Pichler Karl (ITC)

From: Pichler Karl (ITC)
Sent: Thursday, February 08, 2001 4:28 PM
To: Frischknecht Kyle (ITC)
Cc: Proulx George (ITC); Pakbaz Hash (ITC)
Subject: RE: Meeting with Dr. John Affinito

Hi Kyle,

YES, I believe there may be a combination technique with spin-coating that I believe should work (also discussed at FED and I have been considering filing a patent for a long time - lack of time). Spin-, roll- or whatever-coat, cross-link/cure and then sputter the dielectric barrier through a mask over the OLED area only, i.e. leave the contact pads, scribe lines, etc. free from the barrier and then stick the whole thing in, for example, a plasma asher and ash-off the organic where there is no dielectric barrier film. I have a patent from CDT-time (for a completely different purpose) that shows that just a few (say around 10 or more Angstroms) of good sputtered dielectric (e.g. AlOx) act as a perfectly good oxygen plasma ash barrier. Alternatively, I have been thinking if we could deposit the organic liquid layer (via flash-evaporation, spin- or roll-coat or whatever) and then do the UV cross-linking through a mask. The idea is that after this we may be able (don't know if this vill work, never tried) to thermally evaporate or somehow spray/wash off the non-cross-linked molecular organic film and hen sputter the dielectric also through a mask or alternatively make the contacts first and then sputter the dielectric. In addition, the non-cross-linked organic may be volatile enough so laser ablation becomes perfectly feasible - not sure. This may also have the advantage that the mask-cross-linking should provide a smooth transition from the regions with to those without the organic layer (instead of a sharper step).
These are all just 'undeveloped' ideas withouth really having thought through them in detail to spot serious bottlenecks and certainly I have not done any practical trials whatsoever (other than the thin oxide as ash barrier).
Just a note: the reason why I was originally thinking of spinning the layer was that this could very easily added on to e.g. a Satella via a separate spin-chamber without the need to custom-build a flash-evaporator for the organic.

I am looking forward to keep this discussion rolling.
Charlie

-----Original Message-----
From: Frischknecht Kyle (ITC)
Sent: Thursday, February 08, 2001 11:26 PM
To: Pichler Karl (ITC)
Cc: Proulx George (ITC)
Subject: RE: Meeting with Dr. John Affinito

Hi Charlie:

I have also previously considered spin coating the acrylate layer; however, I haven't yet thought up a reasonable method for keeping the electrical pins free of the coating. Performing a subsequent laser ablation seems less than optimum. I anticipate that vapor deposition through a shadow mask will keep the pins free of the coating; therefore, I have been quite partial to the vapor deposition method. Also, I am not too sure if scribing through the multilayer is a good idea; therefore, I anticipate that masking the area for the scribe lines will be a good practice. Obviously, photolithography after cathode deposition (for a "lift-off" technique) doesn't look very promising. Although there will certainly be many equipment issues with PML, it very well may be that vapor deposition through a shadow mask is the easiest method for producing an array of small displays on a large plate of glass. If you are really opposed to the vapor/mask method, I guess we could consider printing techniques (Screen/Inkjet), but when you get down to the details, these methods will have their respective equipment issues as well. Any thoughts on masking for spin coating?

Kyle

-----Original Message-----
From: Pichler Karl (ITC)
Sent: Thursday, February 08, 2001 1:28 AM
To: Proulx George (ITC); 'Guenther Ewald'; Antoniadis Homer (ITC); Pakbaz Hash (ITC); Frischknecht Kyle (ITC); Larson Otto (ITC); Allemand Pierre-Marc (ITC); Cumpston Brian (ITC); 'ZT - Wittmann Georg'; 'ZT - Stoessel Matthias'
Subject: RE: Meeting with Dr. John Affinito

Hi all,
Just a smal and CONFIDENTIAL point to be aware of in the future should we need it:
While working with PML encapsulation at FED (eMagin) I and others there discussed and stressed that LML, i.e. spinning in inert conditions a carefully outgased cross-linkable solution onto the 8" wafers with subsequent cross-linking and barrier layer sputtering should be perfectly feasible and avoid many equipment issues with PML. I do not know if this was actually tried there after I left and/or if a patent was filed. These discussions happened probably from around mid 1999 onwards.
Charlie

-----Original Message-----

Pictiva EX2006-p. 1
Samsung v Pictiva
IPR2024-01222

INVENTION DISCLOSURE

Return this completed form,
with any necessary attachments, to:
SIEMENS CORPORATION
Intellectual Property Department (IPD)
4900 Old Ironsides Drive, M/S 503
Santa Clara, CA 95054
phone +1-732-321-3026
fax +1-732-321-3014
PLEASE KEEP A COPY FOR YOUR RECORDS

THIS SE[illegible] I FOR IPD USE ONLY
Receipt Date Stamp

Division/Dept Code _____
Cost Center Code _____
Docket No. 01E 18483 US
IP Attorney _____

1. Your Div.'s Project # _____; Invention Title Encapsulation of OLED devices

2. INVENTOR

At the time the invention was conceived, this inventor was
☐ *an employee of a German legal entity (e.g. Siemens AG)*
☒ *an employee of a non-German entity (e.g. Siemens Automotive Corporation or Siemens Canada Limited)*
If you are not sure, contact IPD at +1-732-321-3026

Full Name : Karl PICHLER
Home Address [redacted]
Santa Clara, CA 95050

Citizen of [redacted]
Soc. Sec. # [redacted]
COMPANY/LOCATION INFORMATION
Employer Osram Opto-Semicoinductor
Division OLED R&D
Address 3870 North 1st Street
San Jose, CA 95134

Work telephone 408 456 4175
Fax 408 456 4305
Email karl.pichler@osram-os.com

Signature _____
Date _____

3. CO-INVENTOR (if any)
(use additional forms for more co-inventors)

At the time the invention was conceived, this inventor was
☐ *an employee of a German legal entity (e.g. Siemens AG)*
☐ *an employee of a non-German entity (e.g. Siemens Automotive Corporation or Siemens Canada Limited)*
If you are not sure, contact IPD at +1-732-321-3026

Full Name _____
Home Address _____

Citizen of _____
Soc. Sec. # _____
COMPANY/LOCATION INFORMATION
Employer _____
Division _____
Address _____

Work telephone _____
Fax _____
Email _____

Signature _____
Date _____

4. Purpose(s), and likely field(s) of use of this invention Encapsulation of OLED devices

5. Is this invention still secret within Siemens? YES ☒ NO ☐
Do you soon plan to make the invention information available outside of Siemens? YES ☐ NO ☒
Based on your answer to Question #5, explain when and how this invention was/will be made available to someone outside of Siemens (e.g. trade show at location/date, customer presentation at company/location/attendees/date, supplier prototyping by company/date, included in product brochure or advertisement in publication/date, industry technical symposium paper presented place/date, etc) ____

6. Where is this invention described? List all documents containing aspects of this invention (e.g. engineer notebook date/page, internal status report, test logs, physical prototypes, customer presentation, etc) Karl Pichler Laboratory Lab Book # 7; pages 7 & 9.

7. What date do you recall creating this invention? Have been 'carrying around' part of the invention for a long time (>1 year); frist written description in internal e-mail dated Feb 8, 2001 to Kyle Frischknecht.
When do you recall first explaining this invention to a witness who is not also a co-inventor? Feb 8, 2001; (only part of the invention)
Who was those witness(es)? Kyle Frischknecht et al., (only part of the invention)
Has this invention been prototyped or tested yet? If so, when, where, by who? What were the results? Not tested yet; internally I am certain and outside our company - I am not aware of anybody who tried it and/or any prior art; Important note: I conceived a significant part of this invention, namely ink-jet printing of the UV-curable liquid prior to the dielectric deposition on August 14, 2001 and did not tell anybody about it; I did some prior art seaching to check UV-curable liquid ink-jet printing. Only when I sat down to write this invention disclosure and looked up old e-mails (that to Kyle Frischknecht on Feb 8, 2001), I realized that in fact Kyle was thinking about ink-jet (or screen printing) of the PML UV-curable liquid plus other parts of the invention himself also; see attached e-mail conversation.

8. I have ☒ have not ☐ attached _____ number of additional sheets to better describe this invention.

9. Identify all non-Siemens companies that may in the future benefit from the use of this invention through a license.
Potentially a huge range of companies, notably all those working in the field of Organic Light-Emitting Devices (OLEDS); current count well over 100 companies worldwide, essentially almost all display manufacturing companies plus several others entering the display manufacturing field as newcomers (US, Japan, Europe, Taiwan, South Korea, China, etc.); anybody seeking to direct-encapsulate OLEDs (see below for further desctiption).

10. Was this invention developed under, or quoted for, a customer contract? YES ☐ NO ☒
Was it developed under a government contract? YES ☐ NO ☒
If yes to either, please give contract name and number, and further explain the situation N/A

IF THE ANSWERS TO ANY OF THESE QUESTIONS CHANGE BEFORE THIS INVENTION IS FILED AS A PATENT APPLICATION WITH THE GOVERNMENT, MAKE SURE TO SEND AN UPDATE TO SIEMENS IPD.

11. WITNESSED AND UNDERSTOOD BY:

Signature _____ Company Name _____

THIS INVENTION DISCLOSURE IS SIEMENS PROPRIETARY INFORMATION, AND IS CONFIDENTIAL. THIS DISCLOSURE, AND ITS SUBJECT MATTER, MAY NOT BE DISCLOSED IN WHOLE OR IN PART TO ANYONE OUTSIDE OF SIEMENS EXCEPT AS APPROVED UNDER SIEMENS CORPORATE PROCEDURES.

Tabulations on 1100 or 1200

Name _____ _____ Company Address _____

Date _____ _____

THIS INVENTION DISCLOSURE IS SIEMENS PROPRIETARY INFORMATION, AND IS CONFIDENTIAL. THIS DISCLOSURE, AND ITS SUBJECT MATTER, MAY NOT BE DISCLOSED IN WHOLE OR IN PART TO ANYONE OUTSIDE OF SIEMENS EXCEPT AS APPROVED UNDER SIEMENS CORPORATE PROCEDURES.

INSTRUCTION ON HOW TO USE THIS INVENTION DISCLOSURE

General

- PLEASE TYPE OR PRINT CLEARLY. Answer all questions. Use N/A when not applicable.
- Sign and date each page in ink.
  Sign and date all attached additional sheets, diagrams, photographs, etc
  Please provide all of your given names in full in sections 2 and 3. When there are more than two inventors, use another form and complete and sign items 1, 2, 3 and 10 on the extra forms.
- Every page of the form and accompanying papers should bear the signature of a witness and the date of his/her signing. The witness should have read the forms and attached papers, and should understand the invention before witnessing. The witness should have a technical background related to the invention, to reduce the chances that someone can later challenge his/her ability to have understood the invention.
- A co-inventor should not the witness. If you have a choice of several qualified witnesses, choose the witness you believe is most likely to still be a Siemens employee available in this country if a question comes up several years from now. That means you should avoid having a co-op student, contract engineer, or a retiring engineer serve as your witness.

Detailed Description

- The description you provide may serve as the basis for a patent application. Therefore, be as complete and as accurate as possible. Attach pages as necessary, using the following checklist as a guide for content.
  - *Abstract:*
    In one or two sentences, briefly describe what your Invention does and how it is used,
    e.g., " A voltage-controlled oscillator (VCO) has its period controlled by a current provided by a current source. The current is proportional to the reciprocal of a control signal so that the VCO frequency is directly proportional to the control signal."
  - *Background Information:*
    What is the function of your invention?
    What is the problem solved by your invention?
    How was the function of your invention performed by any prior systems, either a competitor's or ours?
    What are the disadvantages of these prior systems?
    What are the advantages of your invention over them?
  - *Details*:
    Describe in detail the structural and functional operation of your invention. Use drawings and graphs where they would be helpful. Give specific details, not just general information.
    Point out things such as what improvements your invention incorporates, or how and why it achieves superior performance (if you know why).
    Are there alternative methods or different structural embodiments of your invention?
    Can the general idea or technique of your invention be extended to other related fields? How?
    Which features are believed to be new?
    Describe how you best envision your invention being put to use.

Related Art

Attach a copy (or bibliographic citation) of all publications, patents, etc. that you know about which relate to your invention, and which you think might be important to consider in understanding how your invention differs from prior work.

Potential Licensing Opportunities

Please identify, in relation to item 9, all companies that are not a part of Siemens and may benefit, in the future, from the use of this invention. This will be helpful in identifying potential licensing opportunities for this invention.

REMEMBER TO UPDATE THE IPD IF ANY OF THE INFORMATION YOU PROVIDED CHANGES.

☐ **Yes, I promise I will update the Siemens Intellectual Property Department (IPD) if any of the information I've provided changes**

THIS INVENTION DISCLOSURE IS SIEMENS PROPRIETARY INFORMATION, AND IS CONFIDENTIAL. THIS DISCLOSURE, AND ITS SUBJECT MATTER, MAY NOT BE DISCLOSED IN WHOLE OR IN PART TO ANYONE OUTSIDE OF SIEMENS EXCEPT AS APPROVED UNDER SIEMENS CORPORATE PROCEDURES

SUPPLEMENTAL SHEET FOR INVENTION DISCLOSURE

ABSTRACT:

A manufacturing method for the direct encapsulation of OLED devices that encapsulates the sensitive active light-emitting OLED area with at least one encapsulation layer directly over and in contact with the OLED layers but which leaves other, non-light-emitting, areas of the display free of said encapsulation layer.\

BACKGROUND:

Presently, OLEDs are typically developed or fabricated on large sheets of glass with several or tens or even in excess of 100 displays per sheet and, once the OLED fabrication on the sheet of glass is finished, the OLED is encapsulated with a second piece of glass or a metal cap, typically with a cavity between the OLED glass and the encapsulation part; said cavity typically holds a getter materials that absorbs or adsorbs residual oxygen and in particular moisture in the package and oxygen and moisture that penetrate into the display package subsequent to encapsulation, typically done by bonding the two pieces together with an epoxy adhesive. After this process the glass, now encapsulated with getter and a second glass or metal cap, is scribed and broken into the individual displays. This encapsulation process is very difficult to manufacture with high yield and reliability, time-consuming (for example the epoxy glue dispense), is very costly (the getter material and the cover glass or metal cap) and adds to the thickness and weight of the overall display.

To get around these problems, various research groups and companies have been developing so-called 'direct encapsulation' methods. One of these techniques, known as Polymer-Multi-Layer (PML) technology, deposits at least one layer of a UV-curable organic liquid material over the whole display glass, said layer is then UV-cured, followed by the deposition of a barrier layer, e.g. a sputtered metal-oxide or generally a dielectric layer. This process may be repeated, to yield largely impermeable barrier layers and to avoid e.g. external particle/dirt-induced pinholes in said encapsulation layer. The problem with the prior art using these approaches is, that only parts of these displays, essentially the active light-emitting OLED area, must be encapsulated against the ingress of e.g. oxygen and moisture but other parts of the display should be kept exposed, for example the contact pads at which the display is connected to external driver circuitry, power supply, etc. In the PML technology for example, a problem arises with the presence of one or more of the direct-encapsulation layers over areas where encapsulation is not required and/or detrimental, such as over the contact pads.

Alternative techniques known in the prior art are to deposit for example 'Parylene' layer or a polysiloxane layer but these techniques also have the problem as the PML technology described above. Alternatively, a dielectric layer such as SiOx, SiNx, SiOxNy, etc. can be deposited over the OLED for direct encapsulation. This direct dielectric layer encapsulation, in-turn is susceptible to pin-holes and although the deposition (e.g. by sputtering) can be done through masks to block areas over which the encapsulation layer is not desired, this causes additional processing and reliability problems associated with for example the sputter-deposition through masks.

The present invention gets around problems of the prior art by providing processes for an improved direct-encapsulation of OLED devices.

