ I hereby appoint Practitioner(s) named in the attached list (form PTO/AIA/82C) as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the patent application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above. (Note: Complete form PTO/AIA/82C.)

Please recognize or change the correspondence address for the application identified in the attached transmittal letter or the boxes above to:

☐ The address associated with the above-mentioned Customer Number

OR

☑ The address associated with Customer Number: 93726

OR

☐ Firm or Individual Name					
Address					
City		State		Zip	
Country					
Telephone		Email			

I am the Applicant (if the Applicant is a juristic entity, list the Applicant name in the box):

Universitat Politécnica de Catalunya

☐ Inventor or Joint Inventor (title not required below)

☐ Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)

☑ Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)

☐ Person Who Otherwise Shows Sufficient Proprietary Interest (e.g., a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document) (provide signer's title if applicant is a juristic entity)

SIGNATURE of Applicant for Patent

The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

Signature		Date (Optional)	March 26, 2019
Name	Jordi Berenguer Sau		
Title	Vice-rector for Knowledge Transfer and Innovation		

NOTE: Signature - This form must be signed by the applicant in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. If more than one applicant, use multiple forms.

☐ Total of forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Doc Code: PA..
Document Description: Power of Attorney

PTO/AIA/82B (07-13)
Approved for use through 01/31/2018. OMB 0651-0035
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number

POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in either the attached transmittal letter or the boxes below.

Application Number	Filing Date
PCT/EP2017/076203	October 13, 2017

(Note: The boxes above may be left blank if information is provided on form PTO/AIA/82A.)

☑ I hereby appoint the Patent Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above: 93726

OR

☐ I hereby appoint Practitioner(s) named in the attached list (form PTO/AIA/82C) as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the patent application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above. (Note: Complete form PTO/AIA/82C.)

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☐ The address associated with the above-mentioned Customer Number

OR

☑ The address associated with Customer Number: 93726

OR

☐ Firm or Individual Name					
Address					
City		State		Zip	
Country					
Telephone		Email			

I am the Applicant (if the Applicant is a juristic entity, list the Applicant name in the box):

Universitat de Barcelona

☐ Inventor or Joint Inventor (title not required below)

☐ Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)

☑ Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)

☐ Person Who Otherwise Shows Sufficient Proprietary Interest (e.g., a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document) (provide signer's title if applicant is a juristic entity)

SIGNATURE of Applicant for Patent

The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

Signature	77288064Z M... CARME ... (Firmado digitalmente por 77288064Z M... CARME VERDAGUER ...)	Date (Optional)	March 28, 2019
Name	Mr. Oscar Grau Quer Montanyà		
Title	Managing Director of Fundació Bosch i Gimpera (management order from UB dated on 08 Feb 2010)		

NOTE: Signature - This form must be signed by the applicant in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. If more than one applicant, use multiple forms.

☐ Total of forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

PTO-1390 (01-18)
Approved for use through 8/31/2019. OMB 0651-0021
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A SUBMISSION UNDER 35 U.S.C. 371

Attorney Docket No.	
MEWE-072	
U.S. Application No. (if known, see 37 CFR 1.5)	

International Application No.	International Filing Date	Priority Date Claimed
PCT/EP2017/076203	October 13, 2017	October 14, 2016

Title of Invention
Use of Barocaloric Materials and Barocaloric Devices

First Named Inventor
Javier Eduardo Moya Raposo

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information.

1. ■ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). NOTE: The express request under 35 U.S.C. 371(f) will not be effective unless the requirements under 35 U.S.C. 371(c)(1), (2), and (4) for payment of the basic national fee, copy of the International Application and English translation thereof (if required), and the oath or declaration of the inventor(s) have been received.
2. ■ A copy of the International Application (35 U.S.C. 371(c)(2)) is attached hereto (not required if the International Application was previously communicated by the International Bureau or was filed in the United States Receiving Office (RO/US)).
3. An English language translation of the International Application (35 U.S.C. 371(c)(2))
   a. ☐ is attached hereto.
   b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
4. An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4))
   a. ☐ is attached.
   b. ☐ was previously filed in the international phase under PCT Rule 4.17(iv).

Items 5 to 8 below concern amendments made in the international phase.

PCT Article 19 and 34 amendments

5. ☐ Amendments to the claims under PCT Article 19 are attached (not required if communicated by the International Bureau) (35 U.S.C. 371(c)(3)).
6. ☐ English translation of the PCT Article 19 amendment is attached (35 U.S.C. 371(c)(3)).
7. ☐ English translation of annexes (Article 19 and/or 34 amendments only) of the International Preliminary Examination Report is attached (35 U.S.C. 371(c)(5)).

Cancellation of amendments made in the international phase

8a. ☐ Do not enter the amendment made in the international phase under PCT Article 19.

8b. ☐ Do not enter the amendment made in the international phase under PCT Article 34.

NOTE: A proper amendment made in English under Article 19 or 34 will be entered in the U.S. national phase application absent a clear instruction from applicant not to enter the amendment(s).

The following items 9 to 17 concern a document(s) or information included.

9. ■ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
10. ■ A preliminary amendment.
11. ■ An Application Data Sheet under 37 CFR 1.76.
12. ☐ A substitute specification. NOTE: A substitute specification cannot include claims. See 37 CFR 1.125(b).
13. ■ A power of attorney and/or change of address letter.
14. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13*ter*.3 and 37 CFR 1.821-1.825 (not required if sequence listing in text format was indicated on the PCT Request as part of the International Application and the sequence listing was published as part of the international application).
15. ☐ Assignment papers *(cover sheet and document(s))*. Name of Assignee: _____
16. ☐ 37 CFR 3.73(c) Statement *(when there is an Assignee)*.

This collection of information is required by 37 CFR 1.414 and 1.491-1.492. The information is required to obtain or retain a benefit by the public, which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 15 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Mail Stop PCT, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

U.S. APPLN. No. (if known – see 37 CFR 1.5)	INTERNATIONAL APPLICATION No.	ATTORNEY DOCKET No.
	PCT/EP2017/076203	MEWE-072

17. [X] Other items or information:

Notification of the Recording of a Change for correcting the name of four inventors

The following fees have been submitted.	CALCULATIONS
18. [■] Basic national fee (37 CFR 1.492(a)) **$300**	$ 300
19. [■] Examination fee (37 CFR 1.492(c)) • If the written opinion prepared by ISA/US or the international preliminary examination report prepared by IPEA/US indicates all claims satisfy provisions of PCT Article 33(1)-(4)..... **$0** • All other situations **$760**	$ 760
20. [■] Search fee (37 CFR 1.492(b)) • If the written opinion prepared by ISA/US or the international preliminary examination report prepared by IPEA/US indicates all claims satisfy provisions of PCT Article 33(1)-(4)..... **$0** • Search fee (37 CFR 1.445(a)(2)) has been paid on the international application to the USPTO as an International Searching Authority ..... **$140** • International Search Report prepared by an ISA other than the US and provided to the Office or previously communicated to the US by the IB..... **$520** • All other situations **$660**	$ 520
TOTAL OF 18, 19, and 20 =	$ 1,580

[ ] Additional fee for specification and drawings filed in paper over 100 sheets (excluding sequence listing in compliance with 37 CFR 1.821(c) or (e) in an electronic medium or computer program listing in an electronic medium) (37 CFR 1.492(j)).

Fee for each additional 50 sheets of paper or fraction thereof **$400**

Total Sheets	Extra Sheets	Number of each additional 50 or fraction thereof (round **up** to a whole number)	RATE
- 100 =	/ 50 =		x **$400**

$

Surcharge for furnishing any of the search fee, examination fee, or the oath or declaration after the date of commencement of the national stage (37 CFR 1.492(h))..... **$140**	$ 140

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	
Total claims	23 - 20 =	3	x **$100**	$ 300
Independent claims	- 3 =		x **$460**	$
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			**+ $820**	$

Fee for submission of Sequence Listing text file of 300 MB to 800 MB (37 CFR 1.21(o)(1))..... **$1,000**	$
Fee for submission of Sequence Listing text file of more than 800 MB (37 CFR 1.21(o)(2))..... **$10,000**	$
Processing fee for furnishing the English translation later than 30 months from the earliest claimed priority date (37 CFR 1.492(i))..... **$140 +**	$
TOTAL OF ABOVE CALCULATIONS =	$ 2,020
[ ] **Applicant asserts small entity status.** See 37 CFR 1.27. Fees above are reduced by ½.	
[ ] **Applicant certifies micro entity status.** See 37 CFR 1.29. Fees above are reduced by ¾. Applicant must attach form PTO/SB/15A or B or equivalent.	
TOTAL NATIONAL FEE =	$ 2,020
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31)..... **$50.00** per property **+**	$
TOTAL FEES ENCLOSED =	$ 2,020

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Pascal Technologies v. Cambridge Enterprise Limited, Universitat De Barcelona, and Universitat Politècnica De Catalunya
IPR2024-01235

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☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013, and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.

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Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	Use of Barocaloric Materials and Barocaloric Devices
First Named Inventor/Applicant Name:	Javier Eduardo Moya Raposo
Filer:	Bret E. Field/Eri Baker
Attorney Docket Number:	MEWE-072

Filed as Large Entity

Filing Fees for U.S. National Stage under 35 USC 371

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
NATIONAL STAGE FEE	1631	1	300	300
NATL STAGE SEARCH FEE - REPORT PROVIDED	1642	1	520	520
NATIONAL STAGE EXAM - ALL OTHER CASES	1633	1	760	760
Pages:				
Claims:				
CLAIMS IN EXCESS OF 20	1615	3	100	300
Miscellaneous-Filing:				
OATH/DECL > 30 MOS FROM 371 COMMENCEMENT	1617	1	140	140

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**2020**

Electronic Acknowledgement Receipt

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Application Number:	16341618
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Title of Invention:	Use of Barocaloric Materials and Barocaloric Devices
First Named Inventor/Applicant Name:	Javier Eduardo Moya Raposo
Customer Number:	93726
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Warnings:					
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2		MEWE-072_Preliminary_Amendment.pdf	45258 d90435502aa7cb6ca732088e79a9db2e0aaf4f84	yes	9

Multipart Description/PDF files in .zip description

Document Description	Start	End
Preliminary Amendment	1	1
Claims	2	7
Applicant Arguments/Remarks Made in an Amendment	8	9

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3	Non Patent Literature	Alonso_2017.PDF	2981291 26e83a1c98fc9b4edfe0bd0e5ffbf1d9641e67b7	no	60
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4	Non Patent Literature	Bell_2008.pdf	309135 f9f09b53d56544b133985179ae37a0e15cc1f8e0	no	6
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38	Information Disclosure Statement (IDS) Form (SB08)	MEWE-072_IDS.pdf	1040587 9a601942f9b77005603f212a1b498b20e5236e80	no	7
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39	Application Data Sheet	MEWE-072_ADS.pdf	1823244 71dcf5560c711a48abf6699abe0d3f23846533f1	no	10
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40	Documents submitted with 371 Applications	PCT_IB_306.PDF	162430 7fd667b111bb323b4c9a654da6932a5ad36303d5	no	4

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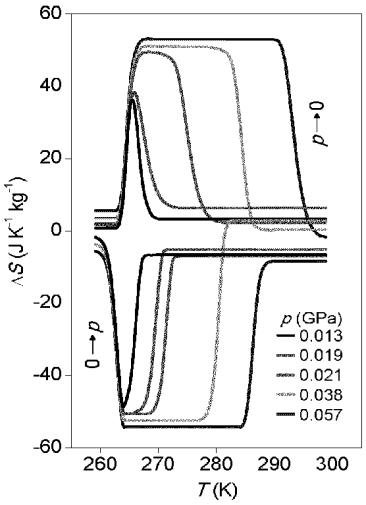
(74) Agent: **MACIVER, Eleanor** et al.; Mewburn Ellis LLP, City Tower, 40 Basinghall Street, London Greater London EC2V 5DE (GB).

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(54) Title: USE OF BAROCALORIC MATERIALS AND BAROCALORIC DEVICES

Fig. 1



(57) Abstract: Described herein is the use of organic materials in methods of barocaloric cooling. The barocaloric effects may be exhibited where the organic material is near a non-isochoric phase transition, such as a non-isochoric first-order phase transition. The organic material has one or more carbon atoms and may be an organic compound or a salt thereof. In some cases that organic material is a soft matter material, such as a plastic crystal or a liquid crystal. The methods may be adapted for use of the organic material as a heating agent.

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[Continued on next page]
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USE OF BAROCALORIC MATERIALS AND BAROCALORIC DEVICES

Related Application

The present case claims priority to, and the benefit of, GB 1617508.5 filed on 14 October 2016 (14/10/2016), the contents of which are hereby incorporated by reference in their entirety.

Funding

The project leading to this application has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (grant agreement No 680032).

Field of the Invention

The present invention provides the use of organic materials in methods of barocaloric cooling. The invention also provides for the use of the organic materials to achieve a barocaloric cooling effect, such as in a method of cooling. Also provided is a cooling device comprising an organic material for use as a barocaloric cooling agent.

Background

Foodstuffs, beverages, medical products and medical samples, electronics, and populated spaces such as offices, all require cooling. Current refrigeration and air-conditioning units rely primarily on the compression and expansion of environmentally harmful fluids, and there is strong interest in developing cooling systems that avoid such fluids. Recent developments in the field have looked at solid materials that display magnetically, electrically and mechanically driven phase transitions near room temperature. These materials will only gain commercial acceptance if they are shown to be inexpensive and capable of exhibiting large reversible thermal changes driven by applied fields that are easy to generate.

Caloric effects are currently under intense study due to the prospect of environmentally-friendly cooling applications. To date the work in this area has focussed on developing large magnetocaloric effects and large electrocaloric effects, but the former require large magnetic fields that are challenging to generate economically and the latter require large electric fields that can typically be applied without breakdown only in thin samples. For these reasons recent work has turned to mechanocaloric effects, such as elastocaloric effects, where the effects are driven by applied uniaxial stress, and barocaloric effects, which are driven by isotropic stress (hydrostatic pressure). These effects are attractive for the reason that mechanical stress is easy to generate and large mechanocaloric effects have been observed at relatively low applied stresses. However, the use of elastocaloric materials is limited, as

these materials exhibit plastic flow which develops in the MPa range for metallic materials. For barocaloric materials there are no energy losses or mechanical breakdown associated with plastic deformation.

Large barocaloric effects (also referred to as BC effects) driven by hydrostatic pressure near phase transitions have been observed, but generally only in a small number of relatively expensive magnetic materials. Here, changes of magnetization are accompanied by changes in volume, with or without changes in crystal symmetry.

It is known that first-order phase transitions release or absorb latent heat. This latent heat may be released or absorbed by the application of a specific field, which in the case of barocaloric materials is the application of a mechanical stress, and more accurately, the application of hydrostatic pressure. Large barocaloric effects are observed near the phase transition temperature when the first-order phase transition is induced by the applied isotropic stress.

For example, Matsunami *et al.* have described large barocaloric effects enhanced by the frustration of the antiferromagnetic phase in Mn_3GaN. Here, the large barocaloric effects are caused by an enhancement of the ratio of volume change against the pressure coefficient of the Néel temperature. The phase transition occurs around 290 K. The material shows a pressure-driven isothermal entropy change of around 21 J K^{-1} kg^{-1} due to a change in hydrostatic pressure of 0.09 GPa (with respect to ambient pressure), providing a barocaloric strength of 232 J K^{-1} kg^{-1} GPa^{-1} ($|\Delta S|/|\Delta p|$ which is maximized with the smallest $|\Delta p|$ compatible with maximizing $|\Delta S|$), and a refrigerant capacity of 125 J kg^{-1}.

Recently the present inventors have described larger barocaloric effects at low pressures in ferrielectric ammonium sulfate (see Lloveras *et al.*). Here ammonium sulfate undergoes a first-order transition between a centrosymmetric orthorhombic structure and an orthorhombic polar structure at around 220 K. The large barocaloric effects are connected with pressure-driven changes in ionic ordering, which contrast with the smaller effects observed in magnetic materials, which are linked to pressure-driven changes in the density of electronic states near the Fermi level.

Ammonium sulfate shows a pressure-driven isothermal entropy change of around 60 J K^{-1} kg^{-1} due to changes in hydrostatic pressure of 0.10 GPa (with respect to ambient pressure), providing a barocaloric strength of 600 J K^{-1} kg^{-1} GPa^{-1}, and a refrigerant capacity of 276 J kg^{-1}.

There is a desire to identify materials exhibiting large barocaloric effects, and most particularly it is desirable to identify materials displaying a large isothermal entropy change at relatively low pressure. It is helpful to identify those materials exhibiting a large adiabatic temperature change in response to an applied isotropic stress, as well as those materials

having a relative large latent heat. There is also the practical need to identify materials where a phase transition occurs near ambient temperatures.

Summary of the Invention

In a general aspect the invention provides for the use of an organic material, such as an organic material having a molecular weight of 2,000 or less, as a barocaloric cooling agent, for example where the organic material is used near a non-isochoric phase transition, such as a non-isochoric first-order phase transition. The methods that permit the use of the organic material as a cooling agent may be adapted for use of the organic material as a heating agent.

Until now the materials known to provide significant barocaloric effects have been generally limited to inorganic materials, such as Mn_3GaN and ammonium sulfate. The inventors have found that organic materials that display volume changes due to first-order phase transitions may be used to provide a barocaloric effect. These organic materials typically display a very large pressure-driven shift in the phase transition temperature. Indeed, small changes in hydrostatic pressure are seen to drive giant barocaloric effects at or near phase transition in these materials.

The barocaloric effects for the organic materials are comparable to or exceed those previously observed for inorganic materials, such as magnetic, ferroelectric and ferrielectric inorganic materials. The organic materials are therefore suitable for use in barocaloric cooling methods and cooling devices. For example, the pressure-driven isothermal entropy change values for the organic materials, such as plastic crystals, may be comparable to or exceed those reported for Mn_3GaN or ammonium sulfate. The latent heat values and adiabatic temperature changes for the organic materials, such as plastic crystals, may be comparable to or exceed those reported for Mn_3GaN or ammonium sulfate. Furthermore, the phase transition temperatures for the organic materials may lie closer to ambient temperatures compared with a material such as ammonium sulfate.

The pressures required to drive the phase transition in the organic materials may also be small compared with the pressures required for the inorganic materials. The phase transitions in organic materials also have latent heat values that are comparable to those reported for the materials currently used in refrigerators and air-conditioning units.

The organic materials are attractive for the reason that they are widely available, and many materials can be obtained on a large scale, at low cost, and the materials have low toxicity, and can be easily and readily disposed of after use. In these respects the use of organic materials has an advantage over the previously reported barocaloric methods which use magnetic materials.

In one aspect of the invention there is provided the use of an organic material as a barocaloric cooling agent. Here, a barocaloric effect, which is typically a large barocaloric effect, may be developed from a relatively low applied hydrostatic pressure.

In a second aspect of the invention there is provided a method of cooling, such as a barocaloric cooling method, the method comprising the steps of:

(i) applying hydrostatic pressure to an organic material; and

(ii) permitting heat flow from or to the organic material, such as from or to the organic material;

(iii) releasing hydrostatic pressure from an organic material that is under applied pressure; and

(iv) permitting heat flow to or from the organic material, such as to or from the organic material.

The method of the invention may comprise repeating steps (i) to (iv), for example to provide sustained cooling. The steps may be repeated as often as is required to provide the desired cooling effect.

A barocaloric organic material is a compound, or a salt of that compound, having a carbon atom, and optionally having one or more carbon-carbon bonds and/or one or more carbon-hydrogen bonds.

The barocaloric organic material may be a material having an observable first-order phase transition. Thus, the phase transition of the organic material may comprise a first-order phase transition, or the phase transition is a first-order phase transition.

The barocaloric organic material may have a molecular weight of 2,000 or less, such as 1,000 or less. Here, the organic material is not a polymer.

The barocaloric organic material may be a plastic crystal.

The barocaloric organic material may be a liquid crystal.

The barocaloric organic material may be an alkyl carboxylate salt.

In the methods of the invention, the hydrostatic pressure is applied near the transition temperature of the organic material, such as a temperature near and above the transition temperature (for conventional barocaloric materials) or near and below the transition temperature (for inverse barocaloric materials). It is here that large barocaloric effects are observed. For example, the hydrostatic pressure is applied at a temperature that is within 50 K, such as within 20 K, such as within 15 K, such as within 10 K, such as within 5 K, such as within 2 K, such as within 1 K, such as within 0.5 K of the transition temperature, which is

the transition temperature of the organic material absent the applied hydrostatic pressure (for example, the transition temperature under ambient pressure).

In the methods of the invention, the hydrostatic pressure may be applied at a level sufficient to induce the phase transition.

In another aspect of the invention there is provided a cooling apparatus, the apparatus comprising an organic material as a barocaloric cooling agent.

The apparatus may also comprise means for applying hydrostatic pressure to the organic material.

The apparatus may also comprise means for transferring heat to and from the organic material.

The organic material may be provided in a pressure-transfer medium, such as a pressure transfer fluid.

These and other aspects and embodiment of the invention are described in further detail below.

Summary of the Figures

Figure 1 shows the change in entropy (J K^{-1} kg^{-1}) with change in temperature (K) for barium dicalcium propionate (BDP) with the application and release of hydrostatic pressure on the organic material, where the lower portion of the graph (negative entropy change) shows data for the application of pressure from no applied pressure to the specified applied pressure (GPa), and the upper portion of the graph (positive entropy change) shows data for the release of pressure from the specified applied pressure (GPa) to no applied pressure.

Figure 2 shows the change in entropy (J K^{-1} kg^{-1}) with change in temperature (K) for barium dicalcium butyrate (BDB) with the application and release of pressure on the organic material, where the lower portion of the graph (negative entropy change) shows data for the application of pressure from no applied pressure to the specified applied pressure (GPa), and the upper portion of the graph (positive entropy change) shows data for the release of pressure from the specified applied pressure (GPa) to no applied pressure.

Figure 3 shows the change in entropy (J K^{-1} kg^{-1}) with change in temperature (K) for the liquid crystal 4-(trans-4-pentylcyclohexyl) benzonitrile (PCH5) with the application and release of pressure on the organic material, where the lower portion of the graph shows data for the application of pressure from no applied pressure to the specified applied pressure

(GPa), and the upper portion of the graph shows data for the release of pressure from the specified applied pressure (GPa) to no applied pressure.

Figure 4 shows the change in entropy (J K^{-1} kg^{-1}) with change in temperature (K) for a plastic crystal neopentyl glycol (NPG) with the application and release of pressure on the organic material, where the lower portion of the graph shows data for the application of pressure from no applied pressure to the specified applied pressure (GPa), and the upper portion of the graph shows data for the release of pressure from the specified applied pressure (GPa) to no applied pressure.

Figure 5 shows the change in entropy (J K^{-1} kg^{-1}) with change in temperature (K) for a plastic crystal 1-adamantanol with the application and release of pressure on the organic material, where the lower portion of the graph shows data for the application of pressure from no applied pressure to the specified applied pressure (GPa), and the upper portion of the graph shows data for the release of pressure from the specified applied pressure (GPa) to no applied pressure.

Figure 6 shows the change in refrigerant capacity, RC, (J kg^{-1}) with the change in hydrostatic pressure $|\Delta p|$ for the organic materials 1-adamantanol, PCH5, NPG, BDP, and BDB (from top to bottom). The solid lines are linear fits to the data.

Detailed Description of the Invention

As noted previously, large barocaloric effects driven by hydrostatic pressure near first-order phase transitions have been experimentally observed in a small number of relatively expensive magnetic materials, where changes of magnetization are accompanied by changes in volume, with or without changes in crystal symmetry.

Recent experimental work from the present inventors has shown that large barocaloric effects are observed in ammonium sulfate near the first-order ferrielectric phase transition of this inorganic material.

The present inventors have now established that organic materials, such as those that display non-isochoric phase transitions, and particularly non-isochoric first order phase transitions, can provide large barocaloric effects. These organic materials may be used as alternatives to the inorganic materials that have previously been described for use in barocaloric cooling.

Rodriguez *et al.* have described the barocaloric temperature changes of poly(methyl methacrylate) under high applied hydrostatic pressure. However, the hydrostatic pressure is not apparently applied at a temperature close to a first-order phase transition of the polymer.

Patel *et al.* have described the elastocaloric in the polyvinylidene difluoride (PVDF) polymer, and barocaloric effects in the polyvinylidene difluoride-trifluoroethylene-chlorotrifluoroethylene (PVDF-TrFE-CTFE) polymer. The authors estimate the barocaloric response of a ferroelectric polymer near its first-order ferroelectric phase transition. The estimation is based on volume versus temperature data originally reported by Roland *et al.*

Mikhaleva *et al.* have described very small barocaloric effects in triglycinesulfate (TGS) near a second-order ferroelectric phase transition. The authors describe these effects as insignificant, and they did not propose the use of TGS in cooling applications.

Xie and Zhu have suggested that dihexadecylphosphatidylethanolamine (DHPE), used in excess water, would exhibit barocaloric effects. Their suggestion is based on earlier reported work by Mencke *et al.* who described a transition of the phospholipid from a lamellar liquid crystal to a lamellar gel when the material was subjected to a pressure jump (from 20 to 60 MPa). Mencke *et al.* detected a temperature change that occurred approximately at the same time as this transition, but this temperature change was likely to have arisen due to pressure-driven temperature changes in water away from any transition, as recognised by the authors in their original paper, and as shown *via* basic thermodynamical calculations using water.

The work of Mencke *et al.* is intended to exemplify a new apparatus for time-resolved X-ray diffraction studies using static and oscillating pressures and pressure jumps. There is no suggestion in this paper that organic materials would be generally useful in providing barocaloric cooling within a cooling apparatus.

The organic materials for use in the present case are also preferably lower molecular weight compounds and the salts thereof. Furthermore, the methods of the invention apply pressure at close to, such as within 50 K of, such as within 10 K of, the phase transition temperature of the organic material.

Organic Material

The organic material for use in the present invention may be an organic compound or a salt thereof. References to the organic compound may include a reference to the ionic form of the compound, as appropriate. Generally, the organic material has a molecular weight that is 2,000 or less. Thus, the organic materials for use in the present case are preferably small molecular weight compounds, and the salts thereof.

The organic compound, or the ionic form of the compound, has one or more carbon atoms, and most typically two or more carbon atoms. The organic compound will usually possess one or more carbon-carbon bonds, such as two or more carbon-carbon bonds. The organic

material may therefore be contrasted with an inorganic material, which does not contain a carbon atom.

The organic compound, or the ionic form of the compound, will typically also contain hydrogen, and the material will usually have one or more carbon-hydrogen bonds, such as two or more carbon-hydrogen bonds.

The organic compound may additionally contain heteroatoms, such as nitrogen, oxygen, sulfur and/or fluorine atoms. The organic compound may therefore contain one or more carbon-heteroatom bonds, such as carbon-oxygen bonds.

The organic compound may contain one or more groups selected from alkyl, alkenyl, alkynyl, cycloalkyl, heterocyclyl, aryl including carboaryl and heteroaryl.

Multiple groups of the same type may be present in the organic compound. For example, an organic material may contain a plurality of cycloalkyl, heterocyclyl, or aryl groups.

Where the organic compound contains ring systems, such as cycloalkyl, heterocyclyl, or aryl groups, these groups may include fused ring systems. For example, an organic material exemplified herein is adamantane, which may be regarded as having fused cycloalkyl groups.

In addition the organic compound may contain one or more groups selected from halo, hydroxyl, carboxyl, oxo such as keto and acyl, ester, carbonate, amino, amido, carbamate, carbamide (urea), cyano, nitrile and nitro.

The carboxyl group may be in ionic form as a carboxylate together with an appropriate counter cation.

The amino group may be in ionic form as a quaternary amine together with an appropriate counter anion.

The organic compound may contain an alkyl group, such as a C_{1-12} alkyl group.

The organic compound may itself be a hydrocarbon. The organic compound may be an alkane, including linear and branched alkanes, or a cycloalkane, such as those having fused carbocyclic rings, such as an alkane or cycloalkane having 4 or more, such as 5 or more, such as 10 or more, carbon atoms. For example, 1,3-dimethyladamantane may be used as an organic material in the methods of the present case.

The organic compound may contain an aryl group, such as a carboaryl or a heteroaryl group. The carboaryl group may be phenyl or naphthyl.

In one embodiment, the organic compound is not a salt.

In one embodiment, the organic material is a salt of an organic compound. Here, the counter ion to the ionic form of the organic compound may be a metal ion or an organic ion. Although a metal counter ion may be present, the material may nevertheless be referred to as an organic material owing to the organic character of the ionic form of the organic compound.

A metal ion may be a mixed metal ion. For example, in the worked examples of the present case a mixed Ba and Ca counter ion is present in a propionate salt and a butyrate salt, and a mixed strontium and calcium counter ion is present in a propionate salt.

In one embodiment, the organic material does not contain a metal.

In one embodiment, the organic material does not contain a metal selected from the group consisting of Group 3 to 16 metals, such as Group 3 to 12 metals.

In other embodiments, the organic material does contain a metal. Typically, where a metal is present it is a counter ion to an ionic form of the organic compound. Thus, the metal is typically a cationic species. Where a metal is present it may be a Group 1 and/or a Group 2 metal. The examples in the present case include anionic forms of organic compounds together with Group 2 metal cations, such as barium, calcium and strontium cations.

In one embodiment, the organic material is an alkyl carboxylic acid or an alkyl carboxylate salt, and preferably an alkyl carboxylate. The alkyl group may have three or more carbon atoms, such as 3 or 4 carbon atoms (including the carbon atom provided by the acid group). The worked examples in the present case show barocaloric effects provided by propionate and butyrate salts.

In one embodiment, the organic material may be an alkyl carboxylic acid or an alkyl carboxylate salt where one or more, such as one or two, hydrogen atoms may be substituted with fluorine. The present inventors have found that alkyl carboxylates may be used in the methods of the present invention and fluorinated versions of the alkyl carboxylates are known to have a number of phase transitions at around ambient temperature and below. For example, Yano *et al.* describe the phase transitions of alkyl carboxylates and fluorinated alkyl carboxylates.

In some embodiments, the organic material is not an aminocarboxylic acid salt such as an amino acid salt, for example, a triglycine salt. In particular, the organic material is not an amino acid sulfate. Preferably the organic material is not triglycine sulfate (TGS). Triglycine sulfate is also known as glycine sulfate.

In one embodiment, the organic material is a soft matter material, such as a plastic crystal or a liquid crystal.

A plastic crystal typically has long-range translational order, which may be seen, for example, in the X-ray diffraction pattern for the material, where sharp Bragg peaks are visible, but there is no orientational order.

A liquid crystal has little or no long-range translational order, but orientational order is present. Thus, Bragg peaks are not visible in the X-ray diffraction pattern of the material. Further, plastic crystals have globular motifs, whereas liquids crystals have non-globular motifs.

An organic material having a plastic crystal phase, where there is no orientational order of the crystals, may be converted to or from a phase where there is orientational order, for example with a change in the temperature. Such a phase transition may be used in the methods of the invention.

A description of organic materials having plastic crystal character is provided by Timmermans, the contents of which are hereby incorporated by reference. A description of organic materials having plastic crystal or liquid crystal character is provided by Wunderlich *et al.*, the contents of which are hereby incorporated by reference.

The worked examples in the present case describe the use of organic materials having a plastic crystal character. Examples include neopentane and adamantane derivatives, such as 1-adamantanol.

The plastic crystal may comprise an alkyl group or a cycloalkyl group.

The cycloalkyl group may be an adamantyl group. The adamantyl group may be optionally substituted with one or more groups selected from the group consisting of alkyl, halo, hydroxyl and oxo.

The alkyl group may be a C_{4-20} alkyl group, such as a C_{4-5} alkyl group. The alkyl group is optionally substituted with one or more groups selected from the group consisting of hydroxyl, amino and nitro.

The worked examples in the present case describe the use of an organic material having a liquid crystal character. An example includes the liquid crystal PCH5.

The liquid crystal may comprise one or more groups selected from alkyl, cycloalkyl and aryl, such as wherein the liquid crystal has an alkyl group, a cycloalkyl group and an aryl group.

In one embodiment, the organic material is not lyotropic. Thus, the organic material may not be a phospholipid. Typically, the organic material is not provided, such as dispersed, within a solvent, such as water.

An organic material may contain one or more different organic compounds or salts thereof, and each of these compounds or salts may be as described herein. The individual compounds or their salts may have different transition temperatures. Such composites can be operated in a parallel or a cascade mode in order to enhance the temperature span of operation.

The organic materials for use in the present case are typically small molecular weight compounds.

The organic material may have a molecular weight that is at least 50, at least 65, at least 70, at least 100, or at least 150.

The organic material may have a molecular weight that is at most 500, at most 700, at most 1,000, at most 2,000, at most 5,000 or at most 10,000.

The organic material may have a molecular weight that is in a range selected from the lower and upper limits given above. For example, the organic material may have a molecular weight that is in the range 50 to 1,000, such as 100 to 500.

Typically, the organic compound is not a high molecular weight compound, such as a polymer.

It is noted that the work of Patel *et al.* uses a PVDF having a molecular weight of 530,000. The molecular weight of the PVDF-TrFE-CTFE polymer used by the authors is not reported. Rodriguez *et al.* study thermoelastic changes in poly(methyl methacrylate). The authors admit that they did not determine the molecular weight of the polymer or its size distribution.

The organic material may not be poly(methyl methacrylate), a polyvinylidene difluoride-containing polymer, such as polyvinylidene difluoride (PVDF) or PVDF-TrFE-CTFE, or a phospholipid, such as dihexadecylphosphatidylethanolamine (DHPE).

Where the organic material is a salt, the molecular weight may be the molecular weight of the ionic form of the organic compound, or the molecular weight of the ionic form of the organic compound together with its counter ion.

The organic material is usually provided within a pressure transmitting medium, which may be a fluid or a solid material, and such are described in further detail below in the detailed

description of the methods of the invention. The organic material is typically not provided in water.

The organic material exhibits certain thermodynamic properties, and these are described below.

Organic Material Properties

The organic materials for use in the present case display barocaloric effects under applied isotropic stress. A reference to organic materials displaying conventional barocaloric effects is also a reference to organic materials displaying inverse barocaloric effects.

Organic materials are generally expected to display conventional barocaloric effects under applied isotropic stress, where the material has a reduced volume at lower temperatures across the phase transition. However, inverse barocaloric effects may be observed in organic materials and such materials are equally useful in the methods of the invention. References to the properties of the organic materials are generally made with respect to those displaying conventional barocaloric effects. However, these references may be construed as references to materials displaying inverse effects, with the skilled person understanding the behaviour of those materials being opposite to those of conventional materials.

The organic material is a solid or it may have the characteristics of a mesophase, for example the organic compound may be a liquid crystal or plastic crystal, such as determined at ambient temperature, such as 270, 280 or 300 K, or at a lower temperature, such as 100, 150, 200, or 250 K, and at ambient pressure, such as at 101.3 kPa.

An organic material for use in the present invention may be a material having a reversible phase transition at a temperature lying in the range 100 to 450 K, such as 200 to 450 K, such as at ambient pressure, such as at 101.3 kPa.

A phase transition may be a transition between solid, plastic and liquid crystal phases. A phase transition may also be a transition between solid phases, or a transition between liquid crystal phases, or a transition between plastic crystal phases, or a transition between liquid and solid phases. In the present case the methods of cooling based on the barocaloric effect make use of these transitions occurring within the range 100 to 450 K, such as within the range 200 to 450 K, and most preferably the methods of the invention make use of transitions between or within solid and plastic crystal phases.

In some embodiments the phase transition is or comprises a first order phase transition, such as a transition between a mesophase, for example, a liquid crystal or plastic crystal phase, and a solid or liquid phase. Preferably, the transition is a first order phase transition.

Without wishing to be bound by theory, an ideal first-order phase transition is a transition in which the molar Gibbs energies or molar Helmholtz energies of the two phases (or chemical potentials of all components in the two phases) are equal at the transition temperature, but their first derivatives with respect to temperature and pressure (for example, specific enthalpy of transition and specific volume) are discontinuous at the transition point, as for two dissimilar phases that coexist and that can be transformed into one another by a change in a field variable such as pressure, temperature, magnetic or electric field.

The inventors have previously found that ammonium sulfate undergoes a transition between a centrosymmetric orthorhombic structure and an orthorhombic polar structure at around 220 K.

An organic material may undergo a displacive or order-disorder phase transition.

The organic materials for use in the present case include alkyl carboxylate salts, such as BDP and BDB. The phase transition observed with these materials is a structural phase transition from cubic symmetry to orthorhombic symmetry, which leads to large changes in the volume of the organic material.

In other embodiments of the invention, organic materials having a plastic crystal phase are provided. The phase transition in these materials may be between the plastic crystal phase and the solid phase. For example, the phase transition, such as on cooling, may be between an orientationally disordered crystal phase and an orientationally ordered crystal phase.

In other embodiments of the invention, organic materials having a liquid crystal phase are provided. The phase transition in these materials, such as on cooling, may be between an orientationally disordered liquid phase and an orientationally ordered liquid phase. Additionally or alternatively, the phase transition may be between a liquid phase and a solid phase.

Other types of phase transition may be utilised in the methods of the invention.

Examples of other types of transition include a phase transition between solid and liquid phases. Such transitions may be utilised with alkane compounds, for example. In a further example, such transitions may be utilised with liquid crystals.

The organic material typically does not exist in the gas phase in the temperature range 100 to 450 K, such as within the range 200 to 450 K, such as at ambient pressure, such as at 101.3 kPa. The methods of the invention do not make use of transitions to or from the gas phase.

For example, the organic material has a reversible phase transition that may lie at a temperature of at least 100, at least 150, at least 200, at least 210, at least 220, at least 230, at least 240, at least 245, at least 250, at least 260, at least 270, or at least 280 K. For example, the reversible phase transition may lie at a temperature of at most 310, at most 315, at most 320, at most 330, at most 340, at most 350, at most 360, at most 370, at most 380, at most 390, at most 400, or at most 450 K.

In one embodiment, the organic material has a reversible phase transition lying in a temperature range selected from the minimum and maximum temperatures given above. For example, the organic material has a reversible phase transition lying in the temperature range 245 to 340 K, such as 245 to 315 K or 280 to 330 K.

Most preferably the phase transition lies at a temperature that is close to, or at, ambient temperatures. Thus, as noted above, the reversible phase transition may lie at a temperature in the range 245 to 340 K, such as 245 to 315 K or 280 to 330 K.

More preferably, the phase transition for a material exhibiting conventional barocaloric effects lies at a temperature that is below ambient temperature, such as below 250 K. When hydrostatic pressure is applied to the organic material the transition temperature may be shifted to a temperature that lies within the ambient range or above, such as within the range 250 to 340 K, such as 270 to 340 K, such as 280 to 330 K.

More preferably, the phase transition for a material exhibiting inverse barocaloric effects lies at a temperature that is above ambient temperature, such as above 350 K. When hydrostatic pressure is applied to the organic material the transition temperature may be shifted to a temperature that lies within the ambient range or below, such as within the range 250 to 340 K, such as 270 to 340 K, such as 280 to 330 K.

The temperature given for the transition temperature may refer to the starting temperature for the transition, which may refer to the onset of the transition in a cooling or heating cycle at a constant rate of temperature change.

Many of the organic materials for use in the present invention have a reversible phase transition that lies in the preferred temperature ranges. For example BDB has a phase transition near 320 K, and BDP has a phase transition near 265 K. Ammonium sulfate has a reversible phase transition near 220 K, although it is noted that this material displays inverse barocaloric effects, whilst the organic materials exemplified in the present case display conventional barocaloric effects.

An organic material may have a plurality of reversible phase transitions and one or each phase transition may occur at a temperature within the limits given above. Where an organic

material has a plurality of reversible phase transitions, the methods of the invention may make use of one or more of these transitions, and typically one of these transitions. The methods of the invention may make use of the transition that lies closest to ambient temperature, such as closest to 270, 280 or 300 K.

The presence of a phase transition in the organic material may be established from the analysis of the heat flow performance of the material across a temperature range including the temperatures mentioned above. For example, the measurements of heat flow may be made by differential scanning calorimetry, such as using a temperature scan rate of 10 K min^{-1}. Lloveras *et al.*, for example, describe a typical experiment for determining the transition temperature at atmospheric pressure (see the *Methods* section, *Calorimetry at Atmospheric Pressure* at page 5, together with Figure 1(b)).

The phase transition temperature may be expressed as the transition temperature observed on heating, cooling, or as the average of the heating and cooling transitions.

An organic material may exhibit an endothermic transition upon heating through the transition point (thus the latent heat Q_0 is > 0). It follows then that the organic materials will exhibit an exothermic transition upon cooling through the transition point (thus Q_0 is < 0).

The entropy change at the transition, $|\Delta S_0|$, may be at least 10, at least 20, at least 50, at least 60, at least 70, at least 80, at least 90, at least 100, at least 110, at least 120 or at least 130 J K^{-1} kg^{-1}, which is the magnitude of the change and this change may be positive or negative as appropriate during heating and cooling through the transition.

However, many of the organic materials tested by the present inventors have a considerably greater entropy change $|\Delta S_0|$ associated with phase transitions. Thus, the entropy change at the transition may be at least 150, at least 200, at least 250, at least 300 or at least 350, at least 400, or at least 450 J K^{-1} kg^{-1}, which is the magnitude of the change and this change may be negative or positive as appropriate during cooling and heating through the transition. These entropy changes are considerably larger than those recorded for ammonium sulfate in the work of Lloveras *et al.* and also considerably larger than the values reported for metallic alloys (see Table 1 of Lloveras *et al.*, for example).

The entropy change may refer to the entropy change for the entire transition. Alternatively, where a transition includes a first-order transition optionally with other order transitions, the entropy change may refer to the entropy change for the first-order transition only. Where there is a first-order transition which is a part of the entire transition, the entropy change for the first-order transition may be at least 30%, at least 40% or at least 50% of the entropy change of the entire transition.

The entropy change may be expressed as the entropy change observed on heating, cooling, or as the average of the heating and cooling transitions.

The entropy change at the transition may be determined by differential scanning calorimetry, as noted above.

The phase transition is accompanied by a change in the unit cell volume of the material, for example the unit cell volume may increase on heating through the phase transition. This is the change observed for conventional barocaloric materials. A decrease in the unit cell volume may be observed for inverse barocaloric materials.

The volume change at the transition may be at least 1.0, at least 5.0, at least 10, at least 15, at least 20, at least 25, at least 30, at least 40 or at least 50 mm^3g^{-1}.

The volume change at the transition may be a change of at least 0.1%, at least 0.2%, at least 0.5%, or at least 1.0%.

The figures given above relate to the magnitude of the change, and this change may be positive or negative as appropriate during heating and cooling through the transition. For example, the volume change may refer to an increase (positive) change in the volume, as such might be observed on heating through the phase transition.

The volume change may refer to the volume change for the entire transition. Alternatively, where a transition includes a first-order transition optionally with other order transitions, the volume change may refer to the volume change for the first-order transition only. Where there is a first-order transition which is a part of the entire transition, the change in volume for the first-order transition may be at least 30%, at least 40% or at least 50% of the volume change for the entire transition.

The change in the volume at the transition may be determined from X-ray diffraction analysis of the organic material during a temperature sweep across the phase transition (where the transition typically occurs across a temperature range). Lloveras *et al.*, for example, describe a typical experiment for determining the volume change at atmospheric pressure (see the *Methods* section, *X-Ray Diffraction* at page 5, together with Figure 1(d)). X-Ray diffraction measurements were used to determine the change in volume for the BDP and BDB organic materials described in the present case. The change in the volume at the transition may be determined from volumetric thermal expansion measurements, or from volumetric isothermal compressibility measurements at various temperatures.

The phase transition in the organic material may display a latent heat, $|Q_0|$, that is at least 1.0, at least 2.0 at least 3.0, at least 4.0, at least 5.0, at least 7.0, at least 9.0 or at least 10.0 $kJ\ kg^{-1}$.

Some organic materials, such as plastic crystals, have a phase transition that displays a latent heat, $|Q_0|$,that is very high. Thus, in some embodiments, the organic material may have a latent heat, $|Q_0|$, that is at least 25, at least 50, at least 75, at least 100, at least 150 or at least 200 kJ kg^{-1}.

The inorganic materials that have previously been used in the art for barocaloric cooling typically have latent heats in the range 2.0 to 13.2 kJ kg^{-1} (see Table 1 of Lloveras *et al.*, for example).

The latent heat values may be determined from the differential scanning calorimetry analysis of the material.

The organic materials display large barocaloric effects under applied pressure. In particular, the organic materials display a strong pressure-induced shift in the phase transition temperature.

The shift in transition temperature with applied pressure dT_0/dp, is relatively high for the organic components used herein. Thus, small or moderate pressures may be used to drive relatively large temperature changes.

In one embodiment, the change in transition temperature is at least 1 K, at least 2 K, at least 3 K, at least 4 K, at least 5 K, or at least 10 K, for example as measured for a change in applied pressure of 0.15 GPa. The figures given here relate to the magnitude of the change, which may be a positive change (for materials displaying conventional barocaloric effects) or a negative change (for materials displaying inverse barocaloric effects). In the worked examples of the present case, the organic materials are conventional and therefore they show a positive change in transition temperature. It will be understood that alternative materials may be used where a negative change in transition temperature is required. In one embodiment, the temperature change is an increase in the transition temperature under the applied pressure.

The temperature change refers to the adiabatic temperature change. The temperature change may be the temperature change derived from $-c\Delta T$ approximating to $T\Delta S = Q$ using the zero-pressure specific heat capacity c, the isothermal entropy change ΔS and the temperature of operation, T (Q is isothermal heat). It is appreciated that a large change in transition temperature with pressure does not always correspond to a large adiabatic temperature change, however in some instances it may do so.

The adiabatic temperature change can be calculated using the values of isothermal entropy change and heat capacity, which is a fundamental quantity known for most materials. The

adiabatic temperature change may also be measured experimentally, for examples using the experimental set up described by Rodriguez *et al.*

In one embodiment, the change in transition temperature as a function of change in applied pressure, dT_0/dp, is at least 50, at least 100, at least 150, at least 200, at least 250, at least 400 or at least 500 K GPa^{-1}. The figures given here relate to the magnitude of the change, which may be positive, for example. The change in transition temperature as a function of change in applied pressure may be determined in heat flow experiments, during a heating step or a cooling step, for example at constant pressure. In the liquid crystal experiment described in the present case, the value of dT_0/dp is 210 K GPa^{-1}.

The organic materials typically have a large refrigerant capacity, RC.

In one embodiment, the refrigerant capacity, RC, is at least 100, at least, 150, at least 200, or at least 250 J kg^{-1}. The RC values may be the value determined at an applied hydrostatic pressure of 0.1, 0.2 or 0.3 GPa. The RC values may be the value determined at an applied hydrostatic pressure of 0.075, 0.01, 0.03 or 0.1 GPa.

Refrigerant capacity may be determined from the product of the maximum values of isothermal entropy change with the full width at half maximum (FWHM) of the isothermal entropy peak with temperature, as the absolute value. Thus, the value of RC may be determined as the product of the maximum isothermal entropy change with the full width at half maximum of the peak in $\Delta S(T)$, thus RC = $|\Delta S \times (\text{FWHM of } \Delta S(T))|$.