DESCRIPTION OF THE INVENTION:

GENERAL (for all aspects of the invention and embodiments that follow below):

OLED can be typical OLED made on piece of glass with first ITO as first electrode (anode), then OLED layers, then top electrode (cathode); bottom-emitting through glass.

Alternatively, the electrodes can be reversed (cathode at bottom and anode at top).

Alternatively, the OLED can be top-emitting (substrate is opaque, emitting through transparent top electrode); both anode top and cathode bottom and reverse can be used.

Can be used with OLEDs on glass, quartz, metal, plastic foils, metal foils, etc.

Inventor's Signature: _____ Witness' Signature: _____

Date: _____ Date: _____

THIS INVENTION DISCLOSURE IS SIEMENS PROPRIETARY INFORMATION, AND IS CONFIDENTIAL. THIS DISCLOSURE, AND ITS SUBJECT MATTER, MAY NOT BE DISCLOSED IN WHOLE OR IN PART TO ANYONE OUTSIDE OF SIEMENS EXCEPT AS APPROVED UNDER SIEMENS CORPORATE PROCEDURES

SUPPLEMENTAL SHEET FOR INVENTION DISCLOSURE

Can be used for active matrix, passive matrix, segmented, alpha-numeric or backlight OLED displays or any combinations thereof or generally any OLED light source or display.

The organic layers used in the invention are generally known in the prior art, e.g. the PML prior art and the UV-curable monomer and monomer mixes (generally UV-curable compositions); could also be Parylene coatings or other organic coatings that can be deposited in any suitable manner on the OLED without damaging it. Generally organic layers that are carefully outgased to remove oxygen, moisture and any other reactive mobile species that coat the OLED substrate largely conformally. UV-curable materials are widely known in the prior art (see PML patent literature, see UV-curable printing inks in e.g. www.markem.com or www.vanet.hitachi.co.jp, or D. J . Hayes et al, Journal of the SID, Vol 9/1, 2001 or Hue P. Le, The Society for Imaging Sciences and Technology, Vol 42, No1, Jan/Feb 1998).

Note added on Oct 14, 2001: could also be electron-beam or thermal cure epoxy.

The barrier layer of the invention is typically a dielectric such as a SiOx, AlOx, SiNx, AlNx, SiOxNy, ITO, ZnOx, Al-doped ZnOx, etc. – generally any high barrier dielectrics (or conductive oxides).

In cases in which the fabricated display is bottom-emitting (through the substrate) and the encapsulation does not have to be transparent, metal films or non-transparent or colored dielectric films can be used as the barrier layer.

The deposition of the barrier layer can be any suitable method known in the prior art to deposit dielectric layers, e.g. sputtering or reactive sputtering (DC, AC, pulsed, combinations thereof, etc.). Evaporation of such dielectrics (resistive heating or electron-beam) or metal films is possible also and so are ion-beam assisted deposition methods or other plasma-enhanced deposition methods. "WET" PROCESS

DIELEC LAYERS ARE NOT SCREEN OR INK JET PRINTER

CLAIMS (aspects of the invention, embodiments; please note that for all of the below-mentioned it is understood that there can be several sequences (multi-layers) of organic + barrier layer):

(HIGH TEMP) & WET PROCESS NOT POSSIBLE W/ DIELEC.

INDEP CLAIM #1

1. A process for directly encapsulating a multitude of OLED devices fabricated on an undevided substrate sheet (can be foil) by putting the encapsulation layer directly (in contact with) on the top-most layer of the to-be encapsulated OLED displays and by using a combination of at least one organic layer and at least one inorganic barrier layer whereby said organic layer is deposited / condensed on the OLED substrate in the form of an unpatterned liquid film; whereby: the unpatterned liquid film is cross-linked in a patterned manner, non-cross-linked areas are subsequently removed, followed by the deposition, in a patterned manner, of a barrier layer over at least part of the layer covered with the cross-linked organic layer.
2. As claim 1 whereby flash evaporation is used to deposit the organic layer (as in PML technology of the prior art).
3. As claim 1 whereby dip-, roll-, blade-coating is used to deposit the organic layer.
4. As claim 1 whereby spin-coating is used to deposit the organic layer.
5. As claim 1 whereby evaporation is used to deposit the organic layer.
6. As claim 1 whereby cross-linking of the organic in a patterned manner is achieved by UV flood-exposure through a mask with the mask being less than 5 and preferably less than 1 and better still less than 0.5 mm away from the OLED substrate.
7. As claim 1 whereby cross-linking of the organic in a patterned manner is achieved by selective UV exposure through an optical patterning system such as a projection exposure system.
8. As claim 1 whereby cross-linking of the organic in a patterned manner is achieved by selective UV exposure with a UV-beam scanning system.
9. As claim 1 whereby the non-exposed areas (non-cross-linked) are removed by thermal evaporation (heating the substrate); can be short higher temperature pulse (e.g. by putting the OLED plate onto hotplate).

Inventor's Signature: _____ Witness' Signature: _____

Date: _____ Date: _____

THIS INVENTION DISCLOSURE IS SIEMENS PROPRIETARY INFORMATION, AND IS CONFIDENTIAL. THIS DISCLOSURE, AND ITS SUBJECT MATTER, MAY NOT BE DISCLOSED IN WHOLE OR IN PART TO ANYONE OUTSIDE OF SIEMENS EXCEPT AS APPROVED UNDER SIEMENS CORPORATE PROCEDURES

Oct 01

(INDEP. CLAIM 4)

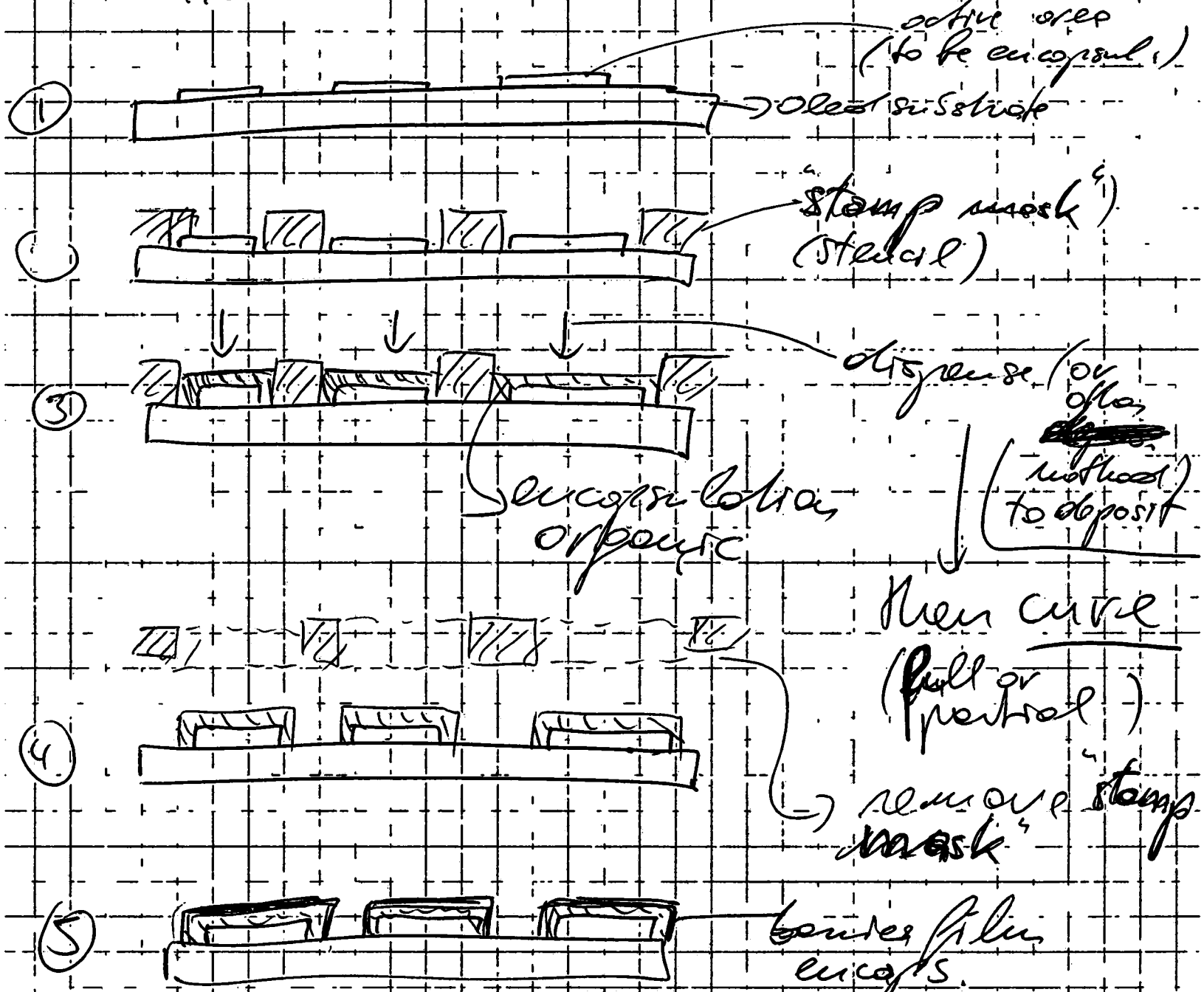


FIG 6 (RE CLAIM 40)

TOPS FORM 3314

SUPPLEMENTAL SHEET
FOR INVENTION DISCLOSURE

10. As claim 1 whereby the non-exposed areas (non-cross-linked) are removed by pumping in vacuum.
11. Combination of claim 9 and 10.
12. As claim 1 whereby the non-exposed areas (non-cross-linked) are removed by immersion in rinse-tank (washing off), spray-rinsing, ultra-sonicing (dry or wet ultra-sonic), mega-sonic (dry or wet); combination of dry ultra-sonic or mega-sonic in vacuum. Note added on October 14, 2001: should use the word liquid instead of wet.
13. As claim 1 whereby the removal of the non-cross-linked areas of the organic layer is assisted by a plasma process (even if this removes also some of the cross-linked area as long as the rate for the removal of the non-cross-linked material is larger than that for the cross-linked material).
14. As claim 1 whereby the barrier layer (materials and deposition methods see above) is sputtered through a shadow mask over the area of UV-cured organic. Note added on October 14, 2001: maybe we should add: barrier is dielectric; alternative barrier is metal or alloy.
15. As claim 14 whereby the barrier layer is slightly larger in x and y to cover also the edges of the organic layer. Note (for the description of the invention): we should state somewhere that because of optical effects the UV-exposed organic is likely not to have a sharp step (e.g. a round/sloped profile instead) and this is advantageous when depositing the barrier layer on top to assure good side-step coverage.
16. As claim 1 whereby the process is used to encapsulate only the organic light-emissive areas (e.g. pixels) of the display and all contact pads and/or auxiliary encapsulation areas (e.g. for secondary encapsulation) and/or scribe/break areas are left free from the organic layer and the barrier layer.

INDEP #2

17. New independent claim: As claim 1 but this time the organic is deposited and cured (if necessary) ALL OVER and only the barrier layer is deposited in a patterned manner, said patterned barrier layer also then acts as an etch stop to remove the organic over unwanted areas (i.e. the areas where the barrier layer is not deposited).
18. For claim 17 we can use all organic layer deposition methods as in claim 1 plus additional ones, namely:
19. As claim 17 whereby evaporation of one or more reactive organic molecules is used to deposit the organic layer, said reactive organic molecules forming a condensed conformal film on the substrate.
20. As claim 17 whereby the methods is as the 'Parylene' coating technology known in the prior art.
21. As claim 17 whereby the organic deposition is a plasma-assisted organic material deposition method.
22. As claim 17 whereby the organic that is subsequently not coated with the barrier is removed by an etching step.
23. As claim 22 whereby the etching is a chemical (dry or wet) etch process suitable to remove the organic.
24. As claim 22 whereby the etching is a plasma-assisted etch process suitable to remove the organic.
25. As claim 22 whereby the etching plasma contains oxygen.
26. As claim 22 whereby reactive ion-etching is used.
27. As claim 22 whereby anisotropic reactive ion-etching is used.

INDEP #3

28. New independent claim: As claim 1 and 17 but now the organic itself is already during the deposition (by nature of the deposition process itself) deposited in a patterned manner, then curing of the organic (if necessary as e.g. for the UV-curable organics) then patterned deposition of the barrier, no need to remove e.g. non-UV-cured organic. Note added on October 14, 2001: we need to make sure to write this broad in the sense that any printing technique suitable for printing the organic layer of the invention is used; ink-jet or screen-printing (below) are only preferred.
29. As claim 28 whereby the organic is deposited through a shadow mask using methods as described for claims 1 and 17.

Inventor's Signature: _____ Witness' Signature: _____

Date: _____ Date: _____

THIS INVENTION DISCLOSURE IS SIEMENS PROPRIETARY INFORMATION, AND IS CONFIDENTIAL. THIS DISCLOSURE, AND ITS SUBJECT MATTER, MAY NOT BE DISCLOSED IN WHOLE OR IN PART TO ANYONE OUTSIDE OF SIEMENS EXCEPT AS APPROVED UNDER SIEMENS CORPORATE PROCEDURES

30. As claim 28 whereby the organic is printed, in particular using screen-printing or ink-jet printing.
31. Any of the preceeding claims: all encapsulation process steps in inert atmosphere (reduced oxygen, ozone, other reactive gases and in particular moisture.
32. As claim 31 but only the first organic layer + first barrier layer 'dyad' in inert atmosphere.
33. As claim 31 but only the first organic layer in inert atmosphere.
34. Independent claim (?) based on ALL preceeding claims: ... whereby said OLED sheet with the encapsulation of the invention is encapsulated with a secondary encapsulation layer for additional encapsulation and/or mechanical protection.
35. As 34 whereby this is laminating or glueing a plastic or metal or metal+plastic foil or thin glass or thicker (rigid) glass or metal sheet over said OLED display sheet. Note: added on October 1, 2001: with or without a space between the OLED sheet/foil and the cover (= 2nd encapsulation) sheet/foil.
36. Finishing all off by singulation of the display (scribe and break) – may not be necessary.
37. As claims 34 – 36 but where the secondary encapsulation is done after singulation.
38.

One such example is shown in figure 1: attach Penang VDOT mask drawing with all layers.