In the present case, BDP has an RC value of 77.6 J kg^{-1} at 0.0075 GPa, BDB has an RC value of 560 J kg^{-1} at 0.1029 GPa, and PCH5 has an RC value of 8,765 J kg^{-1} at 0.104 GPa.

Methods and Uses

The present invention provides a method of cooling which uses the barocaloric effects of the organic materials described herein. Thus, the organic materials find use as cooling agents, for example within a cooling apparatus. The organic material may be referred to as a refrigerant.

The methods of the invention make use of the change in the thermal behaviour of an organic material under an applied pressure. The application of hydrostatic pressure to the organic material induces a change in the transition temperature. The barocaloric effect may be advantageously used within a heat pump cycle or a refrigeration cycle to provide heating or cooling respectively.

The methods of the invention allow for the use of organic materials displaying conventional barocaloric effects and inverse barocaloric effects.

The methods of the invention include the step of applying hydrostatic pressure to the organic material or releasing hydrostatic pressure from an organic material. Hydrostatic pressure refers to isotropic stress. This is to be contrasted with the uniaxial stresses that are applied to materials for use in elastocaloric cooling. Barocaloric materials have the advantage over elastocaloric materials in that they are not limited by the onset of plastic flow, which typically occurs at high applied pressures (typically hundreds of MPa).

The method of the invention may be performed in an environment at ambient temperature, such as a temperature from 0 to 35°C, such as 5 to 35°C, such as 10 to 30°C (corresponding to 273.15 to 308.15 K, such as 278.15 to 308.15 K, such as 283.15 to 303.15 K). The methods of the invention allow for the generation of cooler and warmer localised regions within the environment as part of the barocaloric cooling process. For example, the organic material may become warmer or cooler than the ambient environment in the methods of the invention.

The methods of the invention include the step of applying a pressurizing force to the organic material, thereby to cause a change in the phase transition temperature, such as to increase the transition temperature (as shown in the worked examples of the present case). Organic materials exhibiting inverse barocaloric effects will exhibit a decrease in the transition temperature under the application of pressure.

In one embodiment, a sufficient pressuring force is applied to move the transition temperature to a temperature that is in an ambient temperature, such as a temperature from 0 to 35°C, such as 5 to 35°C, such as 10 to 30°C (corresponding to 273.15 to 308.15 K, such as 278.15 to 308.15 K, such as 283.15 to 303.15 K).

The organic materials for use in the present case provide large changes in transition temperature with relatively small applied pressures. Thus, the value of dT_0/dp is relatively high compared with many of the inorganic materials described previously.

The methods of the invention may use the organic material within conventional heating and cooling cycles in place of conventional materials, where the heating and cooling cycle is adapted to exploit the barocaloric effects of the organic materials.

Thus, the organic materials may be used within, for example, a Brayton cycle, an Ericsson cycle or a Carnot cycle to provide heating or cooling as required. The organic materials may also be used in alternative thermodynamic cycles to provide heating or cooling for a particular environment.

A method of the invention may comprise the steps of:

(i) applying hydrostatic pressure to an organic material; and

(ii) permitting heat flow from or to the organic material.

Where an organic material displays a conventional barocaloric effect upon application of hydrostatic pressure, step (ii) provides for the heat flow from the organic material. Where an organic material displays an inverse barocaloric effect, step (ii) provides for heat flow to the organic material.

A method of the invention may comprise the steps of:

(iii) releasing hydrostatic pressure from an organic material that is under applied pressure; and

(iv) permitting heat flow to or from the organic material.

Step (iii) may be referred to as a depressurisation step.

Where an organic material displays a conventional barocaloric effect upon release of hydrostatic pressure, step (iv) provides for the heat flow to the organic material. Where an organic material displays an inverse barocaloric effect, step (iv) provides for heat flow from the organic material.

The method of the invention may additionally comprise all of steps (i) to (iv) in a complete heat and cool cycle. Typically steps (i) and (ii) are undertaken prior to steps (iii) and (iv). The method may be a cooling method.

Where the method is a part of the Brayton cycle, for example, the pressure may be applied adiabatically, with, for example, a consequential heating of the organic material. In step (ii) there is a subsequent heat flow, for example from the organic material, which allows the organic material to return to its original temperature. In a further part of the cycle step, pressure may be released adiabatically with, for example, a consequential cooling of the organic material. In step (iv) there is a subsequent heat flow, for example to the organic material, which allows the organic material to return to its original temperature.

Where the method is a part of the Ericsson cycle, for example, the pressurisation and depressurisation steps are performed isothermally. Thus, the organic material is maintained at a substantially constant temperature, with heat transfer occurring, and not subsequent to, the pressurisation and depressurisation steps.

The methods of the invention allow heat flow to and from the organic material with changes in applied pressure. The ability of the organic material to absorb heat from the environment, in response to a pressure-induced phase transition, thereby cooling the environment, allows the organic material to be used as a cooling agent in a cooling apparatus.

In the methods of the invention the organic material may be used with a heat transfer fluid to and from which heat may be transferred. The heat transfer fluid is typically a liquid.

The heat transfer fluid may transfer heat to the organic material, thereby resulting in the relative cooling of the heat transfer fluid. The cooled heat transfer fluid may then be taken from the organic material and delivered to a location where cooling is desired.

The heat transfer fluid may accept heat transfer from the organic material, thereby resulting in the relative cooling of the organic material. The heated heat transfer fluid may then be taken from the organic material and delivered to a location for cooling, such as a radiator or another such heat exchanger, for example for cooling to ambient temperature.

It is not necessary for the heat transfer fluid to directly contact the organic material, and the heat transfer may occur *via* a heat exchanger.

A heat exchanger may use a heat switch, such as a thermoelectric heat switch, an electromechanical heat switch, a solid-state thermal diode or a heat pipe. The use of compact switches of these types may improve the design of the cooling devices, and enhance their energy efficiency.

The organic material may also be used together with a regenerator in order to alter or increase the temperature range of operation. The organic material may itself be used as a regenerator.

The barocaloric effects observed with the organic materials can be achieved at relatively low pressures. Accordingly, the pressurizing force applied to the organic material may be relatively low in the methods of the invention.

In the methods of the invention, the hydrostatic pressure is applied in step (i) near the transition temperature of the organic material. It is here that large barocaloric effects are observed. For example, the hydrostatic pressure is applied at a temperature that is within 50 K, within 20 K, within 15 K, within 10 K, such as within 5 K, such as within 2 K, such as within 1 K, such as within 0.5 K of the transition temperature, which is the transition temperature of the organic material absent the applied hydrostatic pressure (for example, the transition temperature under ambient pressure).

In the methods of the invention, the hydrostatic pressure may be applied at a level sufficient to induce the phase transition.

When a hydrostatic pressurizing force is applied, the pressure may be at most 1.0 GPa, at most 0.5 GPa, at most 0.2 GPa, at most 0.15 GPa, at most 0.10 GPa, at most 0.09 GPa, at

most 0.07 GPa, at most 0.06 GPa, at most 0.05 GPa, at most 0.04 GPa, at most 0.03 GPa, at most 0.02 GPa or at most 0.01 GPa.
When a pressurizing force is applied, the pressure may be at least 0.1 MPa, at least 0.5 MPa, at least 1.0 MPa, or at least 5.0 MPa.

The pressure applied may be a hydrostatic pressure in a range with the lower and upper limits selected from the values given above. For example, the hydrostatic pressure may be a pressure in the range 1.0 MPa to 0.1 GPa.

The pressurizing force is the change in pressure applied to the organic material. Typically the change in pressure is to or from ambient (atmospheric) pressure, such as to or from about 101 kPa.

Where the hydrostatic pressure is applied in step (i), there may be a rapid increase in pressure. Where the hydrostatic pressure is released in step (iii), the pressure may be a rapid release. This is preferred for systems operating as part of or whole of a Brayton cycle, in order to achieve adiabatic conditions.

Where the hydrostatic pressure is applied in step (i), there may be a slow increase in pressure. Where the hydrostatic pressure is released in step (iii), the pressure may be a slow release. This is preferred for systems operating as part of or whole of an Ericsson cycle, in order to achieve isothermal conditions.

The values of the transition temperature under a constant applied pressure (constant hydrostatic pressure) may be determined, for example using a differential thermal analyser operating under hydrostatic pressure at a heating or cooling rate of 1-4 k min^{-1}.

The application of hydrostatic pressure may be achieved by applying pressure to the organic material contained provided within a pressure-transmitting medium. Pressure-transmitting media are well known in the art and include liquid and solid materials. Typically, the pressure-transmitting medium is not water.

An example of a pressure-transmitting liquid includes alkoxy silane materials, such as DW-Therm, available from Huber Kältemaschinenbau GmbH.
An example of a pressure-transmitting solid is alumina powder.

The methods of the invention may be for use in cooling foodstuffs or beverages.
The methods of the invention may be for use in cooling medicines.
The methods of the invention may be for use in cooling biological samples, such as tissues.
The methods of the invention may be for use in cooling electronic devices, such as devices for analytical measurements.

The methods of the invention may be used to cool air, such as air within building and vehicles.

Cooling Apparatus

The present invention provides a cooling apparatus containing an organic material as described herein, where the cooling apparatus is adapted to provide barocaloric cooling using the organic material.

The cooling apparatus comprises the organic material. The cooling apparatus may be provided with means for applying pressure to the organic component. The cooling apparatus may also be provided with means for transferring heat to and from the organic material.

Typically, the organic material is provided within a pressure transmitting medium, such as a pressure transmitting fluid, which is contained within a piston head space (or the piston chamber). The pressure transmitting medium is not essential, and pressure may be applied directly to the organic material, such as a material having a liquid phase, such as liquid crystals.

Thus, in one aspect the present invention provides a piston comprising the organic material within the head space.

The cooling apparatus may be for use in cooling foodstuffs and beverages, thus the cooling apparatus may be a component of a refrigerator or a freezer.
The cooling apparatus may find general use in cooling air, thus the cooling apparatus may be a component of an air-conditioning unit.

In other aspects of the invention there is more generally provided a heat engine for the transfer of heat between environments, where the heat engine has an organic material as a barocaloric working agent. Whilst the predominant use of refrigerants is in refrigerators and air-conditioning units, the principles underlying the mechanism of cooling an environment may also be used to heat an indoor environment, for example within an air-source heat pump.

Here, a cool organic material in a first phase may be warmed by the outside ambient environment (including indirectly *via* a heat transfer fluid). The warmed organic material may then be taken isothermally to a second phase, with an associated heat transfer from the environment to the organic material (including indirectly *via* a heat transfer fluid). The organic material is then returned to the indoor environment, where it is permitted to return to the second phase, with an associated heat transfer from the organic material to the indoor environment.

The broad aspects of the invention encompass methods of heat transfer to and from an organic material using barocaloric effects. Thus, the methods of the invention relate to methods of cooling and methods of heating.

Other Preferences

Each and every compatible combination of the embodiments described above is explicitly disclosed herein, as if each and every combination was individually and explicitly recited.

Various further aspects and embodiments of the present invention will be apparent to those skilled in the art in view of the present disclosure.

"and/or" where used herein is to be taken as specific disclosure of each of the two specified features or components with or without the other. For example "A and/or B" is to be taken as specific disclosure of each of (i) A, (ii) B and (iii) A and B, just as if each is set out individually herein.

Unless context dictates otherwise, the descriptions and definitions of the features set out above are not limited to any particular aspect or embodiment of the invention and apply equally to all aspects and embodiments which are described.

Certain aspects and embodiments of the invention will now be illustrated by way of example and with reference to the figures described above.

Experimental Details and Results

The analysis of the organic materials described in the present case follows that of the work described by some of the present inventors in Lloveras *et al.* and Stern-Taulats *et al.*, the contents of both of which are hereby incorporated by reference in their entirety.

Materials

BDP and BDB were prepared, as needed, using standard techniques. An example preparation for BDP is set out below.

Propionic acid (1 L), 100 g of barium carbonate (100 g) and 100 g of calcium carbonate (100 g) were purchased from Sigma Aldrich. Their respective purities were 99%, 99.8% and 99.98%, and the reagents were used directly without further purification.

BDP (around 10 g yield) was synthesized from propionic acid (10 mL), barium carbonate (3 g) and of calcium carbonate (3 g).

Barium carbonate or calcium carbonate, when combined with propionic acid in aqueous solution generates the corresponding propionate hydrate salt. The molar mass of barium carbonate and calcium carbonate could not be immediately established as the two carbonates absorb moisture from the air. For this reason, the barium propionate and calcium propionate were initially made separately. The mass of propionate hydrates is unaffected by humidity. The two propionate hydrates were combined together, to form BDP, keeping a reproducible molar ratio.

The plastic and liquid crystals, NPG and PCH5, were purchased from commercial suppliers. 1-Adamantanol was also purchased from a commercial supplier.

Measurements

Table 1 sets out the values for T_0, $|Q_0|$, $|\Delta S_0|$, dT_0/dp, and $|\Delta V_0|$, determined from the analysis of the organic materials BDP and BDB.

Table 2 sets out the values for T_0, $|Q_0|$, $|\Delta S_0|$, dT_0/dp, and $|\Delta V_0|$, determined from the analysis of various plastic crystals.

Table 3 sets out the values for T_0, $|Q_0|$, $|\Delta S_0|$, dT_0/dp, and $|\Delta V_0|$, determined from the analysis of the liquid crystal PCH5.

The performances of BDP, BDB, PCH5 and NPG under different applied pressures are shown in Figures 1 to 4. Additionally, the performance of the plastic crystal 1-adamantanol is shown in Figure 5.

T_0, $|\Delta S_0|$ and $|Q_0|$ were determined via differential scanning calorimetry at ambient pressure. dT_0/dp was determined *via* differential thermal analysis under applied hydrostatic pressure. $|\Delta V_0|$ was determined, for example, from temperature-dependent X-ray diffraction analysis at ambient pressure.

Barocaloric quantities were determined via quasi-direct methods, using differential thermal analysers that operate under hydrostatic pressure, with Peltier modules or thermocouples heat sensors, as for example described in Lloveras *et al.* (see *BC Effects in AS* at page 3, together with reported results in Figure 3, and the *Methods* section at page 5).

Differential thermal analysis under hydrostatic pressure was performed as described by Mañosa *et al*. The data is shown in Figures 2 and 4 for BDB and PCH5.

Table 1 - Properties of Representative Organic Materials

Organic Material	T_0 (K)	$\lvert Q_0 \rvert$ (J g^{-1})	$\lvert \Delta S_0 \rvert$ (J K^{-1} kg^{-1})	dT_0/dp (K/GPa)	$\lvert \Delta V_0 \rvert$ (mm^3 g^{-1})
BDP $Ba^{2+}Ca^{2+}{}_2[C_2H_5COO^-]_6$	267	10.7	42	332	17.5
BDB $Ba^{2+}Ca^{2+}{}_2[C_3H_7COO^-]_6$	325	4.72	14.5	500	10.1

The table shows transition temperature T_0, latent heat $|Q_0|$, entropy change $|\Delta S_0|$, shift of transition temperature with applied pressure dT_0/dp, and volume change across the transition $|\Delta V_0|$. The organic materials are barium and calcium salts of the organic compounds butyric acid and propionic acid.

Table 2 - Properties of Representative Plastic Crystal Organic Materials

Organic Material	T_0 (K)	$\lvert Q_0 \rvert$ (J g^{-1})	$\lvert \Delta S_0 \rvert$ (J K^{-1} kg^{-1})	dT_0/dp (K/GPa)	$\lvert \Delta V_0 \rvert$ (mm^3 g^{-1})
PG	357.5	177.3	495.2	103.0	51.0
NPG	314.6	122.9	389.8	119.6	46.7
NPA	236.5	45.38	191.7	237.0	45.5
MN	260.1	51.15	196.5	130.7	25.7
MNP	312.0	140.0	449.1	81.0	36.4
AMP	352.6	221.6	629.7	76.0	48.1
TRIS	406.8	280.7	691.0	60.6	41.8
2-Br-Adamantane	277.9	56.20	202.2	243.0	52.8
2-O-Adamantane	221.0	52.79	239.0	181.0	43.5
1-Adamantanol	359.0	85.40	236.5	178.0	42.0
2-Adamantanol	389.3	52.42	134.6	64.3	4.60
1,3-Dimethyladamantane	367.5	46.56	210.7	288.0	60.7

The table shows transition temperature $|T_0|$, latent heat $|Q_0|$, entropy change $|\Delta S_0|$, shift of transition temperature with applied pressure dT_0/dp, and volume change across the transition $|\Delta V_0|$. PG = pentaglycerine; 2-(hydroxymethyl)-2-methylpropane-1,3-diol. NPG = neopentylglycol; 2,2-dimethyl-1,3-propanediol. NPA = neopentyl alcohol; 2,2-dimethyl-1-propanol. MN = 2-methyl-2-nitropropane. MNP = 2-methyl-2-nitro-1-propanol. AMP = 2-amino-2-methyl-1,3-propanediol.
TRIS = Tris(hydroxymethyl)aminomethane.

Table 3 - Properties of a Representative Liquid Crystal Organic Material

Organic Material	T_0 (K)	$\lvert Q_0 \rvert$ (J g^{-1})	$\lvert \Delta S_0 \rvert$ (J K^{-1} kg^{-1})	dT_0/dp (K/kbar)	$\lvert \Delta V_0 \rvert$ (mm^3 g^{-1})
PCH5 *4-(trans*-4-pentylcyclohexyl) benzonitrile	303	87.6	290	210	60.8

The table shows transition temperature T_0, latent heat $|Q_0|$, entropy change $|\Delta S_0|$, shift of transition temperature with applied pressure dT_0/dp, and volume change across the transition $|\Delta V_0|$.

Figure 6 shows the refrigerant capacity, RC, values for the organic materials, BDP, BDB and PCH5, at different applied hydrostatic pressures.

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All documents mentioned in this specification are incorporated herein by reference in their entirety.

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Claims:

1. The use of an organic material as a barocaloric cooling or heating agent.

2. A method of barocaloric cooling or heating, the method comprising the steps of:
(i) applying hydrostatic pressure to an organic material; and
(ii) permitting heat flow from or to the organic material.
(iii) releasing hydrostatic pressure from an organic material that is under applied pressure; and
(iv) permitting heat flow to or from the organic material.

3. A cooling or heating apparatus comprising an organic material as a barocaloric cooling or heating agent.

4. The use, method or apparatus according to any one of claims 1 to 3, wherein the organic material is an organic compound or a salt thereof.

5. The use, method or apparatus according to any one of claims 1 to 3, wherein the organic material has a molecular weight of at most 2,000, such as at most 1,000.

6. The use, method or apparatus according to any one of claims 1 to 5, wherein the organic material has a molecular weight of at least 50.

7. The use, method or apparatus according to any one of claims 1 to 6, wherein the organic material is an organic compound or a salt thereof, and the organic compound has two or more carbon-carbon bonds.

8. The use, method or apparatus according to any one of claims 1 to 7, wherein the organic material is an organic compound or a salt thereof, and the organic compound has two or more carbon-hydrogen bonds.

9. The use, method or apparatus according to any one of claims 1 to 7, wherein the organic material is a liquid crystal or a plastic crystal.

10. The use, method or apparatus according to claim 9, wherein the organic material is a plastic crystal.

11. The use, method or apparatus according to claim 10, wherein the plastic crystal comprises an alkyl group or a cycloalkyl group.

12. The use, method or apparatus according to claim 11, wherein the plastic crystal comprises a cycloalkyl group, and the cycloalkyl group is an adamantantyl group.

13. The use, method or apparatus according to claim 11, wherein the adamantantyl group is optionally substituted with one or more groups selected from the group consisting of alkyl, halo, hydroxyl and oxo.

14. The use, method or apparatus according to claim 11, wherein the plastic crystal comprises an alkyl group, and the alkyl group is a C_{4-20} alkyl group, such as a C_{4-5} alkyl group.

15. The use, method or apparatus according to claim 14, wherein the alkyl group is optionally substituted with one or more groups selected from the group consisting of hydroxyl, amino and nitro.

16. The use, method or apparatus according to claim 9, wherein the organic material is a liquid crystal.

17. The use, method or apparatus according to claim 9, wherein the liquid crystal comprises one or more groups selected from alkyl, cycloalkyl and aryl, such as wherein the liquid crystal has an alkyl group, a cycloalkyl group and an aryl group.

18. The use, method or apparatus according to any one of claims 1 to 8, wherein the organic material is an alkyl carboxylic acid or an alkyl carboxylate salt.

19. The use, method or apparatus according to claim 18, wherein the alkyl group has three or more carbon atoms, such as 3 or 4 carbon atoms.

20. The use, method or apparatus according to any one of claims 1 to 8, wherein the organic material is a hydrocarbon, such as an alkane or a cycloalkane.

21. The use, method or apparatus according to any one of claims 1 to 20, wherein the organic material has a phase transition at a temperature within the range 200 to 450 K, such as 245 to 340 K, such as 245 to 315 K.

22. The use, method or apparatus according to any one of claims 1 to 21, wherein the phase transition of the organic material comprises a first-order phase transition.

23. The use, method or apparatus according to claim 22 wherein the phase transition of the organic material is a first-order phase transition.

24. The use, method or apparatus according to any one of claims 1 to 23, wherein the organic material has an entropy change at a phase transition, $|\Delta S_0|$, of at least 10 J K^{-1} kg^{-1}, such as at least 50 J K^{-1} kg^{-1}, such as at least 100 J K^{-1} kg^{-1}, such as at least 150 J K^{-1} kg^{-1}, such as at least 250 J K^{-1} kg^{-1}, such as at least 400 J K^{-1} kg^{-1}.

25. The use, method or apparatus according to any one of claims 1 to 24, wherein a phase transition in the organic material displays a latent heat, $|Q_0|$, that is at least 1 kJ kg^{-1}, such as at least 5.0 kJ kg^{-1}, such as at least 10.0 kJ kg^{-1}, such as at least 25 kJ kg^{-1}, such as at least 50 kJ kg^{-1}.

26. The use, method or apparatus according to any one of claims 1 to 25, wherein the organic material has a volume change at the phase transition of at least 1.0 mm^3 g^{-1}, such as at least 10 mm^3 g^{-1}, such as at least 50 mm^3 g^{-1}.

27. The use, method or apparatus according to any one of claims 1 to 26, wherein the organic material is provided within a pressure-transmitting medium, such as a pressure-transmitting fluid or a pressure-transmitting solid.

28. The use or method according to claim 1 or claim 2, wherein hydrostatic pressure is applied to the organic material at a temperature that is within 50 K, such as within 10 K, such as within 5 K, such as within 1 K, of a phase transition temperature of the organic material, where the phase transition temperature is the temperature for the phase transition in the absence of the hydrostatic pressure.

29. The use or method according to claim 28, wherein the applied hydrostatic pressure is at most 1.0 GPa, at most 0.5 GPa, at most 0.2 GPa, such as at most 0.1 GPa, such as at most 0.07 GPa.

30. The use or method according to claim 28 or claim 29, wherein the applied hydrostatic pressure is at least 0.1 MPa, such as at least 0.5 MPa, such as at least 5.0 MPa.

Fig. 1

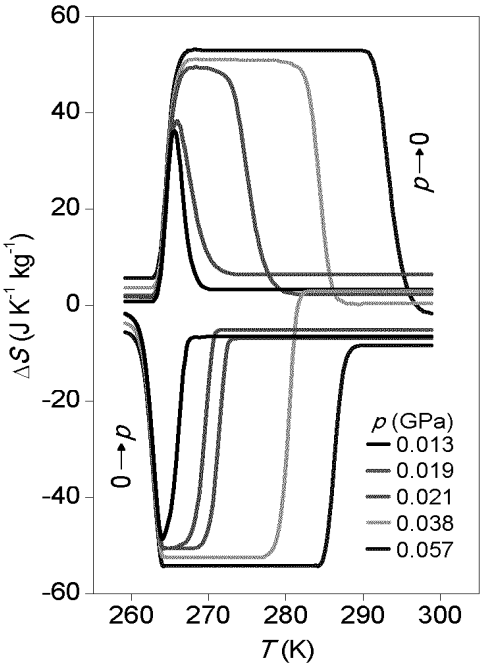

60
40
20
0
-20
-40
-60
260
270
280
290
300
T (K)
ΔS (J K-1 kg-1)
p→0
0→p
p (GPa)
0.013
0.019
0.021
0.038
0.057

Fig. 2

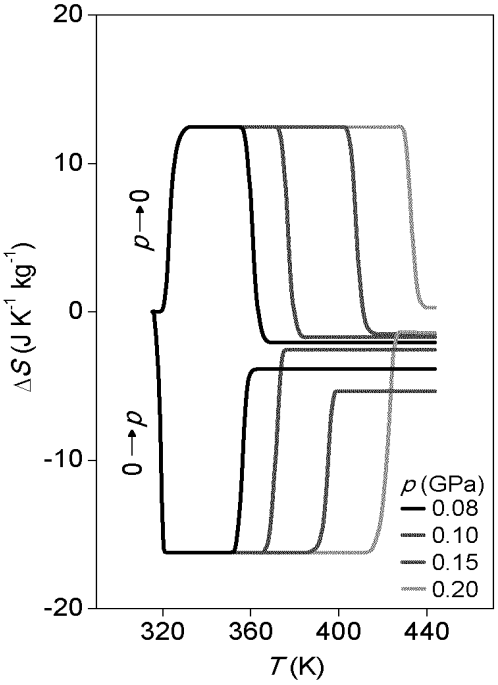

20
10
0
-10
-20
320
360
400
440
T (K)
ΔS (J K-1 kg-1)
p→0
0→p
p (GPa)
0.08
0.10
0.15
0.20

Fig. 3

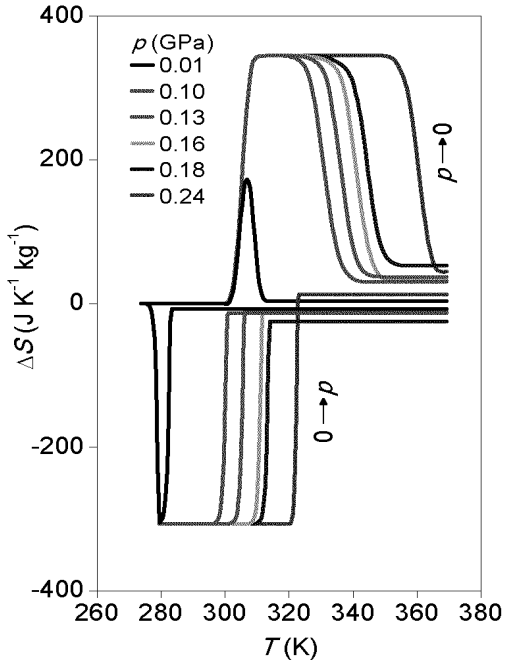

p (GPa)
0.01
0.10
0.13
0.16
0.18
0.24
p→0
0→p
ΔS (J K-1 kg-1)
T (K)
400
200
0
-200
-400
260
280
300
320
340
360
380

Fig. 4

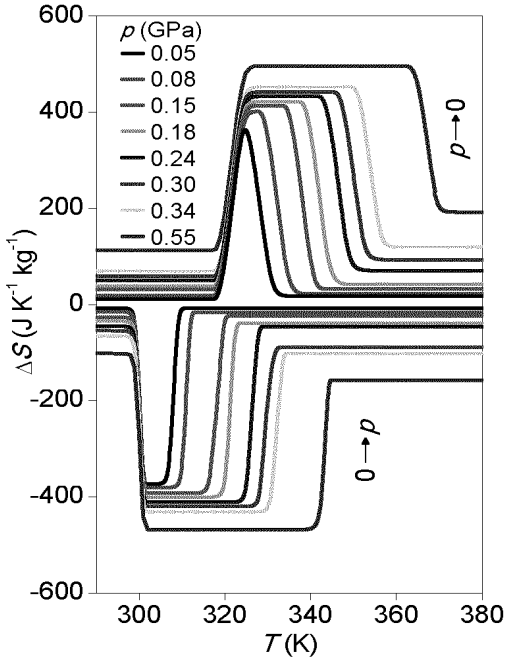

p (GPa)
0.05
0.08
0.15
0.18
0.24
0.30
0.34
0.55
p→0
0→p
ΔS (J K-1 kg-1)
T (K)
600
400
200
0
-200
-400
-600
300
320
340
360
380

Fig. 5

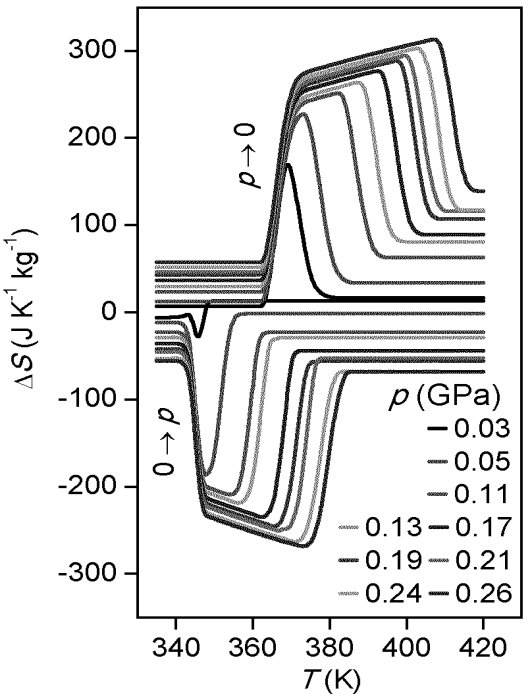
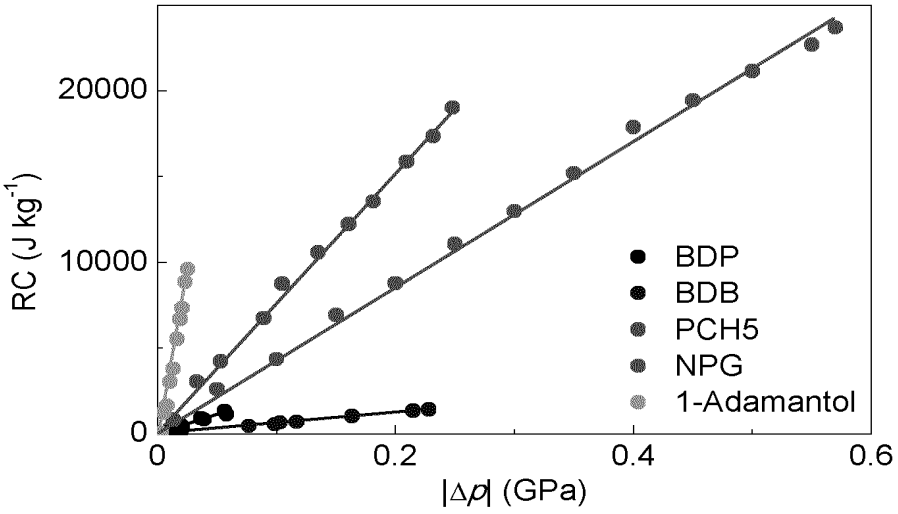

300
200
100
0
-100
-200
-300
ΔS (J K-1 kg-1)
p → 0
0 → p
p (GPa)
0.03
0.05
0.11
0.13
0.17
0.19
0.21
0.24
0.26
340
360
380
400
420
T (K)

Fig. 6


20000
10000
0
RC (J kg-1)
0
0.2
0.4
0.6
|Δp| (GPa)
BDP
BDB
PCH5
NPG
1-Adamantol

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/076203

A. CLASSIFICATION OF SUBJECT MATTER
INV. C09K5/02
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
C09K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	Nuria Pol Català: "Efectes barocalòrics en cristalls plàstics" In: "Efectes barocalòrics en cristalls plàstics", 1 June 2016 (2016-06-01), Escola Tècnica Superior d'Enginyeria Industrial de Barcelona, XP055440639, abstract -----	1-11,14, 15,21-30
X	Lorean Iglesias Gomez: "Efectes barocalòrics colossals en cristalls plàstics derivats del neopentà" In: "Efectes barocalòrics colossals en cristalls plàstics derivats del neopentà", 12 January 2016 (2016-01-12), Escola Tècnica Superior d'Enginyeria Industrial de Barcelona, XP055440641, abstract -----	1-11,14, 15,21-30

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[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15 January 2018	22/01/2018

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Martinez Marcos, V

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	BACEM BEN HASSINE ET AL: "Phase Transition in Hydrogen-Bonded 1-Adamantane-methanol", CRYSTAL GROWTH & DESIGN., vol. 15, no. 8, 5 August 2015 (2015-08-05) , pages 4149-4155, XP055440673, US ISSN: 1528-7483, DOI: 10.1021/acs.cgd.5b00764 Introduction and experimental details; figure 1	1-15, 21-30
X	T ITO: "Pressure-induced phase transition in adamantane", ACTA CRYST., vol. 29, no. 18, 1 January 1973 (1973-01-01), pages 764-767, XP055440624, Experiments	1-12, 20-30
X	S. SINANIS ET AL: "Pressure-jump investigations on the kinetics of the isotropic-nematic phase transition of a liquid crystal: Time behavior of the scattered and transmitted light intensities for PCH 5", BERICHTE DER BUNSEN-GESELLSCHAFT FUR PHYSIKALISCHE CHEMIE., vol. 102, no. 5, 1 May 1998 (1998-05-01), pages 745-750, XP055440635, DE ISSN: 0005-9021, DOI: 10.1002/bbpc.19981020507 Introduction and experimental; figures 1,4	1-9,16, 17,20-30
X	Zhongjian Xie ET AL: "Demonstration of liquid crystal for barocaloric cooling application", Condensed Matter, 26 September 2016 (2016-09-26), XP055440321, Retrieved from the Internet: URL:https://arxiv.org/ftp/arxiv/papers/1609/1609.07939.pdf [retrieved on 2018-01-12] abstract; figure 3 page 2 - page 3	1-9, 16-19, 21-30

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1

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE OLIVEIRA N: "Barocaloric effect and the pressure induced solid state refrigerator", JOURNAL OF APPLIED PHYSICS, AMERICAN INSTITUTE OF PHYSICS, US, vol. 109, no. 5, 11 March 2011 (2011-03-11), pages 53515-53515, XP012147618, ISSN: 0021-8979, DOI: 10.1063/1.3556740 introduction; figure 1	1-30
X,P	Peris Peris Alonso: "Efectes barocalòrics en la transició plàstica del 1-Bromadamantà MEMÒRIA" In: "Efectes barocalòrics en la transició plàstica del 1-Bromadamantà MEMÒRIA", 15 June 2017 (2017-06-15), Escola Tècnica Superior d'Enginyeria Industrial de Barcelona, XP055440643, abstract	1-15, 21-30

Electronically Filed April 12, 2019

PRELIMINARY AMENDMENT Address to: Mail Stop: Amendment P.O. Box 1450 Alexandria, VA 22313-1450	Attorney Docket No.	MEWE-072
	Confirmation No.	
	First Named Inventor	Javier Eduardo Moya Raposo
	Application Number	
	Filing Date	
	Group Art Unit	
	Examiner Name	
	Title: "Use of Barocaloric Materials and Barocaloric Devices"	

Sir:

Prior to the examination of the above-referenced application on the merits, please enter the amendments below.

AMENDMENTS

In the claims:

Claim 1-30. (Cancelled)

31. (New) The use of an organic material as a barocaloric cooling or heating agent.

32. (New) The use, according to claim 31, wherein the organic material is an organic compound or a salt thereof optionally

wherein the organic material has a molecular weight of at most 2,000, such as at most 1,000; and/or

wherein the organic material has a molecular weight of at least 50; and/or

wherein the organic material is an organic compound or a salt thereof, and the organic compound has two or more carbon-carbon bonds; and/or

wherein the organic material is an organic compound or a salt thereof, and the organic compound has two or more carbon-hydrogen bonds; and/or

wherein the organic material is a liquid crystal or a plastic crystal.

33. (New) The use according to claim 31, wherein the organic material is a plastic crystal such as a plastic crystal comprising an alkyl group or a cycloalkyl group optionally

wherein the plastic crystal comprises a cycloalkyl group, and the cycloalkyl group is an adamantantyl group preferably wherein the adamantantyl group is optionally substituted with one or more groups selected from the group consisting of alkyl, halo, hydroxyl and oxo; or

wherein the plastic crystal comprises an alkyl group, and the alkyl group is a C_{4-20} alkyl group, such as a C_{4-5} alkyl group preferably wherein the alkyl group is optionally substituted with one or more groups selected from the group consisting of hydroxyl, amino and nitro.

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34. (New) The use according to claim 31, wherein the organic material is a liquid crystal optionally wherein the liquid crystal comprises one or more groups selected from alkyl, cycloalkyl and aryl, such as wherein the liquid crystal has an alkyl group, a cycloalkyl group and an aryl group.

35. (New) The use according to claim 31, wherein the organic material is an alkyl carboxylic acid or an alkyl carboxylate salt optionally wherein the alkyl group has three or more carbon atoms, such as 3 or 4 carbon atom preferably wherein the organic material is a hydrocarbon, such as an alkane or a cycloalkane.

36. (New) The use according to claim 31, wherein the organic material has a phase transition at a temperature within the range 200 to 450 K, such as 245 to 340 K, such as 245 to 315 K optionally wherein the phase transition of the organic material comprises a first-order phase transition preferably wherein the phase transition of the organic material is a first-order phase transition.

37. (New) The use according to claim 31, wherein

the organic material has an entropy change at a phase transition, $|\Delta S_0|$, of at least 10 J K^{-1} kg^{-1}, such as at least 50 J K^{-1} kg^{-1}, such as at least 100 J K^{-1} kg^{-1}, such as at least 150 J K^{-1} kg^{-1}, such as at least 250 J K^{-1} kg^{-1}, such as at least 400 J K^{-1} kg^{-1}; and/or

wherein a phase transition in the organic material displays a latent heat, $|Q_0|$, that is at least 1 kJ kg^{-1}, such as at least 5.0 kJ kg^{-1}, such as at least 10.0 kJ kg^{-1}, such as at least 25 kJ kg^{-1}, such as at least 50 kJ kg^{-1}:and/or wherein the organic material has a volume change at the phase transition of at least 1.0 mm^3 g^{-1}, such as at least 10 mm^3 g^{-1}, such as at least 50 mm^3 $g^{-1}$and/or wherein the organic material is provided within a pressure-transmitting medium, such as a pressure-transmitting fluid or a pressure-transmitting solid.

38. (New) The use according to claim 31, wherein hydrostatic pressure is applied to the organic material at a temperature that is within 50 K, such as within 10 K, such as within 5 K, such as within 1 K, of a phase transition temperature of the organic material, where the phase transition temperature is the temperature for the phase transition in the absence of the hydrostatic pressure optionally

wherein the applied hydrostatic pressure is at most 1.0 GPa, at most 0.5 GPa, at most 0.2 GPa, such as at most 0.1 GPa, such as at most 0.07 GPa preferably
wherein the applied hydrostatic pressure is at least 0.1 MPa, such as at least 0.5 MPa, such as at least 5.0 MPa.

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39. (New) A method of barocaloric cooling or heating, the method comprising the steps of:
(i) applying hydrostatic pressure to an organic material; and
(ii) permitting heat flow from or to the organic material.
(iii) releasing hydrostatic pressure from an organic material that is under applied pressure; and
(iv) permitting heat flow to or from the organic material.

40. (New) The method according to claim 39, wherein the organic material is an organic compound or a salt thereof optionally

wherein the organic material has a molecular weight of at most 2,000, such as at most 1,000; and/or

wherein the organic material has a molecular weight of at least 50; and/or

wherein the organic material is an organic compound or a salt thereof, and the organic compound has two or more carbon-carbon bonds; and/or

wherein the organic material is an organic compound or a salt thereof, and the organic compound has two or more carbon-hydrogen bonds; and/or

wherein the organic material is a liquid crystal or a plastic crystal.

41. (New) The method according to claim 39, wherein the organic material is a plastic crystal such as a plastic crystal comprising an alkyl group or a cycloalkyl group optionally

wherein the plastic crystal comprises a cycloalkyl group, and the cycloalkyl group is an adamantantyl group preferablywherein the adamantantyl group is optionally substituted with one or more groups selected from the group consisting of alkyl, halo, hydroxyl and oxo; or

wherein the plastic crystal comprises an alkyl group, and the alkyl group is a C_{4-20} alkyl group, such as a C_{4-5} alkyl group preferably wherein the alkyl group is optionally substituted with one or more groups selected from the group consisting of hydroxyl, amino and nitro.

42. (New) The method according to claim 39, wherein the organic material is a liquid crystal optionally wherein the liquid crystal comprises one or more groups selected from alkyl, cycloalkyl and aryl, such as wherein the liquid crystal has an alkyl group, a cycloalkyl group and an aryl group.

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43. (New) The method according to claim 39, wherein the organic material is an alkyl carboxylic acid or an alkyl carboxylate salt optionally wherein the alkyl group has three or more carbon atoms, such as 3 or 4 carbon atom preferably wherein the organic material is a hydrocarbon, such as an alkane or a cycloalkane.

44. (New) The method according to claim 39, wherein the organic material has a phase transition at a temperature within the range 200 to 450 K, such as 245 to 340 K, such as 245 to 315 K, optionally wherein the phase transition of the organic material comprises a first-order phase transition, preferably wherein the phase transition of the organic material is a first-order phase transition.

45. (New) The method according to claim 39, wherein

the organic material has an entropy change at a phase transition, $|\Delta S_0|$, of at least 10 J K^{-1} kg^{-1}, such as at least 50 J K^{-1} kg^{-1}, such as at least 100 J K^{-1} kg^{-1}, such as at least 150 J K^{-1} kg^{-1}, such as at least 250 J K^{-1} kg^{-1}, such as at least 400 J K^{-1} kg^{-1}; and/or

wherein a phase transition in the organic material displays a latent heat, $|Q_0|$, that is at least 1 kJ kg^{-1}, such as at least 5.0 kJ kg^{-1}, such as at least 10.0 kJ kg^{-1}, such as at least 25 kJ kg^{-1}, such as at least 50 kJ kg^{-1}:and/or wherein the organic material has a volume change at the phase transition of at least 1.0 mm^3 g^{-1}, such as at least 10 mm^3 g^{-1}, such as at least 50 mm^3 $g^{-1}$and/or wherein the organic material is provided within a pressure-transmitting medium, such as a pressure-transmitting fluid or a pressure-transmitting solid.

46. (New) The method according to claim 39, wherein hydrostatic pressure is applied to the organic material at a temperature that is within 50 K, such as within 10 K, such as within 5 K, such as within 1 K, of a phase transition temperature of the organic material, where the phase transition temperature is the temperature for the phase transition in the absence of the hydrostatic pressure optionally

wherein the applied hydrostatic pressure is at most 1.0 GPa, at most 0.5 GPa, at most 0.2 GPa, such as at most 0.1 GPa, such as at most 0.07 GPa preferably
wherein the applied hydrostatic pressure is at least 0.1 MPa, such as at least 0.5 MPa, such as at least 5.0 MPa.

47. (New) A cooling or heating apparatus comprising an organic material as a barocaloric cooling or heating agent.

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48. (New) The apparatus according to claim 47, wherein the organic material is an organic compound or a salt thereof optionally

wherein the organic material has a molecular weight of at most 2,000, such as at most 1,000; and/or

wherein the organic material has a molecular weight of at least 50: and/or

wherein the organic material is an organic compound or a salt thereof, and the organic compound has two or more carbon-carbon bonds; and/or

wherein the organic material is an organic compound or a salt thereof, and the organic compound has two or more carbon-hydrogen bonds; and/or

wherein the organic material is a liquid crystal or a plastic crystal.

49. (New) The apparatus according to claim 47, wherein the organic material is a plastic crystal such as a plastic crystal comprising an alkyl group or a cycloalkyl group optionally

wherein the plastic crystal comprises a cycloalkyl group, and the cycloalkyl group is an adamantantyl group preferably wherein the adamantantyl group is optionally substituted with one or more groups selected from the group consisting of alkyl, halo, hydroxyl and oxo; or

wherein the plastic crystal comprises an alkyl group, and the alkyl group is a C_{4-20} alkyl group, such as a C_{4-5} alkyl group preferably wherein the alkyl group is optionally substituted with one or more groups selected from the group consisting of hydroxyl, amino and nitro.

50. (New) The apparatus according to claim 47, wherein the organic material is a liquid crystal optionally wherein the liquid crystal comprises one or more groups selected from alkyl, cycloalkyl and aryl, such as wherein the liquid crystal has an alkyl group, a cycloalkyl group and an aryl group.

51. (New) The apparatus according to claim 47, wherein the organic material is an alkyl carboxylic acid or an alkyl carboxylate salt optionally wherein the alkyl group has three or more carbon atoms, such as 3 or 4 carbon atom preferably wherein the organic material is a hydrocarbon, such as an alkane or a cycloalkane.

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52. (New) The apparatus according to claim 47, wherein the organic material has a phase transition at a temperature within the range 200 to 450 K, such as 245 to 340 K, such as 245 to 315 K optionally wherein the phase transition of the organic material comprises a first-order phase transition preferably wherein the phase transition of the organic material is a first-order phase transition.

53. (New) The apparatus according to claim 47, wherein

the organic material has an entropy change at a phase transition, $|\Delta S_0|$, of at least 10 J K^{-1} kg^{-1}, such as at least 50 J K^{-1} kg^{-1}, such as at least 100 J K^{-1} kg^{-1}, such as at least 150 J K^{-1} kg^{-1}, such as at least 250 J K^{-1} kg^{-1}, such as at least 400 J K^{-1} kg^{-1}; and/or

wherein a phase transition in the organic material displays a latent heat, $|Q_0|$, that is at least 1 kJ kg^{-1}, such as at least 5.0 kJ kg^{-1}, such as at least 10.0 kJ kg^{-1}, such as at least 25 kJ kg^{-1}, such as at least 50 kJ kg^{-1}:and/or wherein the organic material has a volume change at the phase transition of at least 1.0 mm^3 g^{-1}, such as at least 10 mm^3 g^{-1}, such as at least 50 mm^3 g^{-1}; and/or

wherein the organic material is provided within a pressure-transmitting medium, such as a pressure-transmitting fluid or a pressure-transmitting solid.

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REMARKS

The above claim amendments have been made solely to reduce the requisite filing fee. As such, the above amendments have not been made for reasons of patentability, i.e., in order to comply with any statutory requirements for patentability.

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IPR2024-01235

CONCLUSION

Applicant submits that all of the claims are in condition for allowance, which action is requested. If the Examiner finds that a telephone conference would expedite the prosecution of this application, please telephone the undersigned at the number provided.