Show barrier over the edge of the display

CLAIM #40

INDEP #4

Material added on October 14, 2001 (see lab book 07, page 12):

This goes on somewhere after the independent claim 28 and its dependent claims and this section could be the basis for another independent claim, namely:

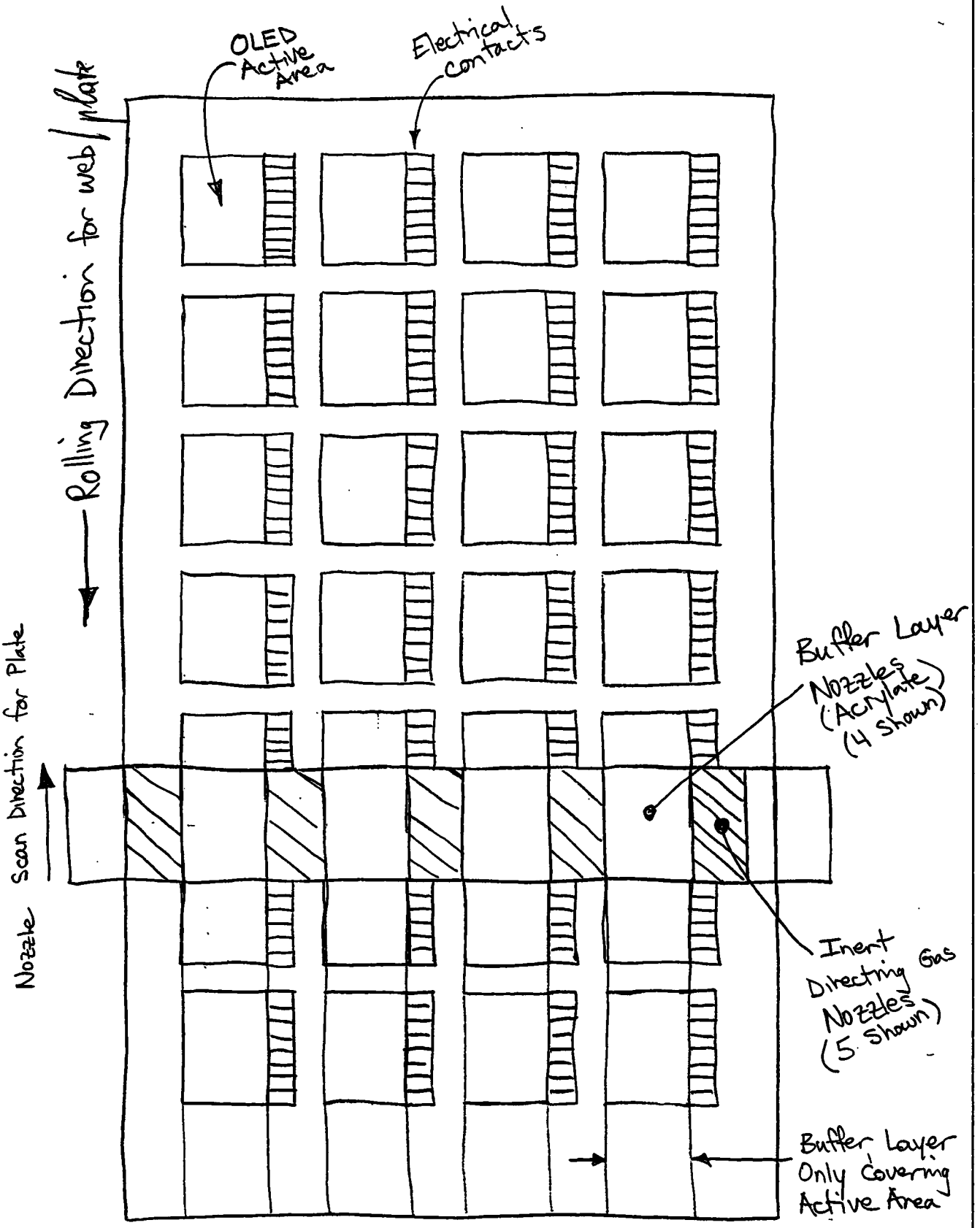
As e.g. claim 28 but instead of directly printing the organic using e.g. screen-printing or ink-jet printing the OLED is covered with a mask which is in direct contact with the OLED and the organic (e.g. the UV cure epoxy) is then dispensed, squashed, rolled, blade coated, dropped into, sprayed onto, etc. the mask openings and then the cure happens; after the cure the mask is removed and the OLED encapsulation (i.e. with the barrier film deposition continues); said mask to confine the organic has openings over the area where the encapsulation on the OLED needs to happen. Said mask could be a film laminated to the OLED or a mask pressed or pushed or clamped etc. to the OLED. The cure of the organic while the mask (to confine the organic) is there could be a multi-step cure, e.g. partical cure, remove the mask and then complete the cure. Said mask could be a multi-use mask or a one-off (e.g. in the case of a lamination) that then gets thrown away. Said mask could be a metal, ceramic or plastic foil or sheet; could in particular be a PTFE (Teflon) or a poly-siloxane-type material (e.g. polydimethylsiloxane such as often used for soft lithography) or generally any material that does not stick to the OLED (too much to cause damage or delaminate OLED material from the OLED glass when the mask is removed) and a material to which the encapsulation organic does not stick to well so that the mask removal after encapsulation organic deposition and cure (complete or partial) does not remove encapsulation organic. ..... but the mask is such that it can be brought in contact with the OLED sufficiently well so that the encapsulation organic is confined over the desired areas and does not seep under the areas where the encapsulation organic is not desired (e.g. contact pads etc.). Said mask is some sort of a 'stamp-mask'. See figure 4 below for a brief description of this concept. This concept is in particular useful for liquid encapsulation organics (see PML).

Inventor's Signature: _____ Witness' Signature: _____

Date: _____ Date: _____

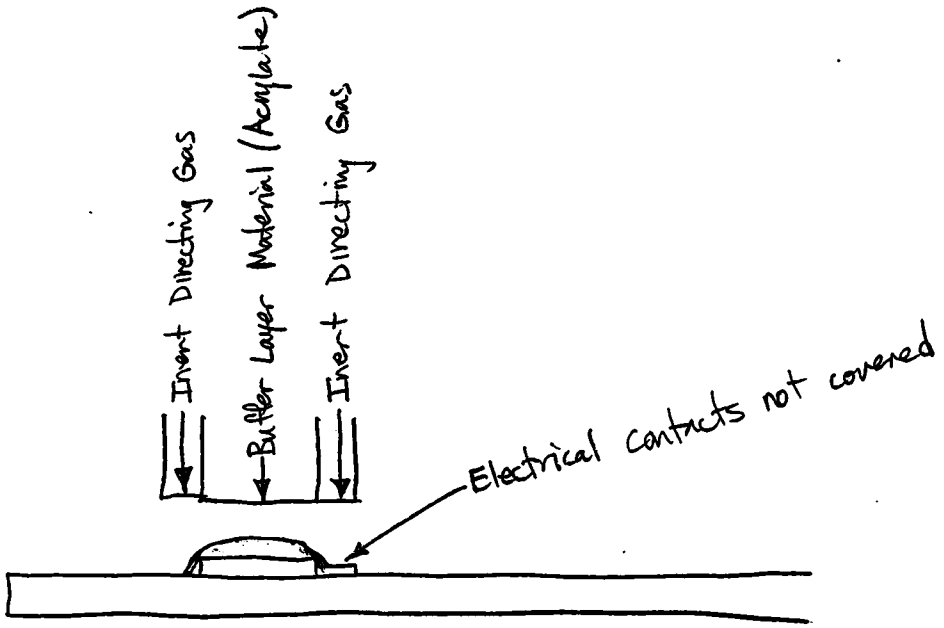
THIS INVENTION DISCLOSURE IS SIEMENS PROPRIETARY INFORMATION, AND IS CONFIDENTIAL. THIS DISCLOSURE, AND ITS SUBJECT MATTER, MAY NOT BE DISCLOSED IN WHOLE OR IN PART TO ANYONE OUTSIDE OF SIEMENS EXCEPT AS APPROVED UNDER SIEMENS CORPORATE PROCEDURES

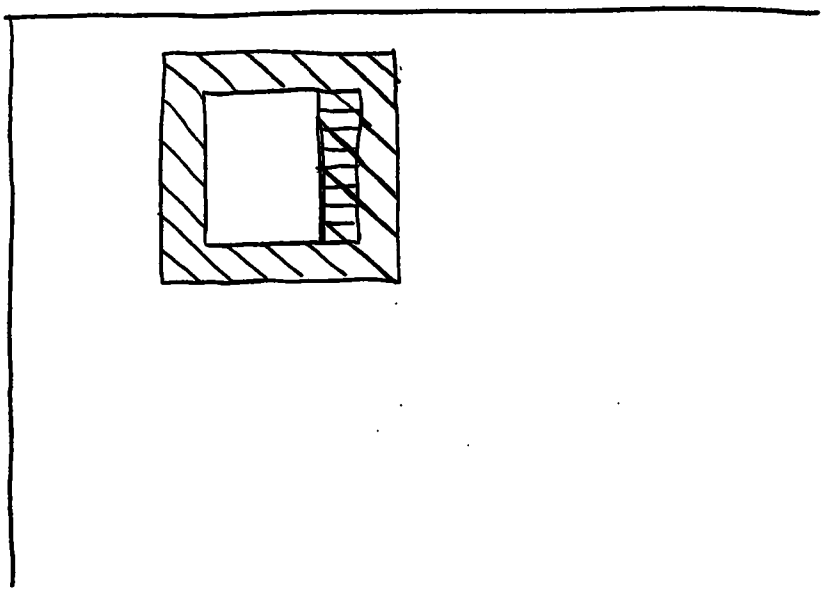
Drawing for Stu | Array | 4/15/02 (Monday)



Nalco Brand 42-182 100 SHEETS Made in U.S.A.

Drawing for Stn | Single Nozzle Unit | 4/15/02 (Monday)





42-182 100 SHEETS
Made in U.S.A.

INVENTION DISCLOSURE

Return this completed form, with any necessary attachment, to:
SIEMENS CORPORATION
Intellectual Property Department (IPD)
4900 Old Ironsides Drive, M/S 503
Santa Clara, CA 95054
phone +1-732-321-3026
fax +1-732-321-3014
PLEASE KEEP A COPY FOR YOUR RECORDS

THIS SECTION FOR IPD USE ONLY
Receipt Date Stamp
Division/Dept Code OSRAM Opto Semiconductor
Cost Center Code 8083
Docket No. 2001E18483US
IP Attorney HJG

RECEIVED
OCT 03 2001
INTELLECTUAL PROPERTY DEPT
WEST COAST

1. Your Div.'s Project # _____; Invention Title Encapsulation of OLED devices
2. INVENTOR

At the time the invention was conceived, this inventor was
☐ *an employee of a German legal entity (e.g. Siemens AG)*
☒ *an employee of a non-German entity (e.g. Siemens Automotive Corporation or Siemens Canada Limited)*
If you are not sure, contact IPD at +1-732-321-3026

Full Name: Karl PICHLER
Home Address [redacted]
Santa Clara, CA 95050

Citizen of [redacted]
Soc. Sec. # [redacted]
COMPANY/LOCATION INFORMATION
Employer Osram Opto-Semicoinductor
Division OLED R&D
Address 3870 North 1st Street
San Jose, CA 95134

Work telephone 408 456 4175
Fax 408 456 4305
Email karl.pichler@osram-os.com

Signature [signature]
Date 30 Sep 01

CO-INVENTOR (if any)
(use additional forms for more co-inventors)

At the time the invention was conceived, this inventor was
☐ *an employee of a German legal entity (e.g. Siemens AG)*
☐ *an employee of a non-German entity (e.g. Siemens Automotive Corporation or Siemens Canada Limited)*
If you are not sure, contact IPD at +1-732-321-3026

Full Name _____
Home Address _____

Citizen of _____
Soc. Sec. # _____
COMPANY/LOCATION INFORMATION
Employer _____
Division _____
Address _____

Work telephone _____
Fax _____
Email _____

Signature _____
Date _____

4. Purpose(s), and likely field(s) of use of this invention Encapsulation of OLED devices
5. Is this invention still secret within Siemens? YES ☒ NO ☐
   Do you soon plan to make the invention information available outside of Siemens? YES ☐ NO ☒

Based on your answer to Question #5, explain when and how this invention was/will be made available to someone outside of Siemens (e.g. trade show at location/date, customer presentation at company/location/attendees/date, supplier prototyping by company/date, included in product brochure or advertisement in publication/date, industry technical symposium paper presented place/date, etc) ____

6. Where is this invention described? List all documents containing aspects of this invention (e.g. engineer notebook date/page, internal status report, test logs, physical prototypes, customer presentation, etc) Karl Pichler Laboratory Lab Book # 7; pages 7 & 9.
7. What date do you recall creating this invention? Have been 'carrying around' part of the invention for a long time (>1 year); frist written description in internal e-mail dated Feb 8, 2001 to Kyle Frischknecht.
   When do you recall first explaining this invention to a witness who is not also a co-inventor? Feb 8, 2001; (only part of the invention)
   Who was those witness(es)? Kyle Frischknecht et al., (only part of the invention)
   Has this invention been prototyped or tested yet? If so, when, where, by who? What were the results? Not tested yet; internally I am certain and outside our company - I am not aware of anybody who tried it and/or any prior art; Important note: I conceived a significant part of this invention, namely ink-jet printing of the UV-curable liquid prior to the dielectric deposition on August 14, 2001 and did not tell anybody about it; I did some prior art seaching to check UV-curable liquid ink-jet printing. Only when I sat down to write this invention disclosure and looked up old e-mails (that to Kyle Frischknecht on Feb 8, 2001), I realized that in fact Kyle was thinking about ink-jet (or screen printing) of the PML UV-curable liquid plus other parts of the invention himself also; see attached e-mail conversation.
8. I have ☒ have not ☐ attached _____ number of additional sheets to better describe this invention.
9. Identify all non-Siemens companies that may in the future benefit from the use of this invention through a license. Potentially a huge range of companies, notably all those working in the field of Organic Light-Emitting Devices (OLEDS); current count well over 100 companies worldwide, essentially almost all display manufacturing companies plus several others entering the display manufacturing field as newcomers (US, Japan, Europe, Taiwan, South Korea, China, etc.); anybody seeking to direct-encapsulate OLEDs (see below for further desctiption).
10. Was this invention developed under, or quoted for, a customer contract? YES ☐ NO ☒
    Was it developed under a government contract? YES ☐ NO ☒
    If yes to either, please give contract name and number, and further explain the situation N/A

IF THE ANSWERS TO ANY OF THESE QUESTIONS CHANGE BEFORE THIS INVENTION IS FILED AS A PATENT APPLICATION WITH THE GOVERNMENT, MAKE SURE TO SEND AN UPDATE TO SIEMENS IPD.

11. WITNESSED AND UNDERSTOOD BY:

Signature [signature] Company Name OOS

THIS INVENTION DISCLOSURE IS SIEMENS PROPRIETARY INFORMATION, AND IS CONFIDENTIAL. THIS DISCLOSURE, AND ITS SUBJECT MATTER, MAY NOT BE DISCLOSED IN WHOLE OR IN PART TO ANYONE OUTSIDE OF SIEMENS EXCEPT AS APPROVED UNDER SIEMENS CORPORATE PROCEDURES

Recd/Rec'd IDF 4/10/01

INVENTION DISCLOSURE

Name Homer Anto Lis

Company Address

Date 10/1/01

30 Sep 01

Oct 1, 2001

THIS INVENTION DISCLOSURE IS SIEMENS PROPRIETARY INFORMATION, AND IS CONFIDENTIAL. THIS DISCLOSURE, AND ITS SUBJECT MATTER, MAY NOT BE DISCLOSED IN WHOLE OR IN PART TO ANYONE OUTSIDE OF SIEMENS EXCEPT AS APPROVED UNDER SIEMENS CORPORATE PROCEDURES.

INVENTION DISCLOSURE

Name Homer Anto's

Company Address

Date 10/1/01

30 Sep 01

Oct 1, 2001

THIS INVENTION DISCLOSURE IS SIEMENS PROPRIETARY INFORMATION, AND IS CONFIDENTIAL. THIS DISCLOSURE, AND ITS SUBJECT MATTER, MAY NOT BE DISCLOSED IN WHOLE OR IN PART TO ANYONE OUTSIDE OF SIEMENS EXCEPT AS APPROVED UNDER SIEMENS CORPORATE PROCEDURES.

30/9

INSTRUCTION ... HOW TO USE THIS INVENTION D . OSURE

General

- PLEASE TYPE OR PRINT CLEARLY. Answer all questions. Use N/A when not applicable.
- Sign and date each page in ink.
  Sign and date all attached additional sheets, diagrams, photographs, etc
  Please provide all of your given names in full in sections 2 and 3. When there are more than two inventors, use another form and complete and sign items 1, 2, 3 and 10 on the extra forms.
- Every page of the form and accompanying papers should bear the signature of a witness and the date of his/her signing. The witness should have read the forms and attached papers, and should understand the invention before witnessing. The witness should have a technical background related to the invention, to reduce the chances that someone can later challenge his/her ability to have understood the invention.
- A co-inventor should not the witness. If you have a choice of several qualified witnesses, choose the witness you believe is most likely to still be a Siemens employee available in this country if a question comes up several years from now. That means you should avoid having a co-op student, contract engineer, or a retiring engineer serve as your witness.