Respectfully submitted,
BOZICEVIC, FIELD & FRANCIS LLP

Date: April 12, 2019

By: /Bret E. Field, Reg. No. 37,620/
Bret E. Field
Registration No. 37,620

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IPR2024-01235

Fig. 1

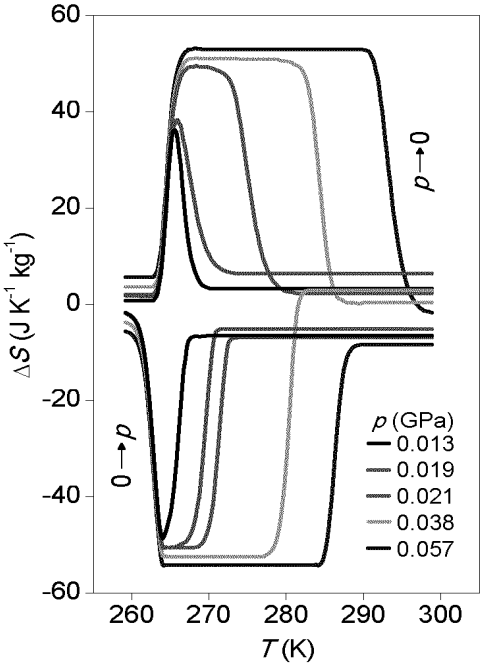

60
40
20
0
-20
-40
-60
260
270
280
290
300
ΔS (J K^{-1} kg^{-1})
T (K)
$p \rightarrow 0$
$0 \rightarrow p$
p (GPa)
0.013
0.019
0.021
0.038
0.057

Fig. 2

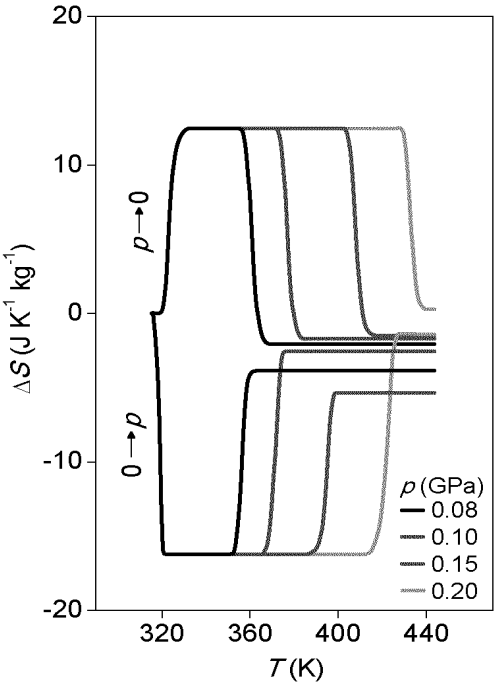

20
10
0
-10
-20
320
360
400
440
ΔS (J K^{-1} kg^{-1})
T (K)
$p \rightarrow 0$
$0 \rightarrow p$
p (GPa)
0.08
0.10
0.15
0.20

Fig. 3

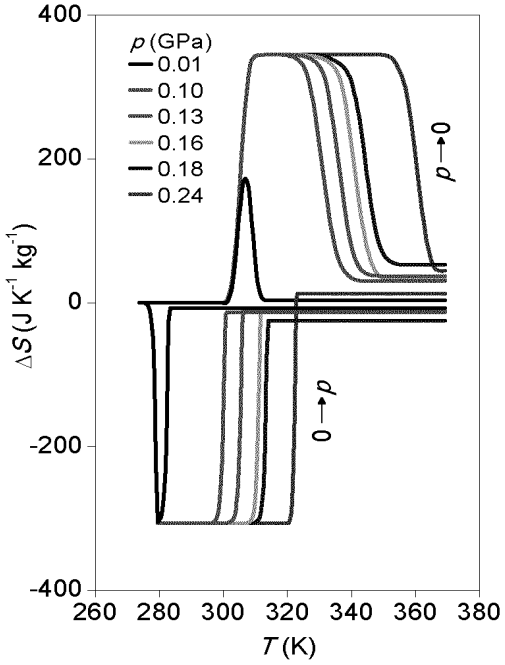

p (GPa)
0.01
0.10
0.13
0.16
0.18
0.24
p→0
0→p
ΔS (J K-1 kg-1)
T (K)
400
200
0
-200
-400
260
280
300
320
340
360
380

Fig. 4

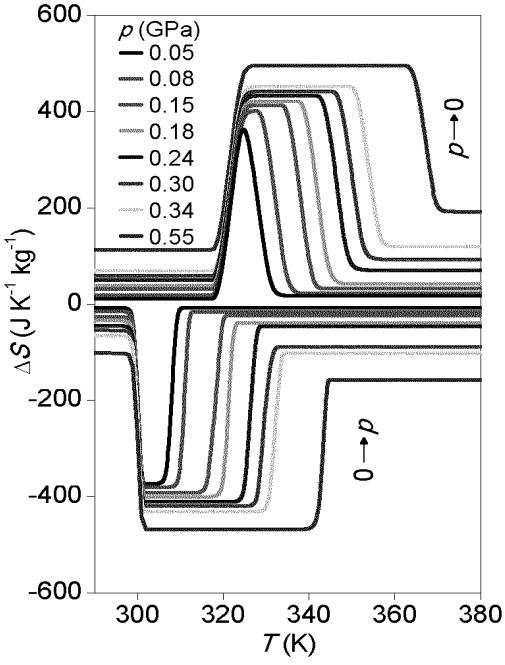

p (GPa)
0.05
0.08
0.15
0.18
0.24
0.30
0.34
0.55
p→0
0→p
ΔS (J K-1 kg-1)
T (K)
600
400
200
0
-200
-400
-600
300
320
340
360
380

Fig. 5

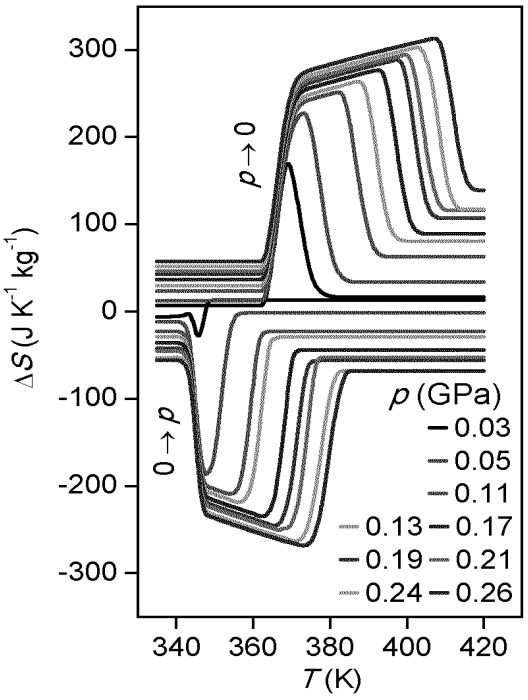
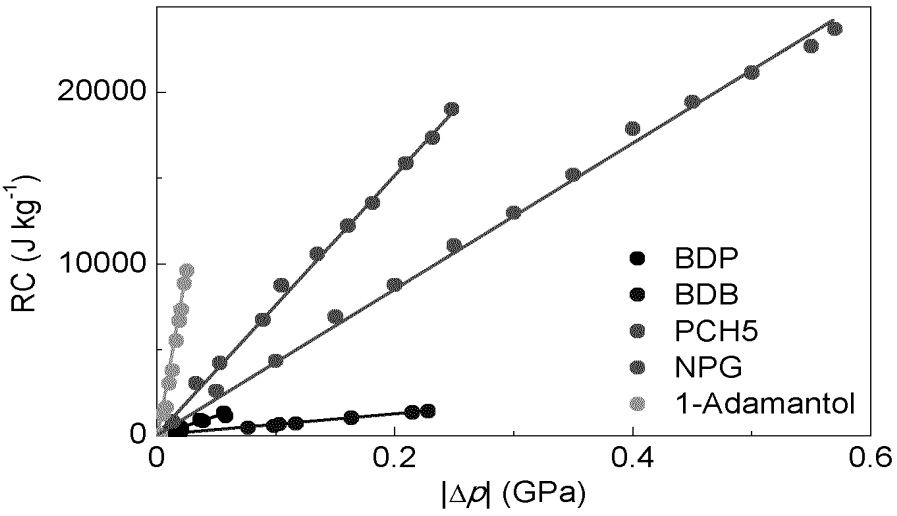

300
200
100
0
-100
-200
-300
ΔS (J K-1 kg-1)
p → 0
0 → p
p (GPa)
0.03
0.05
0.11
0.13
0.17
0.19
0.21
0.24
0.26
340
360
380
400
420
T (K)

Fig. 6


20000
10000
0
RC (J kg-1)
0
0.2
0.4
0.6
|Δp| (GPa)
BDP
BDB
PCH5
NPG
1-Adamantol

Claims:

1. The use of an organic material as a barocaloric cooling or heating agent.

2. A method of barocaloric cooling or heating, the method comprising the steps of:
(i) applying hydrostatic pressure to an organic material; and
(ii) permitting heat flow from or to the organic material.
(iii) releasing hydrostatic pressure from an organic material that is under applied pressure; and
(iv) permitting heat flow to or from the organic material.

3. A cooling or heating apparatus comprising an organic material as a barocaloric cooling or heating agent.

4. The use, method or apparatus according to any one of claims 1 to 3, wherein the organic material is an organic compound or a salt thereof.

5. The use, method or apparatus according to any one of claims 1 to 3, wherein the organic material has a molecular weight of at most 2,000, such as at most 1,000.

6. The use, method or apparatus according to any one of claims 1 to 5, wherein the organic material has a molecular weight of at least 50.

7. The use, method or apparatus according to any one of claims 1 to 6, wherein the organic material is an organic compound or a salt thereof, and the organic compound has two or more carbon-carbon bonds.

8. The use, method or apparatus according to any one of claims 1 to 7, wherein the organic material is an organic compound or a salt thereof, and the organic compound has two or more carbon-hydrogen bonds.

9. The use, method or apparatus according to any one of claims 1 to 7, wherein the organic material is a liquid crystal or a plastic crystal.

10. The use, method or apparatus according to claim 9, wherein the organic material is a plastic crystal.

11. The use, method or apparatus according to claim 10, wherein the plastic crystal comprises an alkyl group or a cycloalkyl group.

12. The use, method or apparatus according to claim 11, wherein the plastic crystal comprises a cycloalkyl group, and the cycloalkyl group is an adamantantyl group.

13. The use, method or apparatus according to claim 11, wherein the adamantantyl group is optionally substituted with one or more groups selected from the group consisting of alkyl, halo, hydroxyl and oxo.

14. The use, method or apparatus according to claim 11, wherein the plastic crystal comprises an alkyl group, and the alkyl group is a C_{4-20} alkyl group, such as a C_{4-5} alkyl group.

15. The use, method or apparatus according to claim 14, wherein the alkyl group is optionally substituted with one or more groups selected from the group consisting of hydroxyl, amino and nitro.

16. The use, method or apparatus according to claim 9, wherein the organic material is a liquid crystal.

17. The use, method or apparatus according to claim 9, wherein the liquid crystal comprises one or more groups selected from alkyl, cycloalkyl and aryl, such as wherein the liquid crystal has an alkyl group, a cycloalkyl group and an aryl group.

18. The use, method or apparatus according to any one of claims 1 to 8, wherein the organic material is an alkyl carboxylic acid or an alkyl carboxylate salt.

19. The use, method or apparatus according to claim 18, wherein the alkyl group has three or more carbon atoms, such as 3 or 4 carbon atoms.

20. The use, method or apparatus according to any one of claims 1 to 8, wherein the organic material is a hydrocarbon, such as an alkane or a cycloalkane.

21. The use, method or apparatus according to any one of claims 1 to 20, wherein the organic material has a phase transition at a temperature within the range 200 to 450 K, such as 245 to 340 K, such as 245 to 315 K.

22. The use, method or apparatus according to any one of claims 1 to 21, wherein the phase transition of the organic material comprises a first-order phase transition.

23. The use, method or apparatus according to claim 22 wherein the phase transition of the organic material is a first-order phase transition.

24. The use, method or apparatus according to any one of claims 1 to 23, wherein the organic material has an entropy change at a phase transition, $|\Delta S_0|$, of at least 10 J K^{-1} kg^{-1}, such as at least 50 J K^{-1} kg^{-1}, such as at least 100 J K^{-1} kg^{-1}, such as at least 150 J K^{-1} kg^{-1}, such as at least 250 J K^{-1} kg^{-1}, such as at least 400 J K^{-1} kg^{-1}.

25. The use, method or apparatus according to any one of claims 1 to 24, wherein a phase transition in the organic material displays a latent heat, $|Q_0|$, that is at least 1 kJ kg^{-1}, such as at least 5.0 kJ kg^{-1}, such as at least 10.0 kJ kg^{-1}, such as at least 25 kJ kg^{-1}, such as at least 50 kJ kg^{-1}.

26. The use, method or apparatus according to any one of claims 1 to 25, wherein the organic material has a volume change at the phase transition of at least 1.0 mm^3 g^{-1}, such as at least 10 mm^3 g^{-1}, such as at least 50 mm^3 g^{-1}.

27. The use, method or apparatus according to any one of claims 1 to 26, wherein the organic material is provided within a pressure-transmitting medium, such as a pressure-transmitting fluid or a pressure-transmitting solid.

28. The use or method according to claim 1 or claim 2, wherein hydrostatic pressure is applied to the organic material at a temperature that is within 50 K, such as within 10 K, such as within 5 K, such as within 1 K, of a phase transition temperature of the organic material, where the phase transition temperature is the temperature for the phase transition in the absence of the hydrostatic pressure.

29. The use or method according to claim 28, wherein the applied hydrostatic pressure is at most 1.0 GPa, at most 0.5 GPa, at most 0.2 GPa, such as at most 0.1 GPa, such as at most 0.07 GPa.

30. The use or method according to claim 28 or claim 29, wherein the applied hydrostatic pressure is at least 0.1 MPa, such as at least 0.5 MPa, such as at least 5.0 MPa.

USE OF BAROCALORIC MATERIALS AND BAROCALORIC DEVICES

Related Application

The present case claims priority to, and the benefit of, GB 1617508.5 filed on 14 October 2016 (14/10/2016), the contents of which are hereby incorporated by reference in their entirety.

Funding

The project leading to this application has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (grant agreement No 680032).

Field of the Invention

The present invention provides the use of organic materials in methods of barocaloric cooling. The invention also provides for the use of the organic materials to achieve a barocaloric cooling effect, such as in a method of cooling. Also provided is a cooling device comprising an organic material for use as a barocaloric cooling agent.

Background

Foodstuffs, beverages, medical products and medical samples, electronics, and populated spaces such as offices, all require cooling. Current refrigeration and air-conditioning units rely primarily on the compression and expansion of environmentally harmful fluids, and there is strong interest in developing cooling systems that avoid such fluids. Recent developments in the field have looked at solid materials that display magnetically, electrically and mechanically driven phase transitions near room temperature. These materials will only gain commercial acceptance if they are shown to be inexpensive and capable of exhibiting large reversible thermal changes driven by applied fields that are easy to generate.

Caloric effects are currently under intense study due to the prospect of environmentally-friendly cooling applications. To date the work in this area has focussed on developing large magnetocaloric effects and large electrocaloric effects, but the former require large magnetic fields that are challenging to generate economically and the latter require large electric fields that can typically be applied without breakdown only in thin samples. For these reasons recent work has turned to mechanocaloric effects, such as elastocaloric effects, where the effects are driven by applied uniaxial stress, and barocaloric effects, which are driven by isotropic stress (hydrostatic pressure). These effects are attractive for the reason that mechanical stress is easy to generate and large mechanocaloric effects have been observed at relatively low applied stresses. However, the use of elastocaloric materials is limited, as

these materials exhibit plastic flow which develops in the MPa range for metallic materials. For barocaloric materials there are no energy losses or mechanical breakdown associated with plastic deformation.

Large barocaloric effects (also referred to as BC effects) driven by hydrostatic pressure near phase transitions have been observed, but generally only in a small number of relatively expensive magnetic materials. Here, changes of magnetization are accompanied by changes in volume, with or without changes in crystal symmetry.

It is known that first-order phase transitions release or absorb latent heat. This latent heat may be released or absorbed by the application of a specific field, which in the case of barocaloric materials is the application of a mechanical stress, and more accurately, the application of hydrostatic pressure. Large barocaloric effects are observed near the phase transition temperature when the first-order phase transition is induced by the applied isotropic stress.

For example, Matsunami *et al.* have described large barocaloric effects enhanced by the frustration of the antiferromagnetic phase in Mn_3GaN. Here, the large barocaloric effects are caused by an enhancement of the ratio of volume change against the pressure coefficient of the Néel temperature. The phase transition occurs around 290 K. The material shows a pressure-driven isothermal entropy change of around 21 J K^{-1} kg^{-1} due to a change in hydrostatic pressure of 0.09 GPa (with respect to ambient pressure), providing a barocaloric strength of 232 J K^{-1} kg^{-1} GPa^{-1} ($|\Delta S|/|\Delta p|$ which is maximized with the smallest $|\Delta p|$ compatible with maximizing $|\Delta S|$), and a refrigerant capacity of 125 J kg^{-1}.

Recently the present inventors have described larger barocaloric effects at low pressures in ferrielectric ammonium sulfate (see Lloveras *et al.*). Here ammonium sulfate undergoes a first-order transition between a centrosymmetric orthorhombic structure and an orthorhombic polar structure at around 220 K. The large barocaloric effects are connected with pressure-driven changes in ionic ordering, which contrast with the smaller effects observed in magnetic materials, which are linked to pressure-driven changes in the density of electronic states near the Fermi level.

Ammonium sulfate shows a pressure-driven isothermal entropy change of around 60 J K^{-1} kg^{-1} due to changes in hydrostatic pressure of 0.10 GPa (with respect to ambient pressure), providing a barocaloric strength of 600 J K^{-1} kg^{-1} GPa^{-1}, and a refrigerant capacity of 276 J kg^{-1}.

There is a desire to identify materials exhibiting large barocaloric effects, and most particularly it is desirable to identify materials displaying a large isothermal entropy change at relatively low pressure. It is helpful to identify those materials exhibiting a large adiabatic temperature change in response to an applied isotropic stress, as well as those materials

having a relative large latent heat. There is also the practical need to identify materials where a phase transition occurs near ambient temperatures.

Summary of the Invention

In a general aspect the invention provides for the use of an organic material, such as an organic material having a molecular weight of 2,000 or less, as a barocaloric cooling agent, for example where the organic material is used near a non-isochoric phase transition, such as a non-isochoric first-order phase transition. The methods that permit the use of the organic material as a cooling agent may be adapted for use of the organic material as a heating agent.

Until now the materials known to provide significant barocaloric effects have been generally limited to inorganic materials, such as Mn_3GaN and ammonium sulfate. The inventors have found that organic materials that display volume changes due to first-order phase transitions may be used to provide a barocaloric effect. These organic materials typically display a very large pressure-driven shift in the phase transition temperature. Indeed, small changes in hydrostatic pressure are seen to drive giant barocaloric effects at or near phase transition in these materials.

The barocaloric effects for the organic materials are comparable to or exceed those previously observed for inorganic materials, such as magnetic, ferroelectric and ferrielectric inorganic materials. The organic materials are therefore suitable for use in barocaloric cooling methods and cooling devices. For example, the pressure-driven isothermal entropy change values for the organic materials, such as plastic crystals, may be comparable to or exceed those reported for Mn_3GaN or ammonium sulfate. The latent heat values and adiabatic temperature changes for the organic materials, such as plastic crystals, may be comparable to or exceed those reported for Mn_3GaN or ammonium sulfate. Furthermore, the phase transition temperatures for the organic materials may lie closer to ambient temperatures compared with a material such as ammonium sulfate.

The pressures required to drive the phase transition in the organic materials may also be small compared with the pressures required for the inorganic materials. The phase transitions in organic materials also have latent heat values that are comparable to those reported for the materials currently used in refrigerators and air-conditioning units.

The organic materials are attractive for the reason that they are widely available, and many materials can be obtained on a large scale, at low cost, and the materials have low toxicity, and can be easily and readily disposed of after use. In these respects the use of organic materials has an advantage over the previously reported barocaloric methods which use magnetic materials.

In one aspect of the invention there is provided the use of an organic material as a barocaloric cooling agent. Here, a barocaloric effect, which is typically a large barocaloric effect, may be developed from a relatively low applied hydrostatic pressure.

In a second aspect of the invention there is provided a method of cooling, such as a barocaloric cooling method, the method comprising the steps of:

(i) applying hydrostatic pressure to an organic material; and

(ii) permitting heat flow from or to the organic material, such as from or to the organic material;

(iii) releasing hydrostatic pressure from an organic material that is under applied pressure; and

(iv) permitting heat flow to or from the organic material, such as to or from the organic material.

The method of the invention may comprise repeating steps (i) to (iv), for example to provide sustained cooling. The steps may be repeated as often as is required to provide the desired cooling effect.

A barocaloric organic material is a compound, or a salt of that compound, having a carbon atom, and optionally having one or more carbon-carbon bonds and/or one or more carbon-hydrogen bonds.

The barocaloric organic material may be a material having an observable first-order phase transition. Thus, the phase transition of the organic material may comprise a first-order phase transition, or the phase transition is a first-order phase transition.

The barocaloric organic material may have a molecular weight of 2,000 or less, such as 1,000 or less. Here, the organic material is not a polymer.

The barocaloric organic material may be a plastic crystal.

The barocaloric organic material may be a liquid crystal.

The barocaloric organic material may be an alkyl carboxylate salt.

In the methods of the invention, the hydrostatic pressure is applied near the transition temperature of the organic material, such as a temperature near and above the transition temperature (for conventional barocaloric materials) or near and below the transition temperature (for inverse barocaloric materials). It is here that large barocaloric effects are observed. For example, the hydrostatic pressure is applied at a temperature that is within 50 K, such as within 20 K, such as within 15 K, such as within 10 K, such as within 5 K, such as within 2 K, such as within 1 K, such as within 0.5 K of the transition temperature, which is

the transition temperature of the organic material absent the applied hydrostatic pressure (for example, the transition temperature under ambient pressure).

In the methods of the invention, the hydrostatic pressure may be applied at a level sufficient to induce the phase transition.

In another aspect of the invention there is provided a cooling apparatus, the apparatus comprising an organic material as a barocaloric cooling agent.

The apparatus may also comprise means for applying hydrostatic pressure to the organic material.

The apparatus may also comprise means for transferring heat to and from the organic material.

The organic material may be provided in a pressure-transfer medium, such as a pressure transfer fluid.

These and other aspects and embodiment of the invention are described in further detail below.

Summary of the Figures

Figure 1 shows the change in entropy (J K^{-1} kg^{-1}) with change in temperature (K) for barium dicalcium propionate (BDP) with the application and release of hydrostatic pressure on the organic material, where the lower portion of the graph (negative entropy change) shows data for the application of pressure from no applied pressure to the specified applied pressure (GPa), and the upper portion of the graph (positive entropy change) shows data for the release of pressure from the specified applied pressure (GPa) to no applied pressure.

Figure 2 shows the change in entropy (J K^{-1} kg^{-1}) with change in temperature (K) for barium dicalcium butyrate (BDB) with the application and release of pressure on the organic material, where the lower portion of the graph (negative entropy change) shows data for the application of pressure from no applied pressure to the specified applied pressure (GPa), and the upper portion of the graph (positive entropy change) shows data for the release of pressure from the specified applied pressure (GPa) to no applied pressure.

Figure 3 shows the change in entropy (J K^{-1} kg^{-1}) with change in temperature (K) for the liquid crystal 4-(trans-4-pentylcyclohexyl) benzonitrile (PCH5) with the application and release of pressure on the organic material, where the lower portion of the graph shows data for the application of pressure from no applied pressure to the specified applied pressure

(GPa), and the upper portion of the graph shows data for the release of pressure from the specified applied pressure (GPa) to no applied pressure.

Figure 4 shows the change in entropy (J K^{-1} kg^{-1}) with change in temperature (K) for a plastic crystal neopentyl glycol (NPG) with the application and release of pressure on the organic material, where the lower portion of the graph shows data for the application of pressure from no applied pressure to the specified applied pressure (GPa), and the upper portion of the graph shows data for the release of pressure from the specified applied pressure (GPa) to no applied pressure.

Figure 5 shows the change in entropy (J K^{-1} kg^{-1}) with change in temperature (K) for a plastic crystal 1-adamantanol with the application and release of pressure on the organic material, where the lower portion of the graph shows data for the application of pressure from no applied pressure to the specified applied pressure (GPa), and the upper portion of the graph shows data for the release of pressure from the specified applied pressure (GPa) to no applied pressure.