Detailed Description

- The description you provide may serve as the basis for a patent application. Therefore, be as complete and as accurate as possible. Attach pages as necessary, using the following checklist as a guide for content.
  - *Abstract:*
    In one or two sentences, briefly describe what your Invention does and how it is used,
    e.g., " A voltage-controlled oscillator (VCO) has its period controlled by a current provided by a current source. The current is proportional to the reciprocal of a control signal so that the VCO frequency is directly proportional to the control signal."
  - *Background Information:*
    What is the function of your invention?
    What is the problem solved by your invention?
    How was the function of your invention performed by any prior systems, either a competitor's or ours?
    What are the disadvantages of these prior systems?
    What are the advantages of your invention over them?
  - *Details*:
    Describe in detail the structural and functional operation of your invention. Use drawings and graphs where they would be helpful. Give specific details, not just general information.
    Point out things such as what improvements your invention incorporates, or how and why it achieves superior performance (if you know why).
    Are there alternative methods or different structural embodiments of your invention?
    Can the general idea or technique of your invention be extended to other related fields? How?
    Which features are believed to be new?
    Describe how you best envision your invention being put to use.

Related Art

Attach a copy (or bibliographic citation) of all publications, patents, etc. that you know about which relate to your invention, and which you think might be important to consider in understanding how your invention differs from prior work.

Potential Licensing Opportunities

Please identify, in relation to item 9, all companies that are not a part of Siemens and may benefit, in the future, from the use of this invention. This will be helpful in identifying potential licensing opportunities for this invention.

REMEMBER TO UPDATE THE IPD IF ANY OF THE INFORMATION YOU PROVIDED CHANGES.

☐ **Yes, I promise I will update the Siemens Intellectual Property Department (IPD) if any of the information I've provided changes**

Oct 1, 2001

30 Sep 01

THIS INVENTION DISCLOSURE IS SIEMENS PROPRIETARY INFORMATION, AND IS CONFIDENTIAL. THIS DISCLOSURE, AND ITS SUBJECT MATTER, MAY NOT BE DISCLOSED IN WHOLE OR IN PART TO ANYONE OUTSIDE OF SIEMENS EXCEPT AS APPROVED UNDER SIEMENS CORPORATE PROCEDURES

SUPPLEMENTAL SHEET FOR INVENTION DISCLOSURE

30 Sep 01

ABSTRACT:

A manufacturing method for the direct encapsulation of OLED devices that encapsulates the sensitive active light-emitting OLED area with at least one encapsulation layer directly over and in contact with the OLED layers but which leaves other, non-light-emitting, areas of the display free of said encapsulation layer.\

Pt. MW kann das nicht mehr recherchiert werden

BACKGROUND:

Presently, OLEDs are typically developed or fabricated on large sheets of glass with several or tens or even in excess of 100 displays per sheet and, once the OLED fabrication on the sheet of glass is finished, the OLED is encapsulated with a second piece of glass or a metal cap, typically with a cavity between the OLED glass and the encapsulation part; said cavity typically holds a getter materials that absorbs or adsorbs residual oxygen and in particular moisture in the package and oxygen and moisture that penetrate into the display package subsequent to encapsulation, typically done by bonding the two pieces together with an epoxy adhesive. After this process the glass, now encapsulated with getter and a second glass or metal cap, is scribed and broken into the individual displays. This encapsulation process is very difficult to manufacture with high yield and reliability, time-consuming (for example the epoxy glue dispense), is very costly (the getter material and the cover glass or metal cap) and adds to the thickness and weight of the overall display.

HEA 20,3,0? UNIAX Patent

To get around these problems, various research groups and companies have been developing so-called 'direct encapsulation' methods. One of these techniques, known as Polymer-Multi-Layer (PML) technology, deposits at least one layer of a UV-curable organic liquid material over the whole display glass, said layer is then UV-cured, followed by the deposition of a barrier layer, e.g. a sputtered metal-oxide or generally a dielectric layer. This process may be repeated, to yield largely impermeable barrier layers and to avoid e.g. external particle/dirt-induced pinholes in said encapsulation layer. The problem with the prior art using these approaches is, that only parts of these displays, essentially the active light-emitting OLED area, must be encapsulated against the ingress of e.g. oxygen and moisture but other parts of the display should be kept exposed, for example the contact pads at which the display is connected to external driver circuitry, power supply, etc. In the PML technology for example, a problem arises with the presence of one or more of the direct-encapsulation layers over areas where encapsulation is not required and/or detrimental, such as over the contact pads. — film damage at scribe lines.

Barrier Layer: • Metal (Al, Cr, Cu, ...) • Ceramic (Al_2O_3, Si_3N_4, WC, ect.)

Alternative techniques known in the prior art are to deposit for example 'Parylene' layer or a polysiloxane layer but these techniques also have the problem as the PML technology described above. Alternatively, a dielectric layer such as SiOx, SiNx, SiOxNy, etc. can be deposited over the OLED for direct encapsulation. This direct dielectric layer encapsulation, in-turn is susceptible to pin-holes and although the deposition (e.g. by sputtering) can be done through masks to block areas over which the encapsulation layer is not desired, this causes additional processing and reliability problems associated with for example the sputter-deposition through masks.

— ITO ?

The present invention gets around problems of the prior art by providing processes for an improved direct-encapsulation of OLED devices.

Misuse of term "dielectric layer" ⇒ In PML literature the organic layer is called the dielectric layer due to the capacitor roots of the technology

DESCRIPTION OF THE INVENTION:

GENERAL (for all aspects of the invention and embodiments that follow below):

OLED can be typical OLED made on piece of glass with first ITO as first electrode (anode), then OLED layers, then top electrode (cathode); bottom-emitting through glass.

Alternatively, the electrodes can be reversed (cathode at bottom and anode at top).

Alternatively, the OLED can be top-emitting (substrate is opaque, emitting through transparent top electrode); both anode top and cathode bottom and reverse can be used.

Can be used with OLEDs on glass, quartz, metal, plastic foils, metal foils, etc. — silicon wafers

Inventor's Signature: _____ Witness' Signature: _____

Date: 30 Sep 01 Date: 10/1/01

THIS INVENTION DISCLOSURE IS SIEMENS PROPRIETARY INFORMATION, AND IS CONFIDENTIAL. THIS DISCLOSURE, AND ITS SUBJECT MATTER, MAY NOT BE DISCLOSED IN WHOLE OR IN PART TO ANYONE OUTSIDE OF SIEMENS EXCEPT AS APPROVED UNDER SIEMENS CORPORATE PROCEDURES

SUPPLEMENTAL SHEET FOR INVENTION DISCLOSURE

Can be used for active matrix, passive matrix, segmented, alpha-numeric or backlight OLED displays or any combinations thereof or generally any OLED light source or display. General Lighting Applications

The organic layers used in the invention are generally known in the prior art, e.g. the PML prior art and the UV-curable monomer and monomer mixes (generally UV-curable compositions); could also be Parylene coatings or other organic coatings that can be deposited in any suitable manner on the OLED without damaging it. Generally organic layers that are carefully outgased to remove oxygen, moisture and any other reactive mobile species that coat the OLED substrate largely conformally. UV-curable materials are widely known in the prior art (see PML patent literature, see UV-curable printing inks in e.g. www.markem.com or www.vanet.hitachi.co.jp, or D. J. Hayes et al, Journal of the SID, Vol 9/1, 2001 or Hue P. Le, The Society for Imaging Sciences and Technology, Vol 42, No1, Jan/Feb 1998).

Fundamental Error: Organic Layer is Non conformal that is why the tech. works!

NOTE ADDED: can also be e.g. e-beam cure or thermal cure

Add Metal!

The barrier layer of the invention is typically a dielectric such as a SiOx, AlOx, SiNx, AlNx, SiOxNy, ITO, ZnOx, Al-doped ZnOx, etc. – generally any high barrier dielectrics (or conductive oxides).

In cases in which the fabricated display is bottom-emitting (through the substrate) and the encapsulation does not have to be transparent, metal films or non-transparent or colored dielectric films can be used as the barrier layer.

The deposition of the barrier layer can be any suitable method known in the prior art to deposit dielectric layers, e.g. sputtering or reactive sputtering (DC, AC, pulsed, combinations thereof, etc.). Evaporation of such dielectrics (resistive heating or electron-beam) or metal films is possible also and so are ion-beam assisted deposition methods or other plasma-enhanced deposition methods. – Such as PECVD.

1) Non conformal organic Layer
2) Barrier Layer: Ceramic – oxide, Nitride, boride, carbide
Metal – Al, Cr, Cu, ect. or Alloy – Al-Si, ect.

CLAIMS (aspects of the invention, embodiments; please note that for all of the below-mentioned it is understood that there can be several sequences (multi-layers) of organic + barrier layer):

1. A process for directly encapsulating a multitude of OLED devices fabricated on an undevided substrate sheet (can be foil) by putting the encapsulation layer directly (in contact with) on the top-most layer of the to-be encapsulated OLED displays and by using a combination of at least one organic layer and at least one inorganic barrier layer whereby said organic layer is deposited / condensed on the OLED substrate in the form of an unpatterned liquid film; whereby: the unpatterned liquid film is cross-linked in a patterned manner, non-cross-linked areas are subsequently removed, followed by the deposition, in a patterned manner, of a barrier layer over at least part of the layer covered with the cross-linked organic layer. – or extending beyond
2. As claim 1 whereby flash evaporation is used to deposit the organic layer (as in PML technology of the prior art).
3. As claim 1 whereby dip-, roll-, blade-coating is used to deposit the organic layer.
4. As claim 1 whereby spin-coating is used to deposit the organic layer.
5. As claim 1 whereby evaporation is used to deposit the organic layer.
6. As claim 1 whereby cross-linking of the organic in a patterned manner is achieved by UV flood-exposure through a mask with the mask being less than 5 and preferably less than 1 and better still less than 0.5 mm away from the OLED substrate.
7. As claim 1 whereby cross-linking of the organic in a patterned manner is achieved by selective UV exposure through an optical patterning system such as a projection exposure system.
8. As claim 1 whereby cross-linking of the organic in a patterned manner is achieved by selective UV exposure with a UV-beam scanning system.
9. As claim 1 whereby the non-exposed areas (non-cross-linked) are removed by thermal evaporation (heating the substrate); can be short higher temperature pulse (e.g. by putting the OLED plate onto hotplate).
10. As claim 1 whereby the non-exposed areas (non-cross-linked) are removed by pumping in vacuum.

Inventor's Signature: _____ Witness' Signature: _____

Date: 30/8/01 Date: 10/1/01

THIS INVENTION DISCLOSURE IS SIEMENS PROPRIETARY INFORMATION, AND IS CONFIDENTIAL. THIS DISCLOSURE, AND ITS SUBJECT MATTER, MAY NOT BE DISCLOSED IN WHOLE OR IN PART TO ANYONE OUTSIDE OF SIEMENS EXCEPT AS APPROVED UNDER SIEMENS CORPORATE PROCEDURES

SUPPLEMENTAL SHEET FOR INVENTION DISCLOSURE

11. Combination of claim 9 and 10. — "MOST LIKELY" – KYKZ
12. As claim 1 whereby the non-exposed areas (non-cross-linked) are removed by immersion in rinse-tank (washing off), spray-rinsing, ultra-sonicing (dry or wet ultra-sonic), mega-sonic (dry or wet); combination of dry ultra-sonic or mega-sonic in vacuum. CHANGE "WET" TO "LIQUID"
13. As claim 1 whereby the removal of the non-cross-linked areas of the organic layer is assisted by a plasma process (even if this removes also some of the cross-linked area as long as the rate for the removal of the non-cross-linked material is larger than that for the cross-linked material).
14. As claim 1 whereby the barrier layer (materials and deposition methods see above) is sputtered through a shadow mask over the area of UV-cured organic. → maybe add: barrier = dielectric, barrier = metal or alloy
15. As claim 14 whereby the barrier layer is slightly larger in x and y to cover also the edges of the organic layer. Note (for the description of the invention): we should state somewhere that because of optical effects the UV-exposed organic is likely not to have a sharp step (e.g. a round/sloped profile instead) and this is advantageous when depositing the barrier layer on top to assure good side-step coverage. Show x & y on diagram
16. As claim 1 whereby the process is used to encapsulate only the organic light-emissive areas (e.g. pixels) of the display and all contact pads and/or auxiliary encapsulation areas (e.g. for secondary encapsulation) and/or scribe/break areas are left free from the organic layer and the barrier layer.

laser removal ↓ IR?

17. New independent claim: As claim 1 but this time the organic is deposited and cured (if necessary) ALL OVER and only the barrier layer is deposited in a patterned manner, said patterned barrier layer also then acts as an etch stop to remove the organic over unwanted areas (i.e. the areas where the barrier layer is not deposited).
18. For claim 17 we can use all organic layer deposition methods as in claim 1 plus additional ones, namely:
19. As claim 17 whereby evaporation of one or more reactive organic molecules is used to deposit the organic layer, said reactive organic molecules forming a condensed conformal film on the substrate. Error!
20. As claim 17 whereby the methods is as the 'Parylene' coating technology known in the prior art.
21. As claim 17 whereby the organic deposition is a plasma-assisted organic material deposition method. e.g. Vapor (solid) deposit.
22. As claim 17 whereby the organic that is subsequently not coated with the barrier is removed by an etching step.
23. As claim 22 whereby the etching is a chemical (dry or wet) etch process suitable to remove the organic.
24. As claim 22 whereby the etching is a plasma-assisted etch process suitable to remove the organic.
25. As claim 22 whereby the etching plasma contains oxygen.
26. As claim 22 whereby reactive ion-etching is used.
27. As claim 22 whereby anisotropic reactive ion-etching is used.

ORGANIC DEPOSITED IN SOLID PHASE (NO CURING NEED)

28. New independent claim: As claim 1 and 17 but now the organic itself is already during the deposition (by nature of the deposition process itself) deposited in a patterned manner, then curing of the organic (if necessary as e.g. for the UV-curable organics) then patterned deposition of the barrier, no need to remove e.g. non-UV-cured organic.
29. As claim 28 whereby the organic is deposited through a shadow mask using methods as described for claims 1 and 17.
30. As claim 28 whereby the organic is printed, in particular using screen-printing or ink-jet printing.
31. Any of the preceeding claims: all encapsulation process steps in inert atmosphere (reduced oxygen, ozone, other reactive gases and in particular moisture.)
32. As claim 31 but only the first organic layer + first barrier layer 'dyad' in inert atmosphere.

Inventor's Signature: _____ Witness' Signature: _____

Date: 30 Sep 01 Date: 10/1/01

THIS INVENTION DISCLOSURE IS SIEMENS PROPRIETARY INFORMATION, AND IS CONFIDENTIAL. THIS DISCLOSURE, AND ITS SUBJECT MATTER, MAY NOT BE DISCLOSED IN WHOLE OR IN PART TO ANYONE OUTSIDE OF SIEMENS EXCEPT AS APPROVED UNDER SIEMENS CORPORATE PROCEDURES

31. As claim 28 whereby organic is patterned during evaporation/CVD process using inert gas nozzles to direct and contain condensing/reactive vapor.

SUPPLEMENTAL SHEET
FOR INVENTION DISCLOSURE

33. As claim 31 but only the first organic layer in inert atmosphere.
34. Independent claim (?) based on ALL preceeding claims: … whereby said OLED sheet with the encapsulation of the invention is encapsulated with a secondary encapsulation layer for additional encapsulation and/or mechanical protection.
35. As 34 whereby this is laminating or glueing a plastic or metal or metal+plastic foil or thin glass or thicker (rigid) glass or metal sheet over said OLED display sheet.
36. Finishing all off by singulation of the display (scribe and break) – may not be necessary.
37. As claims 34 – 36 but where the secondary encapsulation is done after singulation.
38.

One such example is shown in figure 1: attach Penang VDOT mask drawing with all layers.

Show barrier over the edge of the display → fig 3

fig 2: concept of the invention

UB: added on 1 Oct 01:

with or without space between the Oled sheet & the cover (2nd encaps) sheet.

Add also device structure claims ~ on OLED ...

Kyle → add GE patent ⇒ SFE Technologies Filed 01/16/86 US Patent 4,682,565

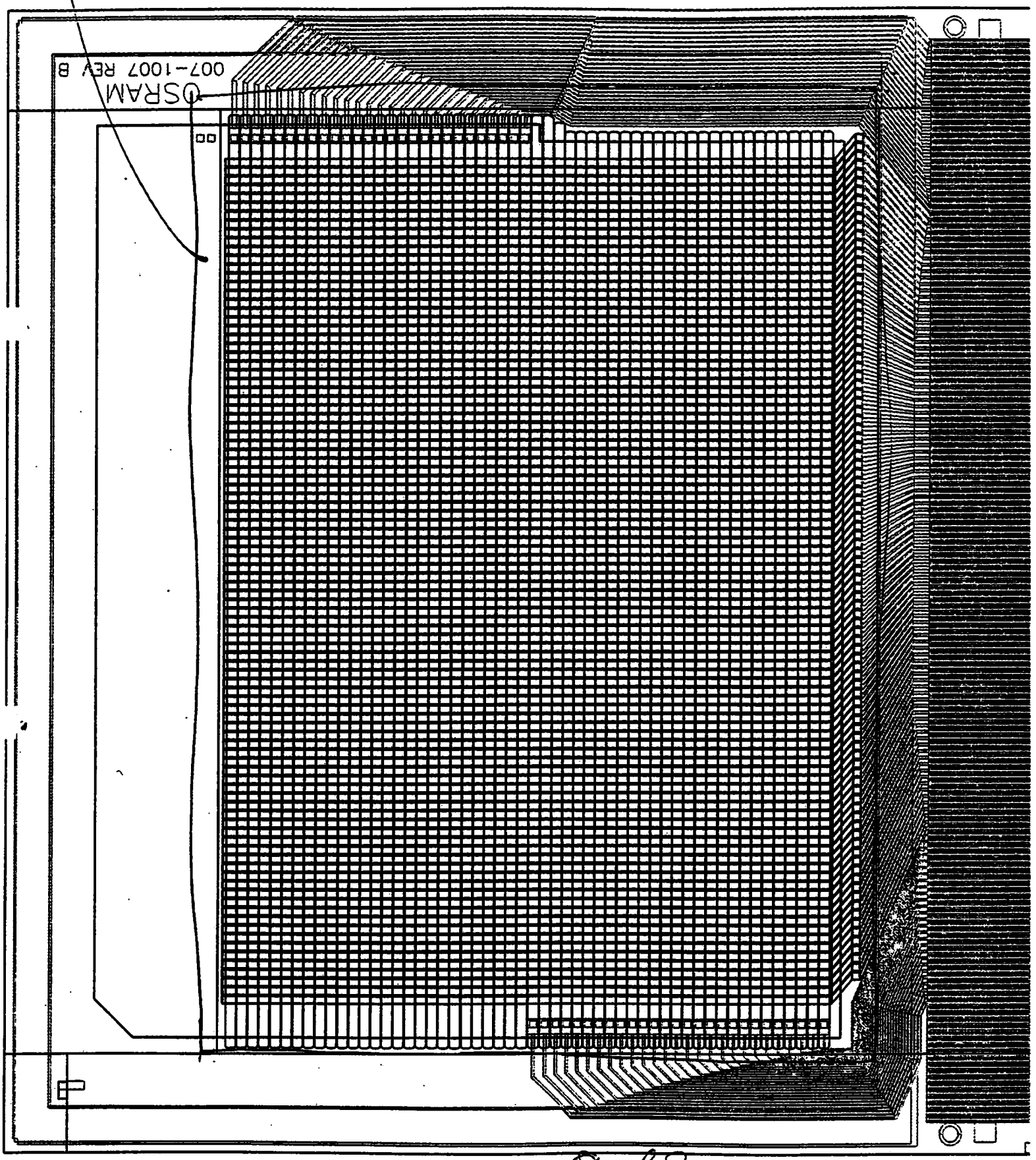
Inventor's Signature: [signature]
Date: 30 Sep 01

Witness' Signature: [signature]
Date: Oct 1, 2001

THIS INVENTION DISCLOSURE IS SIEMENS PROPRIETARY INFORMATION, AND IS CONFIDENTIAL. THIS DISCLOSURE, AND ITS SUBJECT MATTER, MAY NOT BE DISCLOSED IN WHOLE OR IN PART TO ANYONE OUTSIDE OF SIEMENS EXCEPT AS APPROVED UNDER SIEMENS CORPORATE PROCEDURES

Cover with encaps. or perc & dielectric (or metal)

Fig 1



Homer [signature]
10/1/01

p 8 of 9
[signature], 30 Sep 01

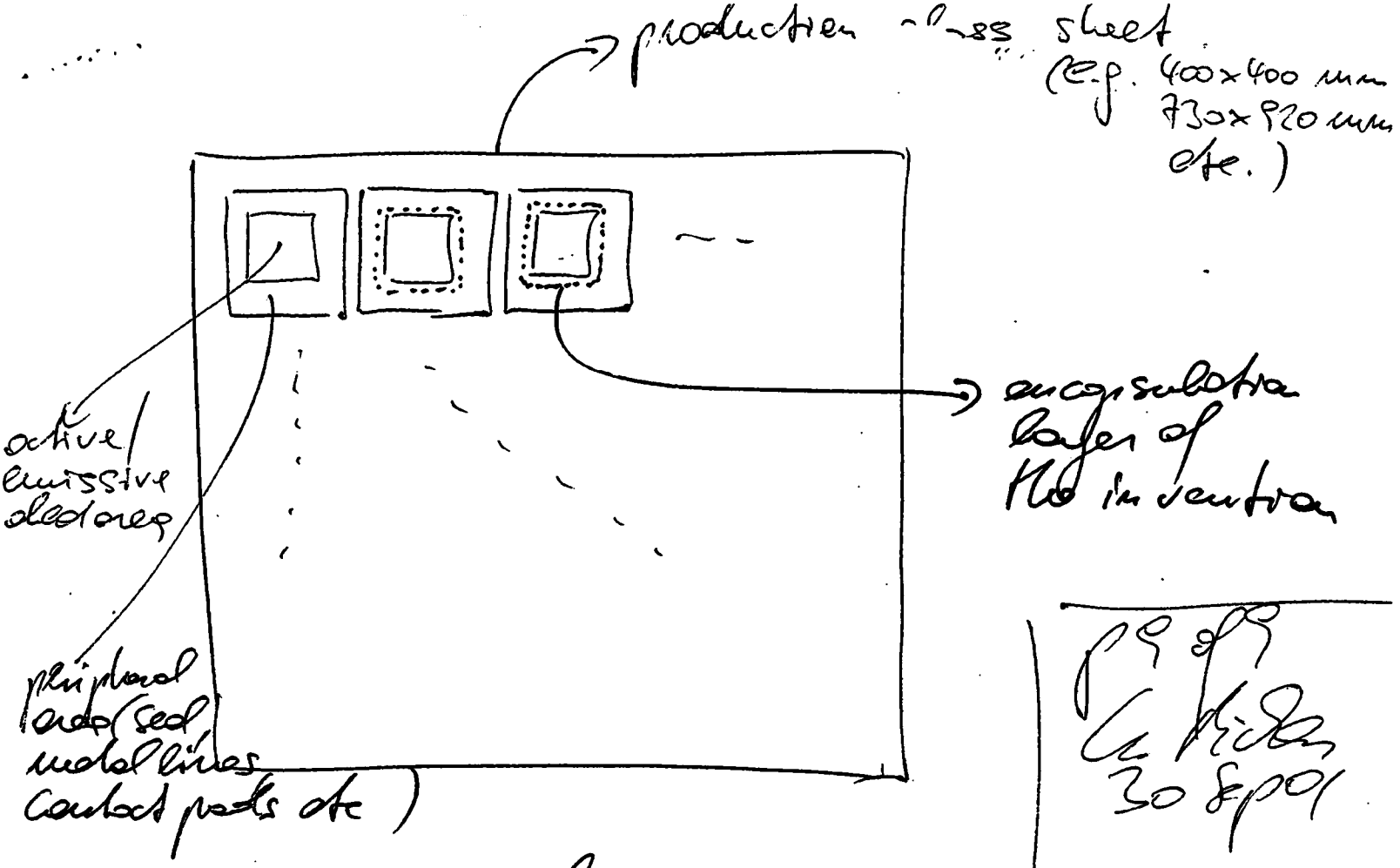


fig 2

p9 of 9
[illegible]
30 Sep 01

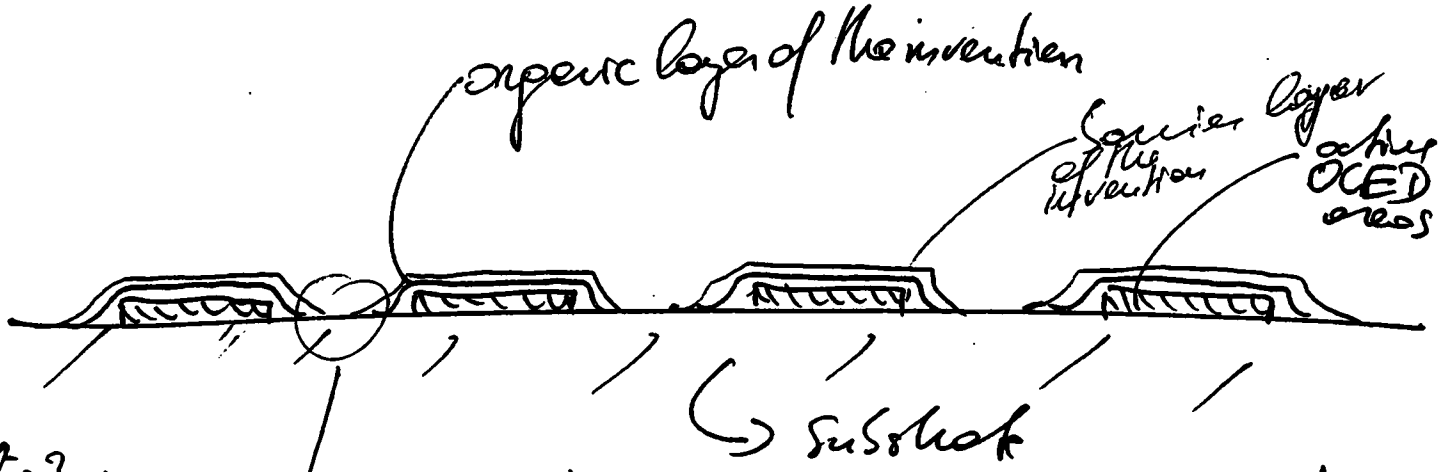


fig 3:

clearer!

10/1/01

3 of 9

INSTRUCTION ... HOW TO USE THIS INVENTION DISCLOSURE

General

- PLEASE TYPE OR PRINT CLEARLY. Answer all questions. Use N/A when not applicable.
- Sign and date each page in ink.
  Sign and date all attached additional sheets, diagrams, photographs, etc
  Please provide all of your given names in full in sections 2 and 3. When there are more than two inventors, use another form and complete and sign items 1, 2, 3 and 10 on the extra forms.
- Every page of the form and accompanying papers should bear the signature of a witness and the date of his/her signing. The witness should have read the forms and attached papers, and should understand the invention before witnessing. The witness should have a technical background related to the invention, to reduce the chances that someone can later challenge his/her ability to have understood the invention.
- A co-inventor should not the witness. If you have a choice of several qualified witnesses, choose the witness you believe is most likely to still be a Siemens employee available in this country if a question comes up several years from now. That means you should avoid having a co-op student, contract engineer, or a retiring engineer serve as your witness.

Detailed Description

- The description you provide may serve as the basis for a patent application. Therefore, be as complete and as accurate as possible. Attach pages as necessary, using the following checklist as a guide for content.
  - *Abstract:*
    In one or two sentences, briefly describe what your Invention does and how it is used,
    e.g., " A voltage-controlled oscillator (VCO) has its period controlled by a current provided by a current source. The current is proportional to the reciprocal of a control signal so that the VCO frequency is directly proportional to the control signal."
  - *Background Information:*
    What is the function of your invention?
    What is the problem solved by your invention?
    How was the function of your invention performed by any prior systems, either a competitor's or ours?
    What are the disadvantages of these prior systems?
    What are the advantages of your invention over them?
  - *Details*:
    Describe in detail the structural and functional operation of your invention. Use drawings and graphs where they would be helpful. Give specific details, not just general information.
    Point out things such as what improvements your invention incorporates, or how and why it achieves superior performance (if you know why).
    Are there alternative methods or different structural embodiments of your invention?
    Can the general idea or technique of your invention be extended to other related fields? How?
    Which features are believed to be new?
    Describe how you best envision your invention being put to use.

Related Art

Attach a copy (or bibliographic citation) of all publications, patents, etc. that you know about which relate to your invention, and which you think might be important to consider in understanding how your invention differs from prior work.

Potential Licensing Opportunities

Please identify, in relation to item 9, all companies that are not a part of Siemens and may benefit, in the future, from the use of this invention. This will be helpful in identifying potential licensing opportunities for this invention.

REMEMBER TO UPDATE THE IPD IF ANY OF THE INFORMATION YOU PROVIDED CHANGES.

☐ **Yes, I promise I will update the Siemens Intellectual Property Department (IPD) if any of the information I've provided changes**

Oct 1, 2001

30 Sep 01

THIS INVENTION DISCLOSURE IS SIEMENS PROPRIETARY INFORMATION, AND IS CONFIDENTIAL. THIS DISCLOSURE, AND ITS SUBJECT MATTER, MAY NOT BE DISCLOSED IN WHOLE OR IN PART TO ANYONE OUTSIDE OF SIEMENS EXCEPT AS APPROVED UNDER SIEMENS CORPORATE PROCEDURES

SUPPLEMENTAL SHEET
FOR INVENTION DISCLOSURE

ABSTRACT:

A manufacturing method for the direct encapsulation of OLED devices that encapsulates the sensitive active light-emitting OLED area with at least one encapsulation layer directly over and in contact with the OLED layers but which leaves other, non-light-emitting, areas of the display free of said encapsulation layer.\

BACKGROUND:

Presently, OLEDs are typically developed or fabricated on large sheets of glass with several or tens or even in excess of 100 displays per sheet and, once the OLED fabrication on the sheet of glass is finished, the OLED is encapsulated with a second piece of glass or a metal cap, typically with a cavity between the OLED glass and the encapsulation part; said cavity typically holds a getter materials that absorbs or adsorbs residual oxygen and in particular moisture in the package and oxygen and moisture that penetrate into the display package subsequent to encapsulation, typically done by bonding the two pieces together with an epoxy adhesive. After this process the glass, now encapsulated with getter and a second glass or metal cap, is scribed and broken into the individual displays. This encapsulation process is very difficult to manufacture with high yield and reliability, time-consuming (for example the epoxy glue dispense), is very costly (the getter material and the cover glass or metal cap) and adds to the thickness and weight of the overall display.

To get around these problems, various research groups and companies have been developing so-called 'direct encapsulation' methods. One of these techniques, known as Polymer-Multi-Layer (PML) technology, deposits at least one layer of a UV-curable organic liquid material over the whole display glass, said layer is then UV-cured, followed by the deposition of a barrier layer, e.g. a sputtered metal-oxide or generally a dielectric layer. This process may be repeated, to yield largely impermeable barrier layers and to avoid e.g. external particle/dirt-induced pinholes in said encapsulation layer. The problem with the prior art using these approaches is, that only parts of these displays, essentially the active light-emitting OLED area, must be encapsulated against the ingress of e.g. oxygen and moisture but other parts of the display should be kept exposed, for example the contact pads at which the display is connected to external driver circuitry, power supply, etc. In the PML technology for example, a problem arises with the presence of one or more of the direct-encapsulation layers over areas where encapsulation is not required and/or detrimental, such as over the contact pads.