Figure 6 shows the change in refrigerant capacity, RC, (J kg^{-1}) with the change in hydrostatic pressure $|\Delta p|$ for the organic materials 1-adamantanol, PCH5, NPG, BDP, and BDB (from top to bottom). The solid lines are linear fits to the data.

Detailed Description of the Invention

As noted previously, large barocaloric effects driven by hydrostatic pressure near first-order phase transitions have been experimentally observed in a small number of relatively expensive magnetic materials, where changes of magnetization are accompanied by changes in volume, with or without changes in crystal symmetry.

Recent experimental work from the present inventors has shown that large barocaloric effects are observed in ammonium sulfate near the first-order ferrielectric phase transition of this inorganic material.

The present inventors have now established that organic materials, such as those that display non-isochoric phase transitions, and particularly non-isochoric first order phase transitions, can provide large barocaloric effects. These organic materials may be used as alternatives to the inorganic materials that have previously been described for use in barocaloric cooling.

Rodriguez *et al.* have described the barocaloric temperature changes of poly(methyl methacrylate) under high applied hydrostatic pressure. However, the hydrostatic pressure is not apparently applied at a temperature close to a first-order phase transition of the polymer.

Patel *et al.* have described the elastocaloric in the polyvinylidene difluoride (PVDF) polymer, and barocaloric effects in the polyvinylidene difluoride-trifluoroethylene-chlorotrifluoroethylene (PVDF-TrFE-CTFE) polymer. The authors estimate the barocaloric response of a ferroelectric polymer near its first-order ferroelectric phase transition. The estimation is based on volume versus temperature data originally reported by Roland *et al.*

Mikhaleva *et al.* have described very small barocaloric effects in triglycinesulfate (TGS) near a second-order ferroelectric phase transition. The authors describe these effects as insignificant, and they did not propose the use of TGS in cooling applications.

Xie and Zhu have suggested that dihexadecylphosphatidylethanolamine (DHPE), used in excess water, would exhibit barocaloric effects. Their suggestion is based on earlier reported work by Mencke *et al.* who described a transition of the phospholipid from a lamellar liquid crystal to a lamellar gel when the material was subjected to a pressure jump (from 20 to 60 MPa). Mencke *et al.* detected a temperature change that occurred approximately at the same time as this transition, but this temperature change was likely to have arisen due to pressure-driven temperature changes in water away from any transition, as recognised by the authors in their original paper, and as shown *via* basic thermodynamical calculations using water.

The work of Mencke *et al.* is intended to exemplify a new apparatus for time-resolved X-ray diffraction studies using static and oscillating pressures and pressure jumps. There is no suggestion in this paper that organic materials would be generally useful in providing barocaloric cooling within a cooling apparatus.

The organic materials for use in the present case are also preferably lower molecular weight compounds and the salts thereof. Furthermore, the methods of the invention apply pressure at close to, such as within 50 K of, such as within 10 K of, the phase transition temperature of the organic material.

Organic Material

The organic material for use in the present invention may be an organic compound or a salt thereof. References to the organic compound may include a reference to the ionic form of the compound, as appropriate. Generally, the organic material has a molecular weight that is 2,000 or less. Thus, the organic materials for use in the present case are preferably small molecular weight compounds, and the salts thereof.

The organic compound, or the ionic form of the compound, has one or more carbon atoms, and most typically two or more carbon atoms. The organic compound will usually possess one or more carbon-carbon bonds, such as two or more carbon-carbon bonds. The organic

material may therefore be contrasted with an inorganic material, which does not contain a carbon atom.

The organic compound, or the ionic form of the compound, will typically also contain hydrogen, and the material will usually have one or more carbon-hydrogen bonds, such as two or more carbon-hydrogen bonds.

The organic compound may additionally contain heteroatoms, such as nitrogen, oxygen, sulfur and/or fluorine atoms. The organic compound may therefore contain one or more carbon-heteroatom bonds, such as carbon-oxygen bonds.

The organic compound may contain one or more groups selected from alkyl, alkenyl, alkynyl, cycloalkyl, heterocyclyl, aryl including carboaryl and heteroaryl.

Multiple groups of the same type may be present in the organic compound. For example, an organic material may contain a plurality of cycloalkyl, heterocyclyl, or aryl groups.

Where the organic compound contains ring systems, such as cycloalkyl, heterocyclyl, or aryl groups, these groups may include fused ring systems. For example, an organic material exemplified herein is adamantane, which may be regarded as having fused cycloalkyl groups.

In addition the organic compound may contain one or more groups selected from halo, hydroxyl, carboxyl, oxo such as keto and acyl, ester, carbonate, amino, amido, carbamate, carbamide (urea), cyano, nitrile and nitro.

The carboxyl group may be in ionic form as a carboxylate together with an appropriate counter cation.

The amino group may be in ionic form as a quaternary amine together with an appropriate counter anion.

The organic compound may contain an alkyl group, such as a C_{1-12} alkyl group.

The organic compound may itself be a hydrocarbon. The organic compound may be an alkane, including linear and branched alkanes, or a cycloalkane, such as those having fused carbocyclic rings, such as an alkane or cycloalkane having 4 or more, such as 5 or more, such as 10 or more, carbon atoms. For example, 1,3-dimethyladamantane may be used as an organic material in the methods of the present case.

The organic compound may contain an aryl group, such as a carboaryl or a heteroaryl group. The carboaryl group may be phenyl or naphthyl.

In one embodiment, the organic compound is not a salt.

In one embodiment, the organic material is a salt of an organic compound. Here, the counter ion to the ionic form of the organic compound may be a metal ion or an organic ion. Although a metal counter ion may be present, the material may nevertheless be referred to as an organic material owing to the organic character of the ionic form of the organic compound.

A metal ion may be a mixed metal ion. For example, in the worked examples of the present case a mixed Ba and Ca counter ion is present in a propionate salt and a butyrate salt, and a mixed strontium and calcium counter ion is present in a propionate salt.

In one embodiment, the organic material does not contain a metal.

In one embodiment, the organic material does not contain a metal selected from the group consisting of Group 3 to 16 metals, such as Group 3 to 12 metals.

In other embodiments, the organic material does contain a metal. Typically, where a metal is present it is a counter ion to an ionic form of the organic compound. Thus, the metal is typically a cationic species. Where a metal is present it may be a Group 1 and/or a Group 2 metal. The examples in the present case include anionic forms of organic compounds together with Group 2 metal cations, such as barium, calcium and strontium cations.

In one embodiment, the organic material is an alkyl carboxylic acid or an alkyl carboxylate salt, and preferably an alkyl carboxylate. The alkyl group may have three or more carbon atoms, such as 3 or 4 carbon atoms (including the carbon atom provided by the acid group). The worked examples in the present case show barocaloric effects provided by propionate and butyrate salts.

In one embodiment, the organic material may be an alkyl carboxylic acid or an alkyl carboxylate salt where one or more, such as one or two, hydrogen atoms may be substituted with fluorine. The present inventors have found that alkyl carboxylates may be used in the methods of the present invention and fluorinated versions of the alkyl carboxylates are known to have a number of phase transitions at around ambient temperature and below. For example, Yano *et al.* describe the phase transitions of alkyl carboxylates and fluorinated alkyl carboxylates.

In some embodiments, the organic material is not an aminocarboxylic acid salt such as an amino acid salt, for example, a triglycine salt. In particular, the organic material is not an amino acid sulfate. Preferably the organic material is not triglycine sulfate (TGS). Triglycine sulfate is also known as glycine sulfate.

In one embodiment, the organic material is a soft matter material, such as a plastic crystal or a liquid crystal.

A plastic crystal typically has long-range translational order, which may be seen, for example, in the X-ray diffraction pattern for the material, where sharp Bragg peaks are visible, but there is no orientational order.

A liquid crystal has little or no long-range translational order, but orientational order is present. Thus, Bragg peaks are not visible in the X-ray diffraction pattern of the material. Further, plastic crystals have globular motifs, whereas liquids crystals have non-globular motifs.

An organic material having a plastic crystal phase, where there is no orientational order of the crystals, may be converted to or from a phase where there is orientational order, for example with a change in the temperature. Such a phase transition may be used in the methods of the invention.

A description of organic materials having plastic crystal character is provided by Timmermans, the contents of which are hereby incorporated by reference. A description of organic materials having plastic crystal or liquid crystal character is provided by Wunderlich *et al.*, the contents of which are hereby incorporated by reference.

The worked examples in the present case describe the use of organic materials having a plastic crystal character. Examples include neopentane and adamantane derivatives, such as 1-adamantanol.

The plastic crystal may comprise an alkyl group or a cycloalkyl group.

The cycloalkyl group may be an adamantyl group. The adamantyl group may be optionally substituted with one or more groups selected from the group consisting of alkyl, halo, hydroxyl and oxo.

The alkyl group may be a C_{4-20} alkyl group, such as a C_{4-5} alkyl group. The alkyl group is optionally substituted with one or more groups selected from the group consisting of hydroxyl, amino and nitro.

The worked examples in the present case describe the use of an organic material having a liquid crystal character. An example includes the liquid crystal PCH5.

The liquid crystal may comprise one or more groups selected from alkyl, cycloalkyl and aryl, such as wherein the liquid crystal has an alkyl group, a cycloalkyl group and an aryl group.

In one embodiment, the organic material is not lyotropic. Thus, the organic material may not be a phospholipid. Typically, the organic material is not provided, such as dispersed, within a solvent, such as water.

An organic material may contain one or more different organic compounds or salts thereof, and each of these compounds or salts may be as described herein. The individual compounds or their salts may have different transition temperatures. Such composites can be operated in a parallel or a cascade mode in order to enhance the temperature span of operation.

The organic materials for use in the present case are typically small molecular weight compounds.

The organic material may have a molecular weight that is at least 50, at least 65, at least 70, at least 100, or at least 150.

The organic material may have a molecular weight that is at most 500, at most 700, at most 1,000, at most 2,000, at most 5,000 or at most 10,000.

The organic material may have a molecular weight that is in a range selected from the lower and upper limits given above. For example, the organic material may have a molecular weight that is in the range 50 to 1,000, such as 100 to 500.

Typically, the organic compound is not a high molecular weight compound, such as a polymer.

It is noted that the work of Patel *et al.* uses a PVDF having a molecular weight of 530,000. The molecular weight of the PVDF-TrFE-CTFE polymer used by the authors is not reported. Rodriguez *et al.* study thermoelastic changes in poly(methyl methacrylate). The authors admit that they did not determine the molecular weight of the polymer or its size distribution.

The organic material may not be poly(methyl methacrylate), a polyvinylidene difluoride-containing polymer, such as polyvinylidene difluoride (PVDF) or PVDF-TrFE-CTFE, or a phospholipid, such as dihexadecylphosphatidylethanolamine (DHPE).

Where the organic material is a salt, the molecular weight may be the molecular weight of the ionic form of the organic compound, or the molecular weight of the ionic form of the organic compound together with its counter ion.

The organic material is usually provided within a pressure transmitting medium, which may be a fluid or a solid material, and such are described in further detail below in the detailed

description of the methods of the invention. The organic material is typically not provided in water.

The organic material exhibits certain thermodynamic properties, and these are described below.

Organic Material Properties

The organic materials for use in the present case display barocaloric effects under applied isotropic stress. A reference to organic materials displaying conventional barocaloric effects is also a reference to organic materials displaying inverse barocaloric effects.

Organic materials are generally expected to display conventional barocaloric effects under applied isotropic stress, where the material has a reduced volume at lower temperatures across the phase transition. However, inverse barocaloric effects may be observed in organic materials and such materials are equally useful in the methods of the invention. References to the properties of the organic materials are generally made with respect to those displaying conventional barocaloric effects. However, these references may be construed as references to materials displaying inverse effects, with the skilled person understanding the behaviour of those materials being opposite to those of conventional materials.

The organic material is a solid or it may have the characteristics of a mesophase, for example the organic compound may be a liquid crystal or plastic crystal, such as determined at ambient temperature, such as 270, 280 or 300 K, or at a lower temperature, such as 100, 150, 200, or 250 K, and at ambient pressure, such as at 101.3 kPa.

An organic material for use in the present invention may be a material having a reversible phase transition at a temperature lying in the range 100 to 450 K, such as 200 to 450 K, such as at ambient pressure, such as at 101.3 kPa.

A phase transition may be a transition between solid, plastic and liquid crystal phases. A phase transition may also be a transition between solid phases, or a transition between liquid crystal phases, or a transition between plastic crystal phases, or a transition between liquid and solid phases. In the present case the methods of cooling based on the barocaloric effect make use of these transitions occurring within the range 100 to 450 K, such as within the range 200 to 450 K, and most preferably the methods of the invention make use of transitions between or within solid and plastic crystal phases.

In some embodiments the phase transition is or comprises a first order phase transition, such as a transition between a mesophase, for example, a liquid crystal or plastic crystal phase, and a solid or liquid phase. Preferably, the transition is a first order phase transition.

Without wishing to be bound by theory, an ideal first-order phase transition is a transition in which the molar Gibbs energies or molar Helmholtz energies of the two phases (or chemical potentials of all components in the two phases) are equal at the transition temperature, but their first derivatives with respect to temperature and pressure (for example, specific enthalpy of transition and specific volume) are discontinuous at the transition point, as for two dissimilar phases that coexist and that can be transformed into one another by a change in a field variable such as pressure, temperature, magnetic or electric field.

The inventors have previously found that ammonium sulfate undergoes a transition between a centrosymmetric orthorhombic structure and an orthorhombic polar structure at around 220 K.

An organic material may undergo a displacive or order-disorder phase transition.

The organic materials for use in the present case include alkyl carboxylate salts, such as BDP and BDB. The phase transition observed with these materials is a structural phase transition from cubic symmetry to orthorhombic symmetry, which leads to large changes in the volume of the organic material.

In other embodiments of the invention, organic materials having a plastic crystal phase are provided. The phase transition in these materials may be between the plastic crystal phase and the solid phase. For example, the phase transition, such as on cooling, may be between an orientationally disordered crystal phase and an orientationally ordered crystal phase.

In other embodiments of the invention, organic materials having a liquid crystal phase are provided. The phase transition in these materials, such as on cooling, may be between an orientationally disordered liquid phase and an orientationally ordered liquid phase. Additionally or alternatively, the phase transition may be between a liquid phase and a solid phase.

Other types of phase transition may be utilised in the methods of the invention.

Examples of other types of transition include a phase transition between solid and liquid phases. Such transitions may be utilised with alkane compounds, for example. In a further example, such transitions may be utilised with liquid crystals.

The organic material typically does not exist in the gas phase in the temperature range 100 to 450 K, such as within the range 200 to 450 K, such as at ambient pressure, such as at 101.3 kPa. The methods of the invention do not make use of transitions to or from the gas phase.

For example, the organic material has a reversible phase transition that may lie at a temperature of at least 100, at least 150, at least 200, at least 210, at least 220, at least 230, at least 240, at least 245, at least 250, at least 260, at least 270, or at least 280 K. For example, the reversible phase transition may lie at a temperature of at most 310, at most 315, at most 320, at most 330, at most 340, at most 350, at most 360, at most 370, at most 380, at most 390, at most 400, or at most 450 K.

In one embodiment, the organic material has a reversible phase transition lying in a temperature range selected from the minimum and maximum temperatures given above. For example, the organic material has a reversible phase transition lying in the temperature range 245 to 340 K, such as 245 to 315 K or 280 to 330 K.

Most preferably the phase transition lies at a temperature that is close to, or at, ambient temperatures. Thus, as noted above, the reversible phase transition may lie at a temperature in the range 245 to 340 K, such as 245 to 315 K or 280 to 330 K.

More preferably, the phase transition for a material exhibiting conventional barocaloric effects lies at a temperature that is below ambient temperature, such as below 250 K. When hydrostatic pressure is applied to the organic material the transition temperature may be shifted to a temperature that lies within the ambient range or above, such as within the range 250 to 340 K, such as 270 to 340 K, such as 280 to 330 K.

More preferably, the phase transition for a material exhibiting inverse barocaloric effects lies at a temperature that is above ambient temperature, such as above 350 K. When hydrostatic pressure is applied to the organic material the transition temperature may be shifted to a temperature that lies within the ambient range or below, such as within the range 250 to 340 K, such as 270 to 340 K, such as 280 to 330 K.

The temperature given for the transition temperature may refer to the starting temperature for the transition, which may refer to the onset of the transition in a cooling or heating cycle at a constant rate of temperature change.

Many of the organic materials for use in the present invention have a reversible phase transition that lies in the preferred temperature ranges. For example BDB has a phase transition near 320 K, and BDP has a phase transition near 265 K. Ammonium sulfate has a reversible phase transition near 220 K, although it is noted that this material displays inverse barocaloric effects, whilst the organic materials exemplified in the present case display conventional barocaloric effects.

An organic material may have a plurality of reversible phase transitions and one or each phase transition may occur at a temperature within the limits given above. Where an organic

material has a plurality of reversible phase transitions, the methods of the invention may make use of one or more of these transitions, and typically one of these transitions. The methods of the invention may make use of the transition that lies closest to ambient temperature, such as closest to 270, 280 or 300 K.

The presence of a phase transition in the organic material may be established from the analysis of the heat flow performance of the material across a temperature range including the temperatures mentioned above. For example, the measurements of heat flow may be made by differential scanning calorimetry, such as using a temperature scan rate of 10 K min^{-1}. Lloveras *et al.*, for example, describe a typical experiment for determining the transition temperature at atmospheric pressure (see the *Methods* section, *Calorimetry at Atmospheric Pressure* at page 5, together with Figure 1(b)).

The phase transition temperature may be expressed as the transition temperature observed on heating, cooling, or as the average of the heating and cooling transitions.

An organic material may exhibit an endothermic transition upon heating through the transition point (thus the latent heat Q_0 is > 0). It follows then that the organic materials will exhibit an exothermic transition upon cooling through the transition point (thus Q_0 is < 0).

The entropy change at the transition, $|\Delta S_0|$, may be at least 10, at least 20, at least 50, at least 60, at least 70, at least 80, at least 90, at least 100, at least 110, at least 120 or at least 130 J K^{-1} kg^{-1}, which is the magnitude of the change and this change may be positive or negative as appropriate during heating and cooling through the transition.

However, many of the organic materials tested by the present inventors have a considerably greater entropy change $|\Delta S_0|$ associated with phase transitions. Thus, the entropy change at the transition may be at least 150, at least 200, at least 250, at least 300 or at least 350, at least 400, or at least 450 J K^{-1} kg^{-1}, which is the magnitude of the change and this change may be negative or positive as appropriate during cooling and heating through the transition. These entropy changes are considerably larger than those recorded for ammonium sulfate in the work of Lloveras *et al.* and also considerably larger than the values reported for metallic alloys (see Table 1 of Lloveras *et al.*, for example).

The entropy change may refer to the entropy change for the entire transition. Alternatively, where a transition includes a first-order transition optionally with other order transitions, the entropy change may refer to the entropy change for the first-order transition only. Where there is a first-order transition which is a part of the entire transition, the entropy change for the first-order transition may be at least 30%, at least 40% or at least 50% of the entropy change of the entire transition.

The entropy change may be expressed as the entropy change observed on heating, cooling, or as the average of the heating and cooling transitions.

The entropy change at the transition may be determined by differential scanning calorimetry, as noted above.

The phase transition is accompanied by a change in the unit cell volume of the material, for example the unit cell volume may increase on heating through the phase transition. This is the change observed for conventional barocaloric materials. A decrease in the unit cell volume may be observed for inverse barocaloric materials.

The volume change at the transition may be at least 1.0, at least 5.0, at least 10, at least 15, at least 20, at least 25, at least 30, at least 40 or at least 50 mm^3g^{-1}.

The volume change at the transition may be a change of at least 0.1%, at least 0.2%, at least 0.5%, or at least 1.0%.

The figures given above relate to the magnitude of the change, and this change may be positive or negative as appropriate during heating and cooling through the transition. For example, the volume change may refer to an increase (positive) change in the volume, as such might be observed on heating through the phase transition.

The volume change may refer to the volume change for the entire transition. Alternatively, where a transition includes a first-order transition optionally with other order transitions, the volume change may refer to the volume change for the first-order transition only. Where there is a first-order transition which is a part of the entire transition, the change in volume for the first-order transition may be at least 30%, at least 40% or at least 50% of the volume change for the entire transition.

The change in the volume at the transition may be determined from X-ray diffraction analysis of the organic material during a temperature sweep across the phase transition (where the transition typically occurs across a temperature range). Lloveras *et al.*, for example, describe a typical experiment for determining the volume change at atmospheric pressure (see the *Methods* section, *X-Ray Diffraction* at page 5, together with Figure 1(d)). X-Ray diffraction measurements were used to determine the change in volume for the BDP and BDB organic materials described in the present case. The change in the volume at the transition may be determined from volumetric thermal expansion measurements, or from volumetric isothermal compressibility measurements at various temperatures.

The phase transition in the organic material may display a latent heat, $|Q_0|$, that is at least 1.0, at least 2.0 at least 3.0, at least 4.0, at least 5.0, at least 7.0, at least 9.0 or at least 10.0 $kJ\ kg^{-1}$.

Some organic materials, such as plastic crystals, have a phase transition that displays a latent heat, $|Q_0|$,that is very high. Thus, in some embodiments, the organic material may have a latent heat, $|Q_0|$, that is at least 25, at least 50, at least 75, at least 100, at least 150 or at least 200 kJ kg^{-1}.

The inorganic materials that have previously been used in the art for barocaloric cooling typically have latent heats in the range 2.0 to 13.2 kJ kg^{-1} (see Table 1 of Lloveras *et al.*, for example).

The latent heat values may be determined from the differential scanning calorimetry analysis of the material.

The organic materials display large barocaloric effects under applied pressure. In particular, the organic materials display a strong pressure-induced shift in the phase transition temperature.

The shift in transition temperature with applied pressure dT_0/dp, is relatively high for the organic components used herein. Thus, small or moderate pressures may be used to drive relatively large temperature changes.

In one embodiment, the change in transition temperature is at least 1 K, at least 2 K, at least 3 K, at least 4 K, at least 5 K, or at least 10 K, for example as measured for a change in applied pressure of 0.15 GPa. The figures given here relate to the magnitude of the change, which may be a positive change (for materials displaying conventional barocaloric effects) or a negative change (for materials displaying inverse barocaloric effects). In the worked examples of the present case, the organic materials are conventional and therefore they show a positive change in transition temperature. It will be understood that alternative materials may be used where a negative change in transition temperature is required. In one embodiment, the temperature change is an increase in the transition temperature under the applied pressure.

The temperature change refers to the adiabatic temperature change. The temperature change may be the temperature change derived from $-c\Delta T$ approximating to $T\Delta S = Q$ using the zero-pressure specific heat capacity c, the isothermal entropy change ΔS and the temperature of operation, T (Q is isothermal heat). It is appreciated that a large change in transition temperature with pressure does not always correspond to a large adiabatic temperature change, however in some instances it may do so.

The adiabatic temperature change can be calculated using the values of isothermal entropy change and heat capacity, which is a fundamental quantity known for most materials. The

adiabatic temperature change may also be measured experimentally, for examples using the experimental set up described by Rodriguez *et al.*

In one embodiment, the change in transition temperature as a function of change in applied pressure, dT_0/dp, is at least 50, at least 100, at least 150, at least 200, at least 250, at least 400 or at least 500 K GPa^{-1}. The figures given here relate to the magnitude of the change, which may be positive, for example. The change in transition temperature as a function of change in applied pressure may be determined in heat flow experiments, during a heating step or a cooling step, for example at constant pressure. In the liquid crystal experiment described in the present case, the value of dT_0/dp is 210 K GPa^{-1}.