Alternative techniques known in the prior art are to deposit for example 'Parylene' layer or a polysiloxane layer but these techniques also have the problem as the PML technology described above. Alternatively, a dielectric layer such as SiOx, SiNx, SiOxNy, etc. can be deposited over the OLED for direct encapsulation. This direct dielectric layer encapsulation, in-turn is susceptible to pin-holes and although the deposition (e.g. by sputtering) can be done through masks to block areas over which the encapsulation layer is not desired, this causes additional processing and reliability problems associated with for example the sputter-deposition through masks.

The present invention gets around problems of the prior art by providing processes for an improved direct-encapsulation of OLED devices.

DESCRIPTION OF THE INVENTION:

GENERAL (for all aspects of the invention and embodiments that follow below):

OLED can be typical OLED made on piece of glass with first ITO as first electrode (anode), then OLED layers, then top electrode (cathode); bottom-emitting through glass.

Alternatively, the electrodes can be reversed (cathode at bottom and anode at top).

Alternatively, the OLED can be top-emitting (substrate is opaque, emitting through transparent top electrode); both anode top and cathode bottom and reverse can be used.

Can be used with OLEDs on glass, quartz, metal, plastic foils, metal foils, etc.

Inventor's Signature: _____ Witness' Signature: _____

Date: 30 Sep 01 Date: 10/1/01

THIS INVENTION DISCLOSURE IS SIEMENS PROPRIETARY INFORMATION, AND IS CONFIDENTIAL. THIS DISCLOSURE, AND ITS SUBJECT MATTER, MAY NOT BE DISCLOSED IN WHOLE OR IN PART TO ANYONE OUTSIDE OF SIEMENS EXCEPT AS APPROVED UNDER SIEMENS CORPORATE PROCEDURES

SUPPLEMENTAL SHEET
FOR INVENTION DISCLOSURE

Can be used for active matrix, passive matrix, segmented, alpha-numeric or backlight OLED displays or any combinations thereof or generally any OLED light source or display.

The organic layers used in the invention are generally known in the prior art, e.g. the PML prior art and the UV-curable monomer and monomer mixes (generally UV-curable compositions); could also be Parylene coatings or other organic coatings that can be deposited in any suitable manner on the OLED without damaging it. Generally organic layers that are carefully outgased to remove oxygen, moisture and any other reactive mobile species that coat the OLED substrate largely conformally. UV-curable materials are widely known in the prior art (see PML patent literature, see UV-curable printing inks in e.g. www.markem.com or www.vanet.hitachi.co.jp, or D. J . Hayes et al, Journal of the SID, Vol 9/1, 2001 or Hue P. Le, The Society for Imaging Sciences and Technology, Vol 42, No1, Jan/Feb 1998).

NOTE ADDED: can also be e.g. e-beam cure or thermal cure

The barrier layer of the invention is typically a dielectric such as a SiOx, AlOx, SiNx, AlNx, SiOxNy, ITO, ZnOx, Al-doped ZnOx, etc. – generally any high barrier dielectrics (or conductive oxides).

In cases in which the fabricated display is bottom-emitting (through the substrate) and the encapsulation does not have to be transparent, metal films or non-transparent or colored dielectric films can be used as the barrier layer.

The deposition of the barrier layer can be any suitable method known in the prior art to deposit dielectric layers, e.g. sputtering or reactive sputtering (DC, AC, pulsed, combinations thereof, etc.). Evaporation of such dielectrics (resistive heating or electron-beam) or metal films is possible also and so are ion-beam assisted deposition methods or other plasma-enhanced deposition methods.

<u>CLAIMS (aspects of the invention, embodiments; please note that for all of the below-mentioned it is understood that there can be several sequences (multi-layers) of organic + barrier layer):</u>

1. A process for directly encapsulating a multitude of OLED devices fabricated on an undevided substrate sheet (can be foil) by putting the encapsulation layer directly (in contact with) on the top-most layer of the to-be encapsulated OLED displays and by using a combination of at least one organic layer and at least one inorganic barrier layer whereby said organic layer is deposited / condensed on the OLED substrate in the form of an unpatterned liquid film; whereby: the unpatterned liquid film is cross-linked in a patterned manner, non-cross-linked areas are subsequently removed, followed by the deposition, in a patterned manner, of a barrier layer over at least part of the layer covered with the cross-linked organic layer.
2. As claim 1 whereby flash evaporation is used to deposit the organic layer (as in PML technology of the prior art).
3. As claim 1 whereby dip-, roll-, blade-coating is used to deposit the organic layer.
4. As claim 1 whereby spin-coating is used to deposit the organic layer.
5. As claim 1 whereby evaporation is used to deposit the organic layer.
6. As claim 1 whereby cross-linking of the organic in a patterned manner is achieved by UV flood-exposure through a mask with the mask being less than 5 and preferably less than 1 and better still less than 0.5 mm away from the OLED substrate.
7. As claim 1 whereby cross-linking of the organic in a patterned manner is achieved by selective UV exposure through an optical patterning system such as a projection exposure system.
8. As claim 1 whereby cross-linking of the organic in a patterned manner is achieved by selective UV exposure with a UV-beam scanning system.
9. As claim 1 whereby the non-exposed areas (non-cross-linked) are removed by thermal evaporation (heating the substrate); can be short higher temperature pulse (e.g. by putting the OLED plate onto hotplate).
10. As claim 1 whereby the non-exposed areas (non-cross-linked) are removed by pumping in vacuum.

Inventor's Signature: _____ Witness' Signature: _____

Date: 30/8/01 Date: 10/1/01

THIS INVENTION DISCLOSURE IS SIEMENS PROPRIETARY INFORMATION, AND IS CONFIDENTIAL. THIS DISCLOSURE, AND ITS SUBJECT MATTER, MAY NOT BE DISCLOSED IN WHOLE OR IN PART TO ANYONE OUTSIDE OF SIEMENS EXCEPT AS APPROVED UNDER SIEMENS CORPORATE PROCEDURES

SUPPLEMENTAL SHEET FOR INVENTION DISCLOSURE

11. Combination of claim 9 and 10.
12. As claim 1 whereby the non-exposed areas (non-cross-linked) are removed by immersion in rinse-tank (washing off), spray-rinsing, ultra-sonicing (dry or wet ultra-sonic), mega-sonic (dry or wet); combination of dry ultra-sonic or mega-sonic in vacuum. CHG "WET" TO LIQUID
13. As claim 1 whereby the removal of the non-cross-linked areas of the organic layer is assisted by a plasma process (even if this removes also some of the cross-linked area as long as the rate for the removal of the non-cross-linked material is larger than that for the cross-linked material).
14. As claim 1 whereby the barrier layer (materials and deposition methods see above) is sputtered through a shadow mask over the area of UV-cured organic. → maybe add: {barrier = dielectric, barrier = metal or alloy}
15. As claim 14 whereby the barrier layer is slightly larger in x and y to cover also the edges of the organic layer. Note (for the description of the invention): we should state somewhere that because of optical effects the UV-exposed organic is likely not to have a sharp step (e.g. a round/sloped profile instead) and this is advantageous when depositing the barrier layer on top to assure good side-step coverage.
16. As claim 1 whereby the process is used to encapsulate only the organic light-emissive areas (e.g. pixels) of the display and all contact pads and/or auxiliary encapsulation areas (e.g. for secondary encapsulation) and/or scribe/break areas are left free from the organic layer and the barrier layer.
17. New independent claim: As claim 1 but this time the organic is deposited and cured (if necessary) ALL OVER and only the barrier layer is deposited in a patterned manner, said patterned barrier layer also then acts as an etch stop to remove the organic over unwanted areas (i.e. the areas where the barrier layer is not deposited).
18. For claim 17 we can use all organic layer deposition methods as in claim 1 plus additional ones, namely:
19. As claim 17 whereby evaporation of one or more reactive organic molecules is used to deposit the organic layer, said reactive organic molecules forming a condensed conformal film on the substrate.
20. As claim 17 whereby the methods is as the 'Parylene' coating technology known in the prior art.
21. As claim 17 whereby the organic deposition is a plasma-assisted organic material deposition method.
22. As claim 17 whereby the organic that is subsequently not coated with the barrier is removed by an etching step.
23. As claim 22 whereby the etching is a chemical (dry or wet) etch process suitable to remove the organic.
24. As claim 22 whereby the etching is a plasma-assisted etch process suitable to remove the organic.
25. As claim 22 whereby the etching plasma contains oxygen.
26. As claim 22 whereby reactive ion-etching is used.
27. As claim 22 whereby anisotropic reactive ion-etching is used.
28. New independent claim: As claim 1 and 17 but now the organic itself is already during the deposition (by nature of the deposition process itself) deposited in a patterned manner, then curing of the organic (if necessary as e.g. for the UV-curable organics) then patterned deposition of the barrier, no need to remove e.g. non-UV-cured organic.
29. As claim 28 whereby the organic is deposited through a shadow mask using methods as described for claims 1 and 17.
30. As claim 28 whereby the organic is printed, in particular using screen-printing or ink-jet printing.
31. Any of the preceeding claims: all encapsulation process steps in inert atmosphere (reduced oxygen, ozone, other reactive gases and in particular moisture.
32. As claim 31 but only the first organic layer + first barrier layer 'dyad' in inert atmosphere.

Inventor's Signature: _____ Witness' Signature: _____

Date: 30 Sep 01 Date: 10/1/01

THIS INVENTION DISCLOSURE IS SIEMENS PROPRIETARY INFORMATION, AND IS CONFIDENTIAL. THIS DISCLOSURE, AND ITS SUBJECT MATTER, MAY NOT BE DISCLOSED IN WHOLE OR IN PART TO ANYONE OUTSIDE OF SIEMENS EXCEPT AS APPROVED UNDER SIEMENS CORPORATE PROCEDURES

SUPPLEMENTAL SHEET
FOR INVENTION DISCLOSURE

33. As claim 31 but only the first organic layer in inert atmosphere.
34. Independent claim (?) based on ALL preceeding claims: … whereby said OLED sheet with the encapsulation of the invention is encapsulated with a secondary encapsulation layer for additional encapsulation and/or mechanical protection.
35. As 34 whereby this is laminating or glueing a plastic or metal or metal+plastic foil or thin glass or thicker (rigid) glass or metal sheet over said OLED display sheet.
36. Finishing all off by singulation of the display (scribe and break) – may not be necessary.
37. As claims 34 – 36 but where the secondary encapsulation is done after singulation.
38.

One such example is shown in figure 1: attach Penang VDOT mask drawing with all layers.
Show barrier over the edge of the display → fig 3

fig 2: concept of the invention

UG: added on 10Oct01:

with or without space between the OLED sheet & the cover (the 2nd encaps) sheet.

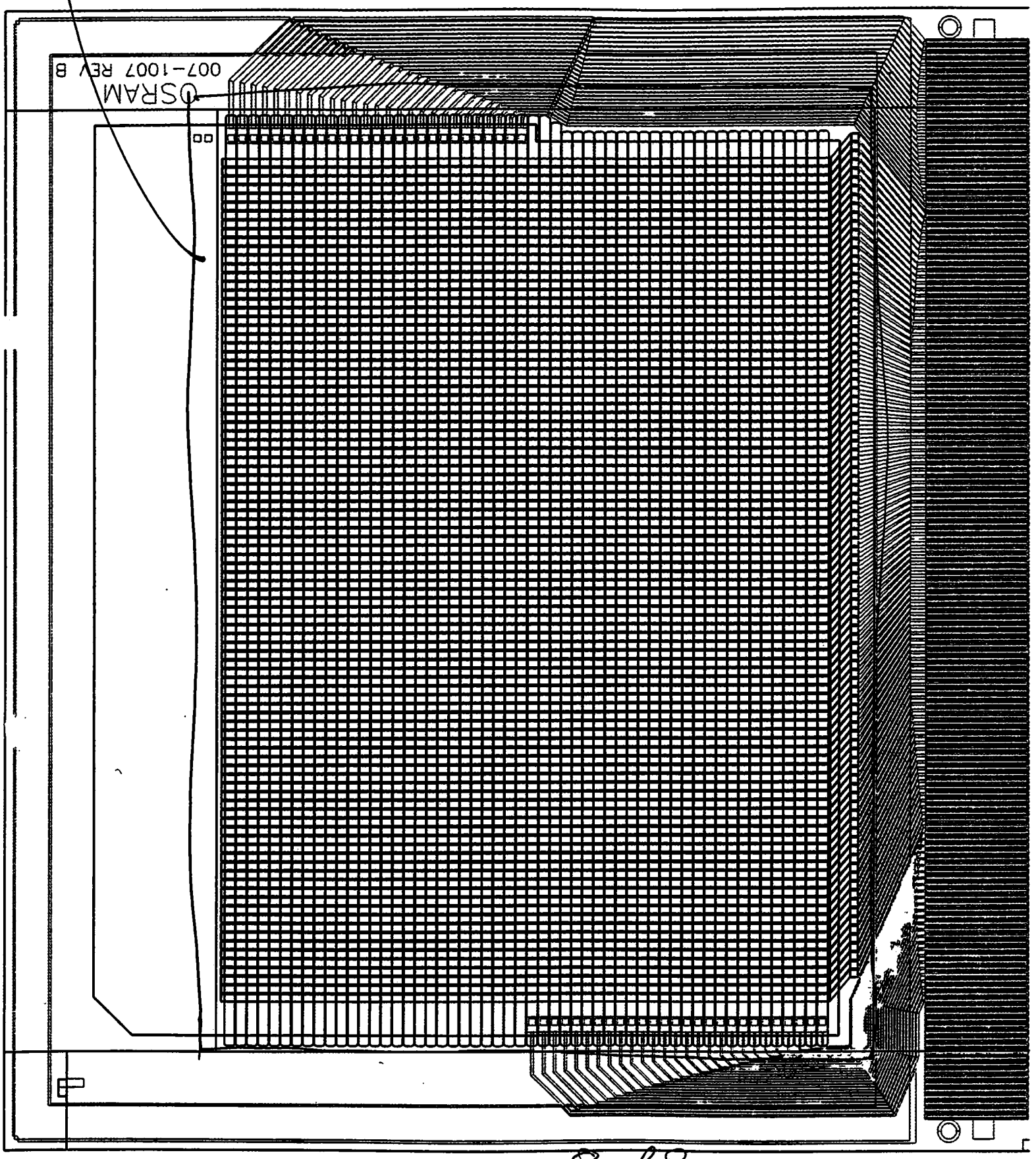
Inventor's Signature: [signature] Date: 30 Sep01

Witness' Signature: [signature] Date: Oct 1, 2001

THIS INVENTION DISCLOSURE IS SIEMENS PROPRIETARY INFORMATION, AND IS CONFIDENTIAL. THIS DISCLOSURE, AND ITS SUBJECT MATTER, MAY NOT BE DISCLOSED IN WHOLE OR IN PART TO ANYONE OUTSIDE OF SIEMENS EXCEPT AS APPROVED UNDER SIEMENS CORPORATE PROCEDURES

Cover with encaps. of pure & dielectric (or metal)