The organic materials typically have a large refrigerant capacity, RC.

In one embodiment, the refrigerant capacity, RC, is at least 100, at least, 150, at least 200, or at least 250 J kg^{-1}. The RC values may be the value determined at an applied hydrostatic pressure of 0.1, 0.2 or 0.3 GPa. The RC values may be the value determined at an applied hydrostatic pressure of 0.075, 0.01, 0.03 or 0.1 GPa.

Refrigerant capacity may be determined from the product of the maximum values of isothermal entropy change with the full width at half maximum (FWHM) of the isothermal entropy peak with temperature, as the absolute value. Thus, the value of RC may be determined as the product of the maximum isothermal entropy change with the full width at half maximum of the peak in $\Delta S(T)$, thus RC = $|\Delta S \times (\text{FWHM of } \Delta S(T))|$.

In the present case, BDP has an RC value of 77.6 J kg^{-1} at 0.0075 GPa, BDB has an RC value of 560 J kg^{-1} at 0.1029 GPa, and PCH5 has an RC value of 8,765 J kg^{-1} at 0.104 GPa.

Methods and Uses

The present invention provides a method of cooling which uses the barocaloric effects of the organic materials described herein. Thus, the organic materials find use as cooling agents, for example within a cooling apparatus. The organic material may be referred to as a refrigerant.

The methods of the invention make use of the change in the thermal behaviour of an organic material under an applied pressure. The application of hydrostatic pressure to the organic material induces a change in the transition temperature. The barocaloric effect may be advantageously used within a heat pump cycle or a refrigeration cycle to provide heating or cooling respectively.

The methods of the invention allow for the use of organic materials displaying conventional barocaloric effects and inverse barocaloric effects.

The methods of the invention include the step of applying hydrostatic pressure to the organic material or releasing hydrostatic pressure from an organic material. Hydrostatic pressure refers to isotropic stress. This is to be contrasted with the uniaxial stresses that are applied to materials for use in elastocaloric cooling. Barocaloric materials have the advantage over elastocaloric materials in that they are not limited by the onset of plastic flow, which typically occurs at high applied pressures (typically hundreds of MPa).

The method of the invention may be performed in an environment at ambient temperature, such as a temperature from 0 to 35°C, such as 5 to 35°C, such as 10 to 30°C (corresponding to 273.15 to 308.15 K, such as 278.15 to 308.15 K, such as 283.15 to 303.15 K). The methods of the invention allow for the generation of cooler and warmer localised regions within the environment as part of the barocaloric cooling process. For example, the organic material may become warmer or cooler than the ambient environment in the methods of the invention.

The methods of the invention include the step of applying a pressurizing force to the organic material, thereby to cause a change in the phase transition temperature, such as to increase the transition temperature (as shown in the worked examples of the present case). Organic materials exhibiting inverse barocaloric effects will exhibit a decrease in the transition temperature under the application of pressure.

In one embodiment, a sufficient pressuring force is applied to move the transition temperature to a temperature that is in an ambient temperature, such as a temperature from 0 to 35°C, such as 5 to 35°C, such as 10 to 30°C (corresponding to 273.15 to 308.15 K, such as 278.15 to 308.15 K, such as 283.15 to 303.15 K).

The organic materials for use in the present case provide large changes in transition temperature with relatively small applied pressures. Thus, the value of dT_0/dp is relatively high compared with many of the inorganic materials described previously.

The methods of the invention may use the organic material within conventional heating and cooling cycles in place of conventional materials, where the heating and cooling cycle is adapted to exploit the barocaloric effects of the organic materials.

Thus, the organic materials may be used within, for example, a Brayton cycle, an Ericsson cycle or a Carnot cycle to provide heating or cooling as required. The organic materials may also be used in alternative thermodynamic cycles to provide heating or cooling for a particular environment.

A method of the invention may comprise the steps of:

(i) applying hydrostatic pressure to an organic material; and

(ii) permitting heat flow from or to the organic material.

Where an organic material displays a conventional barocaloric effect upon application of hydrostatic pressure, step (ii) provides for the heat flow from the organic material. Where an organic material displays an inverse barocaloric effect, step (ii) provides for heat flow to the organic material.

A method of the invention may comprise the steps of:

(iii) releasing hydrostatic pressure from an organic material that is under applied pressure; and

(iv) permitting heat flow to or from the organic material.

Step (iii) may be referred to as a depressurisation step.

Where an organic material displays a conventional barocaloric effect upon release of hydrostatic pressure, step (iv) provides for the heat flow to the organic material. Where an organic material displays an inverse barocaloric effect, step (iv) provides for heat flow from the organic material.

The method of the invention may additionally comprise all of steps (i) to (iv) in a complete heat and cool cycle. Typically steps (i) and (ii) are undertaken prior to steps (iii) and (iv). The method may be a cooling method.

Where the method is a part of the Brayton cycle, for example, the pressure may be applied adiabatically, with, for example, a consequential heating of the organic material. In step (ii) there is a subsequent heat flow, for example from the organic material, which allows the organic material to return to its original temperature. In a further part of the cycle step, pressure may be released adiabatically with, for example, a consequential cooling of the organic material. In step (iv) there is a subsequent heat flow, for example to the organic material, which allows the organic material to return to its original temperature.

Where the method is a part of the Ericsson cycle, for example, the pressurisation and depressurisation steps are performed isothermally. Thus, the organic material is maintained at a substantially constant temperature, with heat transfer occurring, and not subsequent to, the pressurisation and depressurisation steps.

The methods of the invention allow heat flow to and from the organic material with changes in applied pressure. The ability of the organic material to absorb heat from the environment, in response to a pressure-induced phase transition, thereby cooling the environment, allows the organic material to be used as a cooling agent in a cooling apparatus.

In the methods of the invention the organic material may be used with a heat transfer fluid to and from which heat may be transferred. The heat transfer fluid is typically a liquid.

The heat transfer fluid may transfer heat to the organic material, thereby resulting in the relative cooling of the heat transfer fluid. The cooled heat transfer fluid may then be taken from the organic material and delivered to a location where cooling is desired.

The heat transfer fluid may accept heat transfer from the organic material, thereby resulting in the relative cooling of the organic material. The heated heat transfer fluid may then be taken from the organic material and delivered to a location for cooling, such as a radiator or another such heat exchanger, for example for cooling to ambient temperature.

It is not necessary for the heat transfer fluid to directly contact the organic material, and the heat transfer may occur *via* a heat exchanger.

A heat exchanger may use a heat switch, such as a thermoelectric heat switch, an electromechanical heat switch, a solid-state thermal diode or a heat pipe. The use of compact switches of these types may improve the design of the cooling devices, and enhance their energy efficiency.

The organic material may also be used together with a regenerator in order to alter or increase the temperature range of operation. The organic material may itself be used as a regenerator.

The barocaloric effects observed with the organic materials can be achieved at relatively low pressures. Accordingly, the pressurizing force applied to the organic material may be relatively low in the methods of the invention.

In the methods of the invention, the hydrostatic pressure is applied in step (i) near the transition temperature of the organic material. It is here that large barocaloric effects are observed. For example, the hydrostatic pressure is applied at a temperature that is within 50 K, within 20 K, within 15 K, within 10 K, such as within 5 K, such as within 2 K, such as within 1 K, such as within 0.5 K of the transition temperature, which is the transition temperature of the organic material absent the applied hydrostatic pressure (for example, the transition temperature under ambient pressure).

In the methods of the invention, the hydrostatic pressure may be applied at a level sufficient to induce the phase transition.

When a hydrostatic pressurizing force is applied, the pressure may be at most 1.0 GPa, at most 0.5 GPa, at most 0.2 GPa, at most 0.15 GPa, at most 0.10 GPa, at most 0.09 GPa, at

most 0.07 GPa, at most 0.06 GPa, at most 0.05 GPa, at most 0.04 GPa, at most 0.03 GPa, at most 0.02 GPa or at most 0.01 GPa.
When a pressurizing force is applied, the pressure may be at least 0.1 MPa, at least 0.5 MPa, at least 1.0 MPa, or at least 5.0 MPa.

The pressure applied may be a hydrostatic pressure in a range with the lower and upper limits selected from the values given above. For example, the hydrostatic pressure may be a pressure in the range 1.0 MPa to 0.1 GPa.

The pressurizing force is the change in pressure applied to the organic material. Typically the change in pressure is to or from ambient (atmospheric) pressure, such as to or from about 101 kPa.

Where the hydrostatic pressure is applied in step (i), there may be a rapid increase in pressure. Where the hydrostatic pressure is released in step (iii), the pressure may be a rapid release. This is preferred for systems operating as part of or whole of a Brayton cycle, in order to achieve adiabatic conditions.

Where the hydrostatic pressure is applied in step (i), there may be a slow increase in pressure. Where the hydrostatic pressure is released in step (iii), the pressure may be a slow release. This is preferred for systems operating as part of or whole of an Ericsson cycle, in order to achieve isothermal conditions.

The values of the transition temperature under a constant applied pressure (constant hydrostatic pressure) may be determined, for example using a differential thermal analyser operating under hydrostatic pressure at a heating or cooling rate of 1-4 k min^{-1}.

The application of hydrostatic pressure may be achieved by applying pressure to the organic material contained provided within a pressure-transmitting medium. Pressure-transmitting media are well known in the art and include liquid and solid materials. Typically, the pressure-transmitting medium is not water.

An example of a pressure-transmitting liquid includes alkoxy silane materials, such as DW-Therm, available from Huber Kältemaschinenbau GmbH.
An example of a pressure-transmitting solid is alumina powder.

The methods of the invention may be for use in cooling foodstuffs or beverages.
The methods of the invention may be for use in cooling medicines.
The methods of the invention may be for use in cooling biological samples, such as tissues.
The methods of the invention may be for use in cooling electronic devices, such as devices for analytical measurements.

The methods of the invention may be used to cool air, such as air within building and vehicles.

Cooling Apparatus

The present invention provides a cooling apparatus containing an organic material as described herein, where the cooling apparatus is adapted to provide barocaloric cooling using the organic material.

The cooling apparatus comprises the organic material. The cooling apparatus may be provided with means for applying pressure to the organic component. The cooling apparatus may also be provided with means for transferring heat to and from the organic material.

Typically, the organic material is provided within a pressure transmitting medium, such as a pressure transmitting fluid, which is contained within a piston head space (or the piston chamber). The pressure transmitting medium is not essential, and pressure may be applied directly to the organic material, such as a material having a liquid phase, such as liquid crystals.

Thus, in one aspect the present invention provides a piston comprising the organic material within the head space.

The cooling apparatus may be for use in cooling foodstuffs and beverages, thus the cooling apparatus may be a component of a refrigerator or a freezer.
The cooling apparatus may find general use in cooling air, thus the cooling apparatus may be a component of an air-conditioning unit.

In other aspects of the invention there is more generally provided a heat engine for the transfer of heat between environments, where the heat engine has an organic material as a barocaloric working agent. Whilst the predominant use of refrigerants is in refrigerators and air-conditioning units, the principles underlying the mechanism of cooling an environment may also be used to heat an indoor environment, for example within an air-source heat pump.

Here, a cool organic material in a first phase may be warmed by the outside ambient environment (including indirectly *via* a heat transfer fluid). The warmed organic material may then be taken isothermally to a second phase, with an associated heat transfer from the environment to the organic material (including indirectly *via* a heat transfer fluid). The organic material is then returned to the indoor environment, where it is permitted to return to the second phase, with an associated heat transfer from the organic material to the indoor environment.

The broad aspects of the invention encompass methods of heat transfer to and from an organic material using barocaloric effects. Thus, the methods of the invention relate to methods of cooling and methods of heating.

Other Preferences

Each and every compatible combination of the embodiments described above is explicitly disclosed herein, as if each and every combination was individually and explicitly recited.

Various further aspects and embodiments of the present invention will be apparent to those skilled in the art in view of the present disclosure.

"and/or" where used herein is to be taken as specific disclosure of each of the two specified features or components with or without the other. For example "A and/or B" is to be taken as specific disclosure of each of (i) A, (ii) B and (iii) A and B, just as if each is set out individually herein.

Unless context dictates otherwise, the descriptions and definitions of the features set out above are not limited to any particular aspect or embodiment of the invention and apply equally to all aspects and embodiments which are described.

Certain aspects and embodiments of the invention will now be illustrated by way of example and with reference to the figures described above.

Experimental Details and Results

The analysis of the organic materials described in the present case follows that of the work described by some of the present inventors in Lloveras *et al.* and Stern-Taulats *et al.*, the contents of both of which are hereby incorporated by reference in their entirety.

Materials

BDP and BDB were prepared, as needed, using standard techniques. An example preparation for BDP is set out below.

Propionic acid (1 L), 100 g of barium carbonate (100 g) and 100 g of calcium carbonate (100 g) were purchased from Sigma Aldrich. Their respective purities were 99%, 99.8% and 99.98%, and the reagents were used directly without further purification.

BDP (around 10 g yield) was synthesized from propionic acid (10 mL), barium carbonate (3 g) and of calcium carbonate (3 g).

Barium carbonate or calcium carbonate, when combined with propionic acid in aqueous solution generates the corresponding propionate hydrate salt. The molar mass of barium carbonate and calcium carbonate could not be immediately established as the two carbonates absorb moisture from the air. For this reason, the barium propionate and calcium propionate were initially made separately. The mass of propionate hydrates is unaffected by humidity. The two propionate hydrates were combined together, to form BDP, keeping a reproducible molar ratio.

The plastic and liquid crystals, NPG and PCH5, were purchased from commercial suppliers. 1-Adamantanol was also purchased from a commercial supplier.

Measurements

Table 1 sets out the values for T_0, $|Q_0|$, $|\Delta S_0|$, $\mathrm{d}T_0/\mathrm{d}p$, and $|\Delta V_0|$, determined from the analysis of the organic materials BDP and BDB.

Table 2 sets out the values for T_0, $|Q_0|$, $|\Delta S_0|$, $\mathrm{d}T_0/\mathrm{d}p$, and $|\Delta V_0|$, determined from the analysis of various plastic crystals.

Table 3 sets out the values for T_0, $|Q_0|$, $|\Delta S_0|$, $\mathrm{d}T_0/\mathrm{d}p$, and $|\Delta V_0|$, determined from the analysis of the liquid crystal PCH5.

The performances of BDP, BDB, PCH5 and NPG under different applied pressures are shown in Figures 1 to 4. Additionally, the performance of the plastic crystal 1-adamantanol is shown in Figure 5.

T_0, $|\Delta S_0|$ and $|Q_0|$ were determined via differential scanning calorimetry at ambient pressure. $\mathrm{d}T_0/\mathrm{d}p$ was determined *via* differential thermal analysis under applied hydrostatic pressure. $|\Delta V_0|$ was determined, for example, from temperature-dependent X-ray diffraction analysis at ambient pressure.

Barocaloric quantities were determined via quasi-direct methods, using differential thermal analysers that operate under hydrostatic pressure, with Peltier modules or thermocouples heat sensors, as for example described in Lloveras *et al.* (see *BC Effects in AS* at page 3, together with reported results in Figure 3, and the *Methods* section at page 5).

Differential thermal analysis under hydrostatic pressure was performed as described by Mañosa *et al*. The data is shown in Figures 2 and 4 for BDB and PCH5.

Table 1 - Properties of Representative Organic Materials

Organic Material	T_0 (K)	$\lvert Q_0 \rvert$ (J g^{-1})	$\lvert \Delta S_0 \rvert$ (J K^{-1} kg^{-1})	dT_0/dp (K/GPa)	$\lvert \Delta V_0 \rvert$ (mm^3 g^{-1})
BDP $Ba^{2+}Ca^{2+}{}_2[C_2H_5COO^-]_6$	267	10.7	42	332	17.5
BDB $Ba^{2+}Ca^{2+}{}_2[C_3H_7COO^-]_6$	325	4.72	14.5	500	10.1

The table shows transition temperature T_0, latent heat $|Q_0|$, entropy change $|\Delta S_0|$, shift of transition temperature with applied pressure dT_0/dp, and volume change across the transition $|\Delta V_0|$. The organic materials are barium and calcium salts of the organic compounds butyric acid and propionic acid.

Table 2 - Properties of Representative Plastic Crystal Organic Materials

Organic Material	T_0 (K)	$\lvert Q_0 \rvert$ (J g^{-1})	$\lvert \Delta S_0 \rvert$ (J K^{-1} kg^{-1})	dT_0/dp (K/GPa)	$\lvert \Delta V_0 \rvert$ (mm^3 g^{-1})
PG	357.5	177.3	495.2	103.0	51.0
NPG	314.6	122.9	389.8	119.6	46.7
NPA	236.5	45.38	191.7	237.0	45.5
MN	260.1	51.15	196.5	130.7	25.7
MNP	312.0	140.0	449.1	81.0	36.4
AMP	352.6	221.6	629.7	76.0	48.1
TRIS	406.8	280.7	691.0	60.6	41.8
2-Br-Adamantane	277.9	56.20	202.2	243.0	52.8
2-O-Adamantane	221.0	52.79	239.0	181.0	43.5
1-Adamantanol	359.0	85.40	236.5	178.0	42.0
2-Adamantanol	389.3	52.42	134.6	64.3	4.60
1,3-Dimethyladamantane	367.5	46.56	210.7	288.0	60.7

The table shows transition temperature $|T_0|$, latent heat $|Q_0|$, entropy change $|\Delta S_0|$, shift of transition temperature with applied pressure dT_0/dp, and volume change across the transition $|\Delta V_0|$. PG = pentaglycerine; 2-(hydroxymethyl)-2-methylpropane-1,3-diol. NPG = neopentylglycol; 2,2-dimethyl-1,3-propanediol. NPA = neopentyl alcohol; 2,2-dimethyl-1-propanol. MN = 2-methyl-2-nitropropane. MNP = 2-methyl-2-nitro-1-propanol. AMP = 2-amino-2-methyl-1,3-propanediol.
TRIS = Tris(hydroxymethyl)aminomethane.

Table 3 - Properties of a Representative Liquid Crystal Organic Material

Organic Material	T_0 (K)	$\lvert Q_0 \rvert$ (J g^{-1})	$\lvert \Delta S_0 \rvert$ (J K^{-1} kg^{-1})	dT_0/dp (K/kbar)	$\lvert \Delta V_0 \rvert$ (mm^3 g^{-1})
PCH5 *4-(trans*-4-pentylcyclohexyl) benzonitrile	303	87.6	290	210	60.8

The table shows transition temperature T_0, latent heat $|Q_0|$, entropy change $|\Delta S_0|$, shift of transition temperature with applied pressure dT_0/dp, and volume change across the transition $|\Delta V_0|$.

Figure 6 shows the refrigerant capacity, RC, values for the organic materials, BDP, BDB and PCH5, at different applied hydrostatic pressures.

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All documents mentioned in this specification are incorporated herein by reference in their entirety.

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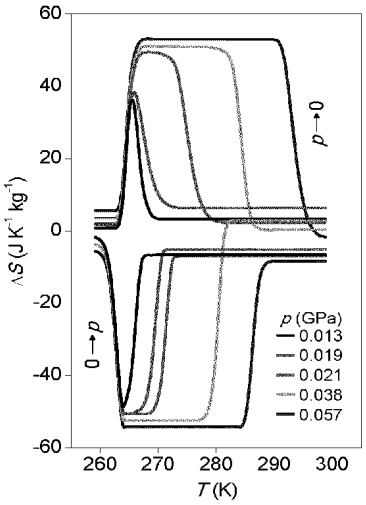
(74) Agent: **MACIVER, Eleanor** et al.; Mewburn Ellis LLP, City Tower, 40 Basinghall Street, London Greater London EC2V 5DE (GB).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

(54) Title: USE OF BAROCALORIC MATERIALS AND BAROCALORIC DEVICES

Fig. 1



(57) Abstract: Described herein is the use of organic materials in methods of barocaloric cooling. The barocaloric effects may be exhibited where the organic material is near a non-isochoric phase transition, such as a non-isochoric first-order phase transition. The organic material has one or more carbon atoms and may be an organic compound or a salt thereof. In some cases that organic material is a soft matter material, such as a plastic crystal or a liquid crystal. The methods may be adapted for use of the organic material as a heating agent.

WO 2018/069506 A1

[Continued on next page]

Pascal Technologies v. Cambridge Enterprise Limited, Universitat De Barcelona, and Universitat Politècnica De Catalunya
IPR2024-01235

Published:
— *with international search report (Art. 21(3))*

ADVANCE E-MAIL

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF THE RECORDING OF A CHANGE

(PCT Rule 92*bis*.1 and Administrative Instructions, Section 422)

To:

MACIVER, Eleanor
Mewburn Ellis LLP
City Tower
40 Basinghall Street
London Greater London EC2V 5DE
ROYAUME-UNI

Date of mailing *(day/month/year)*
03 November 2017 (03.11.2017)

Applicant's or agent's file reference
EEMCP7304009

IMPORTANT NOTIFICATION

International application No.
PCT/EP2017/076203

International filing date *(day/month/year)*
13 October 2017 (13.10.2017)

1. The following indications appeared on record concerning:

☐ the applicant ☒ the inventor ☐ the agent ☐ the common representative

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☐ the person ☒ the name ☐ the address ☐ the nationality ☐ the residence

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E-mail address
☐ Notifications by e-mail authorized

3. Further observations, if necessary:

4. A copy of this notification has been sent to:

☒ the receiving Office
☒ the International Searching Authority
☐ the Authority(ies) specified for supplementary search
☐ the International Preliminary Examining Authority
☐ the designated Offices concerned
☐ the elected Offices concerned
☐ other:

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Authorized officer
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Pascal Technologies v. Cambridge Enterprise Limited, Universitat De Barcelona, and Universitat Politècnica De Catalunya
IPR2024-01235

ADVANCE E-MAIL

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF THE RECORDING OF A CHANGE

(PCT Rule 92*bis*.1 and Administrative Instructions, Section 422)

To:

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Mewburn Ellis LLP
City Tower
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ROYAUME-UNI

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IMPORTANT NOTIFICATION

International application No.
PCT/EP2017/076203

International filing date *(day/month/year)*
13 October 2017 (13.10.2017)

1. The following indications appeared on record concerning:

☐ the applicant ☒ the inventor ☐ the agent ☐ the common representative

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E-mail address
☐ Notifications by e-mail authorized

3. Further observations, if necessary:

4. A copy of this notification has been sent to:

☒ the receiving Office
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☐ the Authority(ies) specified for supplementary search
☐ the International Preliminary Examining Authority
☐ the designated Offices concerned
☐ the elected Offices concerned
☐ other:

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Pascal Technologies, Ex. 1002, page 368
Pascal Technologies v. Cambridge Enterprise Limited, Universitat De Barcelona, and Universitat Politècnica De Catalunya
IPR2024-01235

ADVANCE E-MAIL

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF THE RECORDING OF A CHANGE

(PCT Rule 92*bis*.1 and Administrative Instructions, Section 422)

To:

MACIVER, Eleanor
Mewburn Ellis LLP
City Tower
40 Basinghall Street
London Greater London EC2V 5DE
ROYAUME-UNI

Date of mailing *(day/month/year)*
03 November 2017 (03.11.2017)

Applicant's or agent's file reference
EEMCP7304009

IMPORTANT NOTIFICATION

International application No.
PCT/EP2017/076203

International filing date *(day/month/year)*
13 October 2017 (13.10.2017)

1. The following indications appeared on record concerning:

☐ the applicant ☒ the inventor ☐ the agent ☐ the common representative

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State of Nationality | State of Residence

Telephone No.

Facsimile No.