Dip 1



Homer [signature]
10/1/01

P 8 of 9
[signature], 30 Sep 01

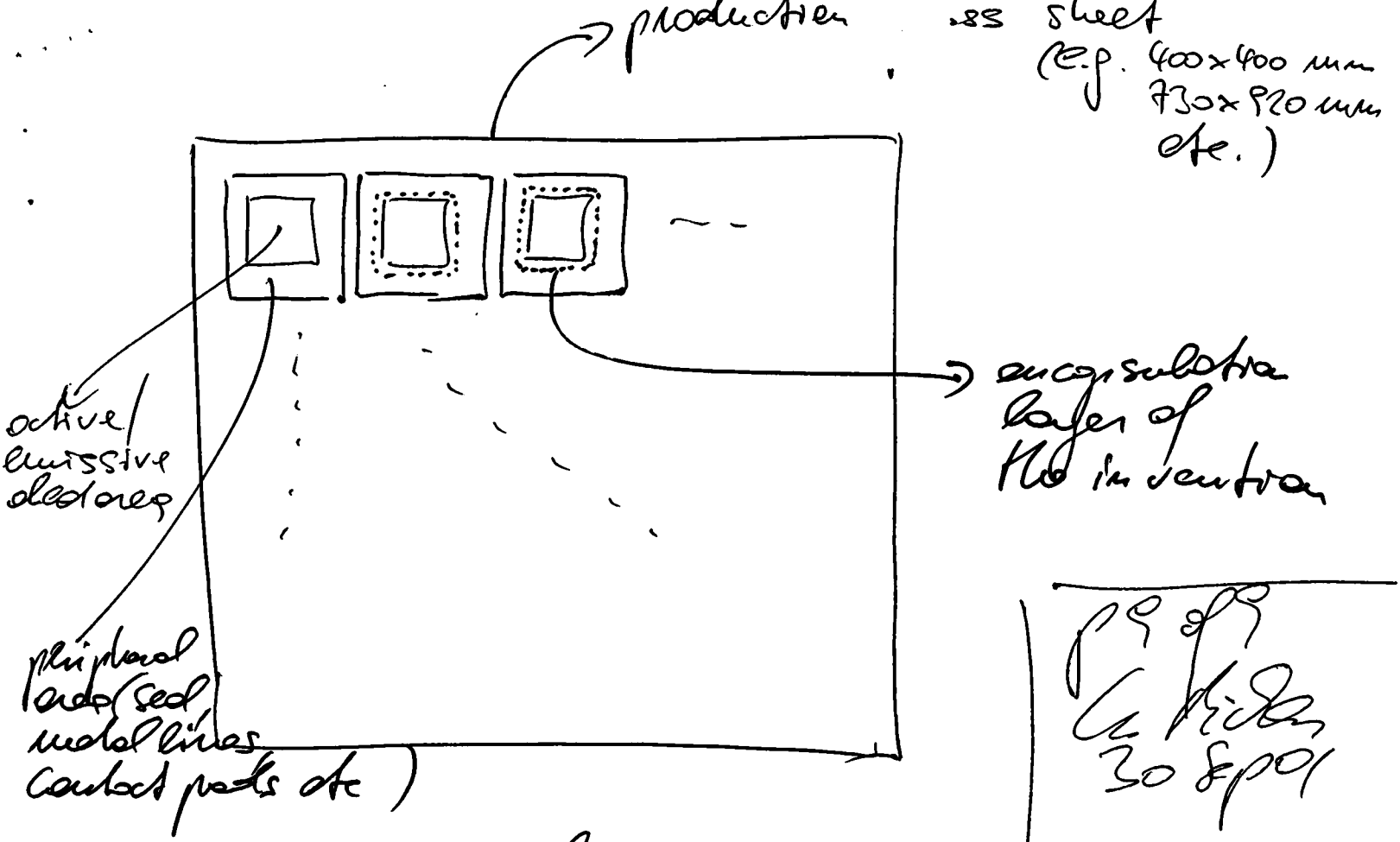


fig 2

p9 of 9
[illegible]
30 Sep 01

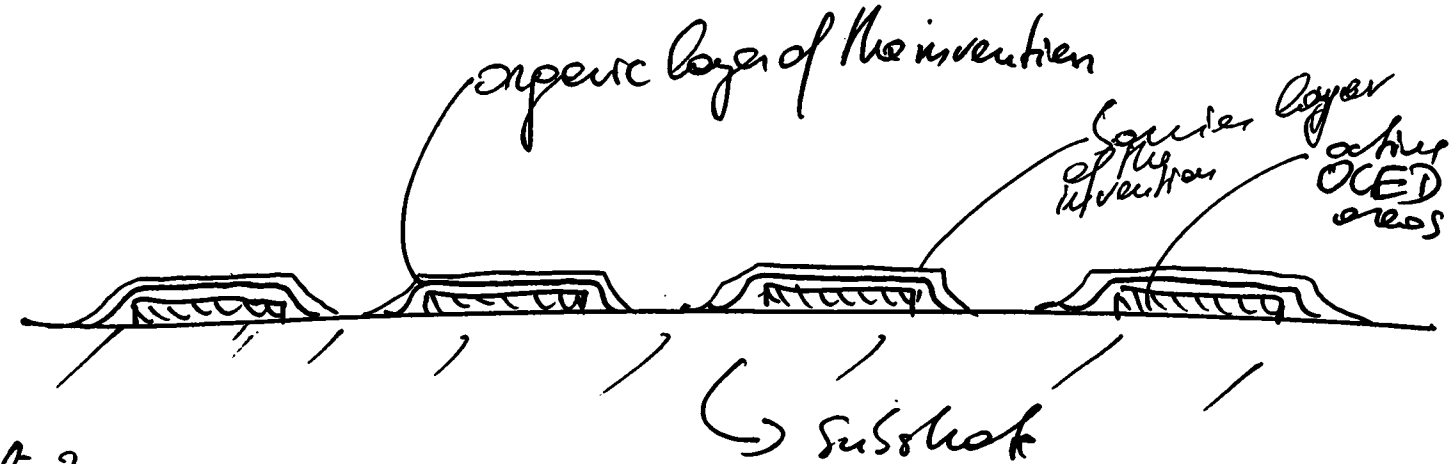


fig 3:

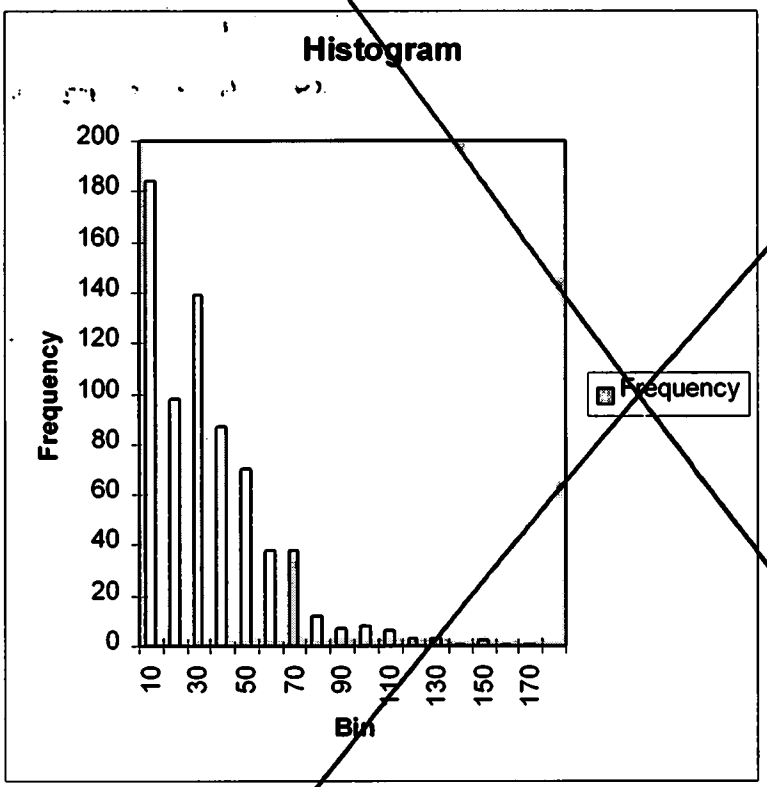
[illegible]
10/1/01

Pichler Karl (ITC)

From: Cumpston Brian (ITC)
Sent: Thursday, August 16, 2001 9:18 AM
To: Pichler Karl (ITC)
Cc: Antoniadis Homer (ITC)
Subject: RE: defect count and size distribution software

FYI, here are histograms I generated from the spreadsheet you sent (the software doesn't count grown-together spots as individual spots)

Sheet 1:



Sheet 3:

Pictiva EX2006-p. 39
Samsung v Pictiva
IPR2024-01222

IDEA: 14 Aug 01 (during Tanney Pines (i.j. seminar)

Problem: cost effective, efficient, simple — Oled encapsul.

~~appar~~

apparently: high throughput (fast) cheap industrial ink-jet printing of liquid monomers that are UV-cross-linkable is well known (acc. to Tanney Pines, Heidelberger, Druckmaschinen make/use such machines)

et. MW kann das nicht mehr recherchiert werden HEA 20.3.09

acc. to Tanney Pines

Oled field: encaps. is a big issue
→ one of the solutions → use of PIL
but: PIL NOT simple (vac flash evap process)
→ temp control problems
→ heat from source
→ not patterned (e.g. cathode also contact pads etc.)

NOTE: I had this idea quietly during the seminar → NOT discussed with any one

idea/invention: → use ↓ to ink jet liquid monomer in patterned fashion over active Oled area → x-link → patterned (e.g. shutter through shadow mask) dielectric (metal dep (can reject)

Continued on Page

Read and Understood By

[signature] 14 Aug 01 [signature] 1/10/01

Signed Date Signed Date

Pictiva EX2006-0.40
Samsung v Pictiva
IPR2024-01222

~~Idea~~ IDEA: 15 Aug 01

↳ BUT: have been "carrying" this idea around with me for ~ 2.5 years! (told Kyle, & others) → see e-mail (8 Feb 01)

→ issue: use of PML to encapsulate OLED

→ problem: liquid monomer (to be x-linked by UV) goes everywhere (also where not wanted, e.g. on contact pads, seal frame, etc.)

idea/solve: → PML → coat monomer liquid film (flash evap)

↳ UV-cross-link through Mask

→ remaining liquid film gets evaporated/washed etc off

→ Spuller encapsulating film on (evap.) top also through mask → may repeat.

→ achieve: encaps OLED active area but leave contact pads etc free

Continued on Page

Read and Understood By

K. Pencer — Signed — 15 Aug 01 — Date — Signed — 01/10/01 — Date

Pictiva EX2006-p. 41
Samsung v Pictiva
IPR2024-01222

INVENTION DISCLOSURE

Return this completed form,
with any necessary attachments, to:
SIEMENS CORPORATION
Intellectual Property Department (IPD)
4900 Old Ironsides Drive, M/S 503
Santa Clara, CA 95054
phone +1-732-321-3026
fax +1-732-321-3014
PLEASE KEEP A COPY FOR YOUR RECORDS

THIS SECTION FOR IPD USE ONLY
Receipt Date Stamp
RECEIVED
OCT 03 2001
INTELLECTUAL PROPERTY DEPT
WEST COAST
Division/Dept Code OSRAM Opto Semi
Cost Center Code 8083
Docket No. 2001E184834US
IP Attorney HJG

1. Your Div.'s Project # _____; Invention Title Encapsulation of OLED devices
2. INVENTOR

(use additional forms for more co-inventors)

At the time the invention was conceived, this inventor was
☐ *an employee of a German legal entity (e.g. Siemens AG)*
☒ *an employee of a non-German entity (e.g. Siemens Automotive Corporation or Siemens Canada Limited)*
If you are not sure, contact IPD at +1-732-321-3026

Full Name: Karl PICHLER
Home Address [redacted]
Santa Clara, CA 95050

Citizen of [redacted]
Soc. Sec. # [redacted]
COMPANY/LOCATION INFORMATION
Employer Osram Opto-Semiconductor
Division OLED R&D
Address 3870 North 1st Street
San Jose, CA 95134

Work telephone 408 456 4175
Fax 408 456 4305
Email karl.pichler@osram-os.com

Signature [signature]
Date 30 Sep 2001

At the time the invention was conceived, this inventor was
☐ *an employee of a German legal entity (e.g. Siemens AG)*
☐ *an employee of a non-German entity (e.g. Siemens Automotive Corporation or Siemens Canada Limited)*
If you are not sure, contact IPD at +1-732-321-3026

Full Name _____
Home Address _____

Citizen of _____
Soc. Sec. # _____
COMPANY/LOCATION INFORMATION
Employer _____
Division _____
Address _____

Work telephone _____
Fax _____
Email _____

Signature _____
Date _____

4. Purpose(s), and likely field(s) of use of this invention Encapsulation of OLED devices
5. Is this invention still secret within Siemens? YES ☒ NO ☐
   Do you soon plan to make the invention information available outside of Siemens? YES ☐ NO ☒
   Based on your answer to Question #5, explain when and how this invention was/will be made available to someone outside of Siemens (e.g. trade show at location/date, customer presentation at company/location/attendees/date, supplier prototyping by company/date, included in product brochure or advertisement in publication/date, industry technical symposium paper presented place/date, etc) ____
6. Where is this invention described? List all documents containing aspects of this invention (e.g. engineer notebook date/page, internal status report, test logs, physical prototypes, customer presentation, etc) Karl Pichler Laboratory Lab Book # 7; pages 7 & 9.
7. What date do you recall creating this invention? Have been 'carrying around' part of the invention for a long time (>1 year); frist written description in internal e-mail dated Feb 8, 2001 to Kyle Frischknecht.
   When do you recall first explaining this invention to a witness who is not also a co-inventor? Feb 8, 2001; (only part of the invention)
   Who was those witness(es)? Kyle Frischknecht et al., (only part of the invention)
   Has this invention been prototyped or tested yet? If so, when, where, by who? What were the results? Not tested yet; internally I am certain and outside our company - I am not aware of anybody who tried it and/or any prior art; Important note: I conceived a significant part of this invention, namely ink-jet printing of the UV-curable liquid prior to the dielectric deposition on August 14, 2001 and did not tell anybody about it; I did some prior art seaching to check UV-curable liquid ink-jet printing. Only when I sat down to write this invention disclosure and looked up old e-mails (that to Kyle Frischknecht on Feb 8, 2001), I realized that in fact Kyle was thinking about ink-jet (or screen printing) of the PML UV-curable liquid plus other parts of the invention himself also; see attached e-mail conversation.
8. I have ☒ have not ☐ attached _____ number of additional sheets to better describe this invention.
9. Identify all non-Siemens companies that may in the future benefit from the use of this invention through a license. Potentially a huge range of companies, notably all those working in the field of Organic Light-Emitting Devices (OLEDS); current count well over 100 companies worldwide, essentially almost all display manufacturing companies plus several others entering the display manufacturing field as newcomers (US, Japan, Europe, Taiwan, South Korea, China, etc.); anybody seeking to direct-encapsulate OLEDs (see below for further desctiption).
10. Was this invention developed under, or quoted for, a customer contract? YES ☐ NO ☒
    Was it developed under a government contract? YES ☐ NO ☒
    If yes to either, please give contract name and number, and further explain the situation N/A

IF THE ANSWERS TO ANY OF THESE QUESTIONS CHANGE BEFORE THIS INVENTION IS FILED AS A PATENT APPLICATION WITH THE GOVERNMENT, MAKE SURE TO SEND AN UPDATE TO SIEMENS IPD.

11. WITNESSED AND UNDERSTOOD BY:

Signature [signature] Company Name OOS

THIS INVENTION DISCLOSURE IS SIEMENS PROPRIETARY INFORMATION, AND IS CONFIDENTIAL. THIS DISCLOSURE, AND ITS SUBJECT MATTER, MAY NOT BE DISCLOSED IN WHOLE OR IN PART TO ANYONE OUTSIDE OF SIEMENS EXCEPT AS APPROVED UNDER SIEMENS CORPORATE PROCEDURES.