E-mail address
☐ Notifications by e-mail authorized

3. Further observations, if necessary:

4. A copy of this notification has been sent to:

☒ the receiving Office
☒ the International Searching Authority
☐ the Authority(ies) specified for supplementary search
☐ the International Preliminary Examining Authority
☐ the designated Offices concerned
☐ the elected Offices concerned
☐ other:

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EAWMK.P307N0200
Pascal Technologies v. Cambridge Enterprise Limited, Universitat De Barcelona, and Universitat Politècnica De Catalunya

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY
(Chapter I of the Patent Cooperation Treaty)

(PCT Rule 44*bis*)

Applicant's or agent's file reference EEMCP7304009	**FOR FURTHER ACTION**	See item 4 below
International application No. PCT/EP2017/076203	International filing date *(day/month/year)* 13 October 2017 (13.10.2017)	Priority date *(day/month/year)* 14 October 2016 (14.10.2016)
International Patent Classification (8th edition unless older edition indicated) See relevant information in Form PCT/ISA/237		
Applicant CAMBRIDGE ENTERPRISE LIMITED		

1. This international preliminary report on patentability (Chapter I) is issued by the International Bureau on behalf of the International Searching Authority under Rule 44 *bis*.1(a).

2. This REPORT consists of a total of 7 sheets, including this cover sheet.

   In the attached sheets, any reference to the written opinion of the International Searching Authority should be read as a reference to the international preliminary report on patentability (Chapter I) instead.

3. This report contains indications relating to the following items:

☒	Box No. I	Basis of the report
☒	Box No. II	Priority
☐	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
☐	Box No. IV	Lack of unity of invention
☒	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
☒	Box No. VI	Certain documents cited
☐	Box No. VII	Certain defects in the international application
☒	Box No. VIII	Certain observations on the international application

4. The International Bureau will communicate this report to designated Offices in accordance with Rules 44*bis*.3(c) and 93*bis*.1 but not, except where the applicant makes an express request under Article 23(2), before the expiration of 30 months from the priority date (Rule 44*bis* .2).

	Date of issuance of this report 16 April 2019 (16.04.2019)
The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No. +41 22 338 82 70	Authorized officer Nora Lindner e-mail: pct.team5@wipo.int

Form PCT/IB/373 (January 2004)

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:

see form PCT/ISA/220

PCT

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing
(day/month/year) see form PCT/ISA/210 (second sheet)

Applicant's or agent's file reference
see form PCT/ISA/220

FOR FURTHER ACTION
See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/EP2017/076203	13.10.2017	14.10.2016

International Patent Classification (IPC) or both national classification and IPC
INV. C09K5/02

Applicant
CAMBRIDGE ENTERPRISE LIMITED

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☒ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
- ☒ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☒ Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will usually be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notifed the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA:	Date of completion of this opinion	Authorized Officer
European Patent Office P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk - Pays Bas Tel. +31 70 340 - 2040 Fax: +31 70 340 - 3016	see form PCT/ISA/210	Martinez Marcos, V Telephone No. +31 70 340-0

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IPR2024-01235

Box No. I Basis of the opinion

1. With regard to the **language**, this opinion has been established on the basis of:

   ☒ the international application in the language in which it was filed.

   ☐ a translation of the international application into , which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1 (b)).

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a))

3. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing:

   a. ☐ forming part of the international application as filed:

      ☐ in the form of an Annex C/ST.25 text file.

      ☐ on paper or in the form of an image file.

   b. ☐ furnished together with the international application under PCT Rule 13*ter*.1(a) for the purposes of international search only in the form of an Annex C/ST.25 text file.

   c. ☐ furnished subsequent to the international filing date for the purposes of international search only:

      ☐ in the form of an Annex C/ST.25 text file (Rule 13*ter*.1(a)).

      ☐ on paper or in the form of an image file (Rule 13*ter*.1(b) and Administrative Instructions, Section 713).

4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that forming part of the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

Box No. II Priority

1. ☒ The validity of the priority claim has not been considered because the International Searching Authority does not have in its possession a copy of the earlier application whose priority has been claimed or, where required, a translation of that earlier application. This opinion has nevertheless been established on the assumption that the relevant date (Rules 43*bis*.1 and 64.1) is the claimed priority date.

2. ☐ This opinion has been established as if no priority had been claimed due to the fact that the priority claim has been found invalid (Rules 43*bis*.1 and 64.1). Thus for the purposes of this opinion, the international filing date indicated above is considered to be the relevant date.

3. Additional observations, if necessary:

Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	
	No:	Claims	1-30
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1-30
Industrial applicability (IA)	Yes:	Claims	1-30
	No:	Claims	

2. Citations and explanations

see separate sheet

Box No. VI Certain documents cited

1. Certain published documents (Rules 43*bis*.1 and 70.10)

and / or

2. Non-written disclosures (Rules 43*bis*.1 and 70.9)

see form 210

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

Pascal Technologies v. Cambridge Enterprise Limited, Universitat De Barcelona, and Universitat Politècnica De Catalunya
IPR2024-01235

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1 **Cited Documents**

D1 Nuria Pol Català: "Efectes barocalòrics en cristalls plàstics" In: "Efectes barocalòrics en cristalls plàstics", 1 June 2016, Escola Tècnica Superior d'Enginyeria Industrial de Barcelona, XP055440639,

D2 Lorean Iglesias Gomez: "Efectes barocalòrics colossals en cristalls plàstics derivats del neopentà" In: "Efectes barocalòrics colossals en cristalls plàstics derivats del neopentà", 12 January 2016, Escola Tècnica Superior d'Enginyeria Industrial de Barcelona, XP055440641,

D3 BACEM BEN HASSINE ET AL: "Phase Transition in Hydrogen-Bonded 1-Adamantane-methanol", CRYSTAL GROWTH & DESIGN., vol. 15, no. 8, 5 August 2015, pages 4149-4155, XP055440673,

D4 T ITO: "Pressure-induced phase transition in adamantane", ACTA CRYST., vol. 29, no. 18, 1 January 1973, pages 764-767, XP055440624,

D5 S. SINANIS ET AL: "Pressure-jump investigations on the kinetics of the isotropic-nematic phase transition of a liquid crystal: Time behavior of the scattered and transmitted light intensities for PCH 5", BERICHTE DER BUNSEN-GESELLSCHAFT FUR PHYSIKALISCHE CHEMIE., vol. 102, no. 5, 1 May 1998, pages 745-750, XP055440635

D6 Zhongjian Xie ET AL: "Demonstration of liquid crystal for barocaloric cooling application", Condensed Matter, 26 September 2016, XP055440321

D7 DE OLIVEIRA N: "Barocaloric effect and the pressure induced solid state refrigerator", JOURNAL OF APPLIED PHYSICS, AMERICAN INSTITUTE OF PHYSICS, vol. 109, no. 5, 11 March 2011, pages 53515-53515, XP012147618

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Pascal Technologies v. Cambridge Enterprise Limited, Universitat De Barcelona, and Universitat Politècnica De Catalunya
IPR2024-01235

2 Novelty

The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of claims 1-30 is not new in the sense of Article 33(2) PCT.

2.1 Document **D1** discloses (abstract) the use of neopentyl alcohol and tris(hydroxymethyl)aminomethane as barocaloric agents in a device to produce cooling/heating under hyrostatic pressure.

The subject-matter of claims 1-11, 14, 15, 21-30 is not new in the sense of Article 33(2) PCT.

2.2 Document **D2** discloses (abstract) the use of pentaglycerine and 2-amino-2-methyl-1,3-propanediol as barocaloric agents in a device to produce cooling/heating under hydrostatic pressure.

The subject-matter of claims 1-11, 14, 15, 21-30 is not new in the sense of Article 33(2) PCT.

2.3 Document **D3** discloses (Introduction and experimental details; figure 1) solid-solid transitions of 1-adamantane-methanol observed in a device capable of applying hydrostatic pressure.

The subject-matter of claims 2-15, 21-30 is not new in the sense of Article 33(2) PCT.

2.4 Document **D4** discloses (Experiments) solid-solid transitions of adamantane observed in a device capable of applying hydrostatic pressure.

The subject-matter of claims 2-12, 20-30 is not new in the sense of Article 33(2) PCT.

2.5 Document **D5** discloses (Introduction and experimental; figures 1,4) Isotropic-Nematic phase transition of PCH5 observed in a device capable of applying hydrostatic pressure.

The subject-matter of claims 2-9, 16, 17, 20-30 is not new in the sense of Article 33(2) PCT.

2.6 Document **D6** discloses (abstract; figure 3; page 2 - page 3) the use of 1,2-diacylphophatidylcholines and lipides as barocaloric agents in a device to produce cooling/heating under hydrostatic pressure.

The subject-matter of claims 1-9, 16-19, 21-30 is not new in the sense of Article 33(2) PCT.

Pascal Technologies, Ex. 1002, page 375
Pascal Technologies v. Cambridge Enterprise Limited, Universitat De Barcelona, and Universitat Politècnica De Catalunya
IPR2024-01235

Re Item VI

Certain documents cited

D8 Peris Peris Alonso: "Efectes barocalòrics en la transició plàstica del 1-Bromadamantà MEMÒRIA" In: "Efectes barocalòrics en la transició plàstica del 1-Bromadamantà MEMÒRIA", 15 June 2017, Escola Tècnica Superior d'Enginyeria Industrial de Barcelona, XP055440643,

Document D8 discloses (abstract) the use of 1-Br-Adamantane as barocaloric agents in a device to produce cooling/heating under hydrostatic pressure. This document may be relevant if the priority claim is found invalid.

Re Item VIII

Certain observations on the international application

1 **Clarity**

The application does not meet the requirements of Article 6 PCT, because claims 21-30 are not clear.

1.1 Claims 21-30 do not meet the requirements of Article 6 PCT because the matter for which protection is sought is not clearly defined. The claims attempt to define the subject-matter in terms of the result to be achieved, which merely amounts to a statement of the underlying problem, without providing the technical features necessary for achieving this result.

Pascal Technologies, Ex. 1002, page 376
Pascal Technologies v. Cambridge Enterprise Limited, Universitat De Barcelona, and Universitat Politècnica De Catalunya
IPR2024-01235

ADVANCE E-MAIL

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF THE RECORDING OF A CHANGE

(PCT Rule 92*bis*.1 and Administrative Instructions, Section 422)

To:

MACIVER, Eleanor
Mewburn Ellis LLP
City Tower
40 Basinghall Street
London Greater London EC2V 5DE
ROYAUME-UNI

Date of mailing *(day/month/year)*
03 November 2017 (03.11.2017)

Applicant's or agent's file reference
EEMCP7304009

IMPORTANT NOTIFICATION

International application No.
PCT/EP2017/076203

International filing date *(day/month/year)*
13 October 2017 (13.10.2017)

1. The following indications appeared on record concerning:

☐ the applicant ☒ the inventor ☐ the agent ☐ the common representative

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3. Further observations, if necessary:

4. A copy of this notification has been sent to:

☒ the receiving Office
☒ the International Searching Authority
☐ the Authority(ies) specified for supplementary search
☐ the International Preliminary Examining Authority
☐ the designated Offices concerned
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Pascal Technologies, Ex. 1002, page 377
Pascal Technologies v. Cambridge Enterprise Limited, Universitat De Barcelona, and Universitat Politècnica De Catalunya
IPR2024-01235

PCT REQUEST

Print Out (Original in Electronic Form)

0	**For receiving Office use only**	
0-1	International Application No.	**PCT/EP2017/076203**
0-2	International Filing Date	**13 OCT 2017 (13.10.2017)**
0-3	Name of receiving Office and "PCT International Application"	**RO/EP**

0-4	**Form PCT/RO/101 PCT Request**	
0-4-1	Prepared Using	PCT Online Filing Version 3.5.000.251e MT/FOP 20141031/0.20.5.20
0-5	**Petition** The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty	
0-6	**Receiving Office (specified by the applicant)**	European Patent Office (EPO) (RO/EP)
0-7	**Applicant's or agent's file reference**	EEMCP7304009
I	**Title of Invention**	USE OF BAROCALORIC MATERIALS AND BAROCALORIC DEVICES
II	**Applicant**	
II-1	This person is	Applicant only
II-2	Applicant for	All designated States
II-4	Name	CAMBRIDGE ENTERPRISE LIMITED
II-5	Address	The Old Schools Trinity Lane Cambridge Cambridgeshire CB2 1TN United Kingdom
II-6	State of nationality	GB
II-7	State of residence	GB
III-1	**Applicant and/or inventor**	
III-1-1	This person is	Applicant only
III-1-2	Applicant for	All designated States
III-1-4	Name	UNIVERSITAT POLITÈCNICA DE CATALUNYA
III-1-5	Address	C/Jordi Girona 31 08034 Barcelona Spain
III-1-6	State of nationality	ES
III-1-7	State of residence	ES

PCT REQUEST

Print Out (Original in Electronic Form)

III-2	**Applicant and/or inventor**	
III-2-1	This person is	Applicant only
III-2-2	Applicant for	All designated States
III-2-4	Name	UNIVERSITAT DE BARCELONA
III-2-5	Address	Centre de Patents de la UB Baldiri Reixac, 4 – Torre D 08028 Barcelona Spain
III-2-6	State of nationality	ES
III-2-7	State of residence	ES
III-3	**Applicant and/or inventor**	
III-3-1	This person is	Inventor only
III-3-3	Inventor for	All designated States
III-3-4	Name (LAST, First)	MOYA, Xavier
III-3-5	Address	Department of Materials Science & Metallurgy University of Cambridge 27 Charles Babbage Road Cambridge Cambridgeshire CB3 0FS United Kingdom
III-4	**Applicant and/or inventor**	
III-4-1	This person is	Inventor only
III-4-3	Inventor for	All designated States
III-4-4	Name (LAST, First)	AVRAMENKO, Alexandrovich
III-4-5	Address	Department of Materials Science & Metallurgy University of Cambridge 27 Charles Babbage Road Cambridge Cambridgeshire CB3 0FS United Kingdom
III-5	**Applicant and/or inventor**	
III-5-1	This person is	Inventor only
III-5-3	Inventor for	All designated States
III-5-4	Name (LAST, First)	CARRERA, Lluís Mañosa
III-5-5	Address	Universitat de Barcelona Centre de Patents de la UB Baldiri Reixac, 4 – Torre D 08028 Barcelona Spain

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III-6	**Applicant and/or inventor**	
III-6-1	This person is	Inventor only
III-6-3	Inventor for	All designated States
III-6-4	Name (LAST, First)	MUR, Josep Lluís Tamarit
III-6-5	Address	Universitat Politècnica de Catalunya C/Jordi Girona 31 08034 Barcelona Spain
III-7	**Applicant and/or inventor**	
III-7-1	This person is	Inventor only
III-7-3	Inventor for	All designated States
III-7-4	Name (LAST, First)	MUNTANÉ, Pol Marcel Lloveras
III-7-5	Address	Universitat Politècnica de Catalunya C/Jordi Girona 31 08034 Barcelona Spain
IV-1	**Agent or common representative; or address for correspondence**	
	The person identified below is hereby/ has been appointed to act on behalf of the applicant(s) before the competent International Authorities as:	Agent
IV-1-1	Name (LAST, First)	MACIVER, Eleanor
IV-1-2	Address	Mewburn Ellis LLP City Tower 40 Basinghall Street London Greater London EC2V 5DE United Kingdom
IV-1-3	Telephone No.	+44 20 7776 5300
IV-1-4	Facsimile No.	+44 33 0111 4455
IV-1-5	e-mail	mail@mewburn.com
IV-1-5(a)	E-mail authorization The receiving Office, the International Searching Authority, the International Bureau and the International Preliminary Examining Authority are authorized to use this e-mail address, if the Office or Authority so wishes, to send notifications issued in respect of this international application:	as advance copies followed by paper notifications
IV-1-6	Agent's registration No.	9271170
IV-2	**Additional agent(s)**	additional agent(s) with same address as first named agent
IV-2-1	Name(s)	ADDISS, John(9249550); ANDREWS, Robert(9237240); BAILEY, Sam(9209370); BRASNETT, Adrian(73110); BREARLEY, Sarah(9259240); BURNS, Alex(9269520); CARLISLE, Julie(9224710); CARTER,

		Stephen(89190); CASLEY, Christopher(9220630); CLEGG, Richard(135940); CRIPPS, Joanna(89380); DALE, Elizabeth(9255060); DENISON, Christopher(94570); DUNNE, Paul(9255050); FORREST, Graham(135930); FURNIVAL, Tom(9269780); GILL, Stephen(143850); GRAHAM, Emma(9250270); GREEN, Katherine(09233260); GREGORY, Adam(9265300); HARRISON, Susan(123080); HAYES, Emily(9225860); HODSDON, Stephen(9205810); JOHNSON, Richard(9203080); JONES, Rachel(9251290); KEIRSTEAD, Tanis(9226740); KIDDLE, Simon(79860); KREMER, Simon(83790); LEACH, James(9225000); LENTHALL, Joseph(9239800); LYONS, June(76040); MCGUINN, Callum(9264970); MOELLER, Christoph(9229760); MOORE, Graeme(9219490); NAYLOR, Matthew(127090); OXLEY, Rachel(127020); PARRY, Simon(91690); SALISBURY, Frances(9238130); SMITH, Matthew(09231440); STONER, Patrick(59900); SUTCLIFFE, Nicholas(98860); THORNTON, Dan(9270520); TOLLERVEY, Rebecca(144070); WALTON, Seán(77070); WARD, Eliot(9259500); WATSON, Robert(91240); WEBSTER, Jeremy(9205390); WESCOTT, Rhiannon(9259390); WILLS, Jonathan(9218870); WYTENBURG, Wilhelmus(145540)
V	**DESIGNATIONS**	
V-1	**The filing of this request constitutes under Rule 4.9(a), the designation of all Contracting States bound by the PCT on the international filing date, for the grant of every kind of protection available and, where applicable, for the grant of both regional and national patents.**	
VI-1	**Priority claim of earlier national application**	
VI-1-1	Filing date	14 October 2016 (14.10.2016)
VI-1-2	Number	1617508.5
VI-1-3	Country or Member of WTO	GB

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VI-2	**Priority document request** The International Bureau is requested to obtain from a digital library a certified copy of the earlier application(s) identified above as item(s), using, where applicable, the access code(s) indicated:	VI-1 Access code: 9F8C	
VI-3	**Incorporation by reference :** where an element of the international application referred to in Article 11(1)(iii)(d) or (e) or a part of the description, claims or drawings referred to in Rule 20.5(a) is not otherwise contained in this international application but is completely contained in an earlier application whose priority is claimed on the date on which one or more elements referred to in Article 11(1)(iii) were first received by the receiving Office, that element or part is, subject to confirmation under Rule 20.6, incorporated by reference in this international application for the purposes of Rule 20.6.		
VII-1	**International Searching Authority Chosen**	European Patent Office (EPO) (ISA/EP)	
VIII	**Declarations**	Number of declarations	
VIII-1	Declaration as to the identity of the inventor	–	
VIII-2	Declaration as to the applicant's entitlement, as at the international filing date, to apply for and be granted a patent	–	
VIII-3	Declaration as to the applicant's entitlement, as at the international filing date, to claim the priority of the earlier application	–	
VIII-4	Declaration of inventorship (only for the purposes of the designation of the United States of America)	–	
VIII-5	Declaration as to non-prejudicial disclosures or exceptions to lack of novelty	–	
IX	**Check list**	Number of sheets	Electronic file(s) attached
IX-1	Request (including declaration sheets)	6	✓
IX-2	Description	27	✓
IX-3	Claims	3	✓
IX-4	Abstract	1	✓
IX-5	Drawings	3	✓
IX-7	TOTAL	40	

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	Accompanying Items	Paper document(s) attached	Electronic file(s) attached
IX-8	Fee calculation sheet	–	✓
IX-11	Copy of general power of attorney	–	✓
IX-19	Other	Pre-conversion archive	✓
IX-20	**Figure of the drawings which should accompany the abstract**	1	
IX-21	**Language of filing of the international application**	English	
X-1	**Signature of applicant, agent or common representative**	(PKCS7 Digital Signature)	
X-1-1	Name (LAST, First)	MACIVER, Eleanor	
X-1-3	Capacity (if such capacity is not obvious from reading the request)	(Representative)	

FOR RECEIVING OFFICE USE ONLY

10-1	**Date of actual receipt of the purported international application**	**13 OCT 2017 (13.10.2017)**
10-2	**Drawings:**	
10-2-1	Received	received
10-2-2	Not received	
10-3	**Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application**	
10-4	**Date of timely receipt of the required corrections under PCT Article 11(2)**	
10-5	**International Searching Authority**	ISA/EP
10-6	**Transmittal of search copy delayed until search fee is paid**	

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11-1	**Date of receipt of the record copy by the International Bureau**	

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0	**For receiving Office use only**	
0-1	International Application No.	**PCT/EP2017/076203**
0-2	International Filing Date	**13 OCT 2017 (13.10.2017)**
0-3	Name of receiving Office and "PCT International Application"	**RO/EP**

0-4	**Form PCT/RO/101 PCT Request**	
0-4-1	Prepared Using	PCT Online Filing Version 3.5.000.251e MT/FOP 20141031/0.20.5.20
0-5	**Petition** The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty	
0-6	**Receiving Office (specified by the applicant)**	European Patent Office (EPO) (RO/EP)
0-7	**Applicant's or agent's file reference**	EEMCP7304009
I	**Title of Invention**	USE OF BAROCALORIC MATERIALS AND BAROCALORIC DEVICES
II	**Applicant**	
II-1	This person is	Applicant only
II-2	Applicant for	All designated States
II-4	Name	CAMBRIDGE ENTERPRISE LIMITED
II-5	Address	The Old Schools Trinity Lane Cambridge Cambridgeshire CB2 1TN United Kingdom
II-6	State of nationality	GB
II-7	State of residence	GB
III-1	**Applicant and/or inventor**	
III-1-1	This person is	Applicant only
III-1-2	Applicant for	All designated States
III-1-4	Name	UNIVERSITAT POLITÈCNICA DE CATALUNYA
III-1-5	Address	C/Jordi Girona 31 08034 Barcelona Spain
III-1-6	State of nationality	ES
III-1-7	State of residence	ES

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III-2	**Applicant and/or inventor**	
III-2-1	This person is	Applicant only
III-2-2	Applicant for	All designated States
III-2-4	Name	UNIVERSITAT DE BARCELONA
III-2-5	Address	Centre de Patents de la UB Baldiri Reixac, 4 – Torre D 08028 Barcelona Spain
III-2-6	State of nationality	ES
III-2-7	State of residence	ES
III-3	**Applicant and/or inventor**	
III-3-1	This person is	Inventor only
III-3-3	Inventor for	All designated States
III-3-4	Name (LAST, First)	MOYA, Xavier
III-3-5	Address	Department of Materials Science & Metallurgy University of Cambridge 27 Charles Babbage Road Cambridge Cambridgeshire CB3 0FS United Kingdom
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IV-1-3	Telephone No.	+44 20 7776 5300
IV-1-4	Facsimile No.	+44 33 0111 4455
IV-1-5	e-mail	mail@mewburn.com
IV-1-5(a)	E-mail authorization The receiving Office, the International Searching Authority, the International Bureau and the International Preliminary Examining Authority are authorized to use this e-mail address, if the Office or Authority so wishes, to send notifications issued in respect of this international application:	as advance copies followed by paper notifications
IV-1-6	Agent's registration No.	9271170
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VIII-2	Declaration as to the applicant's entitlement, as at the international filing date, to apply for and be granted a patent	–	
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IX-11	Copy of general power of attorney	–	✓
IX-19	Other	Pre-conversion archive	✓
IX-20	**Figure of the drawings which should accompany the abstract**	1	
IX-21	**Language of filing of the international application**	English	
X-1	**Signature of applicant, agent or common representative**	(PKCS7 Digital Signature)	
X-1-1	Name (LAST, First)	MACIVER, Eleanor	
X-1-3	Capacity (if such capacity is not obvious from reading the request)	(Representative)	

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