Pictiva EX2006-p. 42
Samsung v Pictiva
IPR2024-01222

Name Homer Anton dis

Date 10/1/01

Company Address

30 Sep 01

Oct 1, 2001

THIS INVENTION DISCLOSURE IS SIEMENS PROPRIETARY INFORMATION, AND IS CONFIDENTIAL. THIS DISCLOSURE, AND ITS SUBJECT MATTER, MAY NOT BE DISCLOSED IN WHOLE OR IN PART TO ANYONE OUTSIDE OF SIEMENS EXCEPT AS APPROVED UNDER SIEMENS CORPORATE PROCEDURES

30/9

INSTRUCTION ON HOW TO USE THIS INVENTION DISCLOSURE

General

- PLEASE TYPE OR PRINT CLEARLY. Answer all questions. Use N/A when not applicable.
- Sign and date each page in ink.
  Sign and date all attached additional sheets, diagrams, photographs, etc
  Please provide all of your given names in full in sections 2 and 3. When there are more than two inventors, use another form and complete and sign items 1, 2, 3 and 10 on the extra forms.
- Every page of the form and accompanying papers should bear the signature of a witness and the date of his/her signing. The witness should have read the forms and attached papers, and should understand the invention before witnessing. The witness should have a technical background related to the invention, to reduce the chances that someone can later challenge his/her ability to have understood the invention.
- A co-inventor should not the witness. If you have a choice of several qualified witnesses, choose the witness you believe is most likely to still be a Siemens employee available in this country if a question comes up several years from now. That means you should avoid having a co-op student, contract engineer, or a retiring engineer serve as your witness.

Detailed Description

- The description you provide may serve as the basis for a patent application. Therefore, be as complete and as accurate as possible. Attach pages as necessary, using the following checklist as a guide for content.
  - *Abstract:*
    In one or two sentences, briefly describe what your Invention does and how it is used,
    e.g., " A voltage-controlled oscillator (VCO) has its period controlled by a current provided by a current source. The current is proportional to the reciprocal of a control signal so that the VCO frequency is directly proportional to the control signal."
  - *Background Information:*
    What is the function of your invention?
    What is the problem solved by your invention?
    How was the function of your invention performed by any prior systems, either a competitor's or ours?
    What are the disadvantages of these prior systems?
    What are the advantages of your invention over them?
  - *Details*:
    Describe in detail the structural and functional operation of your invention. Use drawings and graphs where they would be helpful. Give specific details, not just general information.
    Point out things such as what improvements your invention incorporates, or how and why it achieves superior performance (if you know why).
    Are there alternative methods or different structural embodiments of your invention?
    Can the general idea or technique of your invention be extended to other related fields? How?
    Which features are believed to be new?
    Describe how you best envision your invention being put to use.

Related Art

Attach a copy (or bibliographic citation) of all publications, patents, etc. that you know about which relate to your invention, and which you think might be important to consider in understanding how your invention differs from prior work.

Potential Licensing Opportunities

Please identify, in relation to item 9, all companies that are not a part of Siemens and may benefit, in the future, from the use of this invention. This will be helpful in identifying potential licensing opportunities for this invention.

REMEMBER TO UPDATE THE IPD IF ANY OF THE INFORMATION YOU PROVIDED CHANGES.

☐ **Yes, I promise I will update the Siemens Intellectual Property Department (IPD) if any of the information I've provided changes**

Oct 1, 2001

30 Sep 01

THIS INVENTION DISCLOSURE IS SIEMENS PROPRIETARY INFORMATION, AND IS CONFIDENTIAL. THIS DISCLOSURE, AND ITS SUBJECT MATTER, MAY NOT BE DISCLOSED IN WHOLE OR IN PART TO ANYONE OUTSIDE OF SIEMENS EXCEPT AS APPROVED UNDER SIEMENS CORPORATE PROCEDURES

SUPPLEMENTAL SHEET FOR INVENTION DISCLOSURE

30 Sep 01

ABSTRACT:

A manufacturing method for the direct encapsulation of OLED devices that encapsulates the sensitive active light-emitting OLED area with at least one encapsulation layer directly over and in contact with the OLED layers but which leaves other, non-light-emitting, areas of the display free of said encapsulation layer.\

BACKGROUND:

Presently, OLEDs are typically developed or fabricated on large sheets of glass with several or tens or even in excess of 100 displays per sheet and, once the OLED fabrication on the sheet of glass is finished, the OLED is encapsulated with a second piece of glass or a metal cap, typically with a cavity between the OLED glass and the encapsulation part; said cavity typically holds a getter materials that absorbs or adsorbs residual oxygen and in particular moisture in the package and oxygen and moisture that penetrate into the display package subsequent to encapsulation, typically done by bonding the two pieces together with an epoxy adhesive. After this process the glass, now encapsulated with getter and a second glass or metal cap, is scribed and broken into the individual displays. This encapsulation process is very difficult to manufacture with high yield and reliability, time-consuming (for example the epoxy glue dispense), is very costly (the getter material and the cover glass or metal cap) and adds to the thickness and weight of the overall display.

To get around these problems, various research groups and companies have been developing so-called 'direct encapsulation' methods. One of these techniques, known as Polymer-Multi-Layer (PML) technology, deposits at least one layer of a UV-curable organic liquid material over the whole display glass, said layer is then UV-cured, followed by the deposition of a barrier layer, e.g. a sputtered metal-oxide or generally a dielectric layer. This process may be repeated, to yield largely impermeable barrier layers and to avoid e.g. external particle/dirt-induced pinholes in said encapsulation layer. The problem with the prior art using these approaches is, that only parts of these displays, essentially the active light-emitting OLED area, must be encapsulated against the ingress of e.g. oxygen and moisture but other parts of the display should be kept exposed, for example the contact pads at which the display is connected to external driver circuitry, power supply, etc. In the PML technology for example, a problem arises with the presence of one or more of the direct-encapsulation layers over areas where encapsulation is not required and/or detrimental, such as over the contact pads.

Alternative techniques known in the prior art are to deposit for example 'Parylene' layer or a polysiloxane layer but these techniques also have the problem as the PML technology described above. Alternatively, a dielectric layer such as SiOx, SiNx, SiOxNy, etc. can be deposited over the OLED for direct encapsulation. This direct dielectric layer encapsulation, in-turn is susceptible to pin-holes and although the deposition (e.g. by sputtering) can be done through masks to block areas over which the encapsulation layer is not desired, this causes additional processing and reliability problems associated with for example the sputter-deposition through masks.

The present invention gets around problems of the prior art by providing processes for an improved direct-encapsulation of OLED devices.

DESCRIPTION OF THE INVENTION:

GENERAL (for all aspects of the invention and embodiments that follow below):

OLED can be typical OLED made on piece of glass with first ITO as first electrode (anode), then OLED layers, then top electrode (cathode); bottom-emitting through glass.

Alternatively, the electrodes can be reversed (cathode at bottom and anode at top).

Alternatively, the OLED can be top-emitting (substrate is opaque, emitting through transparent top electrode); both anode top and cathode bottom and reverse can be used.

Can be used with OLEDs on glass, quartz, metal, plastic foils, metal foils, etc.

Inventor's Signature: _____ Witness' Signature: _____

Date: 30 Sep 01 Date: 10/1/01

THIS INVENTION DISCLOSURE IS SIEMENS PROPRIETARY INFORMATION, AND IS CONFIDENTIAL. THIS DISCLOSURE, AND ITS SUBJECT MATTER, MAY NOT BE DISCLOSED IN WHOLE OR IN PART TO ANYONE OUTSIDE OF SIEMENS EXCEPT AS APPROVED UNDER SIEMENS CORPORATE PROCEDURES

SUPPLEMENTAL SHEET FOR INVENTION DISCLOSURE

Can be used for active matrix, passive matrix, segmented, alpha-numeric or backlight OLED displays or any combinations thereof or generally any OLED light source or display.

The organic layers used in the invention are generally known in the prior art, e.g. the PML prior art and the UV-curable monomer and monomer mixes (generally UV-curable compositions); could also be Parylene coatings or other organic coatings that can be deposited in any suitable manner on the OLED without damaging it. Generally organic layers that are carefully outgased to remove oxygen, moisture and any other reactive mobile species that coat the OLED substrate largely conformally. UV-curable materials are widely known in the prior art (see PML patent literature, see UV-curable printing inks in e.g. www.markem.com or www.vanet.hitachi.co.jp, or D. J . Hayes et al, Journal of the SID, Vol 9/1, 2001 or Hue P. Le, The Society for Imaging Sciences and Technology, Vol 42, No1, Jan/Feb 1998).

NOTE ADDED: can also be e.g. e-beam cu or therm cur

The barrier layer of the invention is typically a dielectric such as a SiOx, AlOx, SiNx, AlNx, SiOxNy, ITO, ZnOx, Al-doped ZnOx, etc. – generally any high barrier dielectrics (or conductive oxides).

In cases in which the fabricated display is bottom-emitting (through the substrate) and the encapsulation does not have to be transparent, metal films or non-transparent or colored dielectric films can be used as the barrier layer.

The deposition of the barrier layer can be any suitable method known in the prior art to deposit dielectric layers, e.g. sputtering or reactive sputtering (DC, AC, pulsed, combinations thereof, etc.). Evaporation of such dielectrics (resistive heating or electron-beam) or metal films is possible also and so are ion-beam assisted deposition methods or other plasma-enhanced deposition methods.

CLAIMS (aspects of the invention, embodiments; please note that for all of the below-mentioned it is understood that there can be several sequences (multi-layers) of organic + barrier layer):

1. A process for directly encapsulating a multitude of OLED devices fabricated on an undevided substrate sheet (can be foil) by putting the encapsulation layer directly (in contact with) on the top-most layer of the to-be encapsulated OLED displays and by using a combination of at least one organic layer and at least one inorganic barrier layer whereby said organic layer is deposited / condensed on the OLED substrate in the form of an unpatterned liquid film; whereby: the unpatterned liquid film is cross-linked in a patterned manner, non-cross-linked areas are subsequently removed, followed by the deposition, in a patterned manner, of a barrier layer over at least part of the layer covered with the cross-linked organic layer.
2. As claim 1 whereby flash evaporation is used to deposit the organic layer (as in PML technology of the prior art).
3. As claim 1 whereby dip-, roll-, blade-coating is used to deposit the organic layer.
4. As claim 1 whereby spin-coating is used to deposit the organic layer.
5. As claim 1 whereby evaporation is used to deposit the organic layer.
6. As claim 1 whereby cross-linking of the organic in a patterned manner is achieved by UV flood-exposure through a mask with the mask being less than 5 and preferably less than 1 and better still less than 0.5 mm away from the OLED substrate.
7. As claim 1 whereby cross-linking of the organic in a patterned manner is achieved by selective UV exposure through an optical patterning system such as a projection exposure system.
8. As claim 1 whereby cross-linking of the organic in a patterned manner is achieved by selective UV exposure with a UV-beam scanning system.
9. As claim 1 whereby the non-exposed areas (non-cross-linked) are removed by thermal evaporation (heating the substrate); can be short higher temperature pulse (e.g. by putting the OLED plate onto hotplate).
10. As claim 1 whereby the non-exposed areas (non-cross-linked) are removed by pumping in vacuum.

Inventor's Signature: _____ Witness' Signature: _____

Date: 30/8/01 Date: 10/1/01

THIS INVENTION DISCLOSURE IS SIEMENS PROPRIETARY INFORMATION, AND IS CONFIDENTIAL. THIS DISCLOSURE, AND ITS SUBJECT MATTER, MAY NOT BE DISCLOSED IN WHOLE OR IN PART TO ANYONE OUTSIDE OF SIEMENS EXCEPT AS APPROVED UNDER SIEMENS CORPORATE PROCEDURES

SUPPLEMENTAL SHEET
FOR INVENTION DISCLOSURE

11. Combination of claim 9 and 10.
12. As claim 1 whereby the non-exposed areas (non-cross-linked) are removed by immersion in rinse-tank (washing off), spray-rinsing, ultra-sonicing (dry or wet ultra-sonic), mega-sonic (dry or wet); combination of dry ultra-sonic or mega-sonic in vacuum. CLG "WET" TO LIQUID
13. As claim 1 whereby the removal of the non-cross-linked areas of the organic layer is assisted by a plasma process (even if this removes also some of the cross-linked area as long as the rate for the removal of the non-cross-linked material is larger than that for the cross-linked material).
14. As claim 1 whereby the barrier layer (materials and deposition methods see above) is sputtered through a shadow mask over the area of UV-cured organic. → maybe add: barrier = dielectr barrier = metal addi
15. As claim 14 whereby the barrier layer is slightly larger in x and y to cover also the edges of the organic layer. Note (for the description of the invention): we should state somewhere that because of optical effects the UV-exposed organic is likely not to have a sharp step (e.g. a round/sloped profile instead) and this is advantageous when depositing the barrier layer on top to assure good side-step coverage.
16. As claim 1 whereby the process is used to encapsulate only the organic light-emissive areas (e.g. pixels) of the display and all contact pads and/or auxiliary encapsulation areas (e.g. for secondary encapsulation) and/or scribe/break areas are left free from the organic layer and the barrier layer.
17. New independent claim: As claim 1 but this time the organic is deposited and cured (if necessary) ALL OVER and only the barrier layer is deposited in a patterned manner, said patterned barrier layer also then acts as an etch stop to remove the organic over unwanted areas (i.e. the areas where the barrier layer is not deposited).
18. For claim 17 we can use all organic layer deposition methods as in claim 1 plus additional ones, namely:
19. As claim 17 whereby evaporation of one or more reactive organic molecules is used to deposit the organic layer, said reactive organic molecules forming a condensed conformal film on the substrate.
20. As claim 17 whereby the methods is as the 'Parylene' coating technology known in the prior art.
21. As claim 17 whereby the organic deposition is a plasma-assisted organic material deposition method.
22. As claim 17 whereby the organic that is subsequently not coated with the barrier is removed by an etching step.
23. As claim 22 whereby the etching is a chemical (dry or wet) etch process suitable to remove the organic.
24. As claim 22 whereby the etching is a plasma-assisted etch process suitable to remove the organic.
25. As claim 22 whereby the etching plasma contains oxygen.
26. As claim 22 whereby reactive ion-etching is used.
27. As claim 22 whereby anisotropic reactive ion-etching is used.
28. New independent claim: As claim 1 and 17 but now the organic itself is already during the deposition (by nature of the deposition process itself) deposited in a patterned manner, then curing of the organic (if necessary as e.g. for the UV-curable organics) then patterned deposition of the barrier, no need to remove e.g. non-UV-cured organic.
29. As claim 28 whereby the organic is deposited through a shadow mask using methods as described for claims 1 and 17.
30. As claim 28 whereby the organic is printed, in particular using screen-printing or ink-jet printing.
31. Any of the preceeding claims: all encapsulation process steps in inert atmosphere (reduced oxygen, ozone, other reactive gases and in particular moisture.
32. As claim 31 but only the first organic layer + first barrier layer 'dyad' in inert atmosphere.

Inventor's Signature: _____ Witness' Signature: _____

Date: 30 Sep 01 Date: 10/1/01

THIS INVENTION DISCLOSURE IS SIEMENS PROPRIETARY INFORMATION, AND IS CONFIDENTIAL. THIS DISCLOSURE, AND ITS SUBJECT MATTER, MAY NOT BE DISCLOSED IN WHOLE OR IN PART TO ANYONE OUTSIDE OF SIEMENS EXCEPT AS APPROVED UNDER SIEMENS CORPORATE PROCEDURES

SUPPLEMENTAL SHEET
FOR INVENTION DISCLOSURE

33. As claim 31 but only the first organic layer in inert atmosphere.
34. Independent claim (?) based on ALL preceeding claims: … whereby said OLED sheet with the encapsulation of the invention is encapsulated with a secondary encapsulation layer for additional encapsulation and/or mechanical protection.
35. As 34 whereby this is laminating or glueing a plastic or metal or metal+plastic foil or thin glass or thicker (rigid) glass or metal sheet over said OLED display sheet.
36. Finishing all off by singulation of the display (scribe and break) – may not be necessary..
37. As claims 34 – 36 but where the secondary encapsulation is done after singulation.
38.

One such example is shown in figure 1: attach Penang VDOT mask drawing with all layers.
Show barrier over the edge of the display → fig 3.

fig 2: concept of the invention

NB: added on 10 Oct 01:

with or without space between the OLED sheet & the cover (the 2nd encaps sheet.

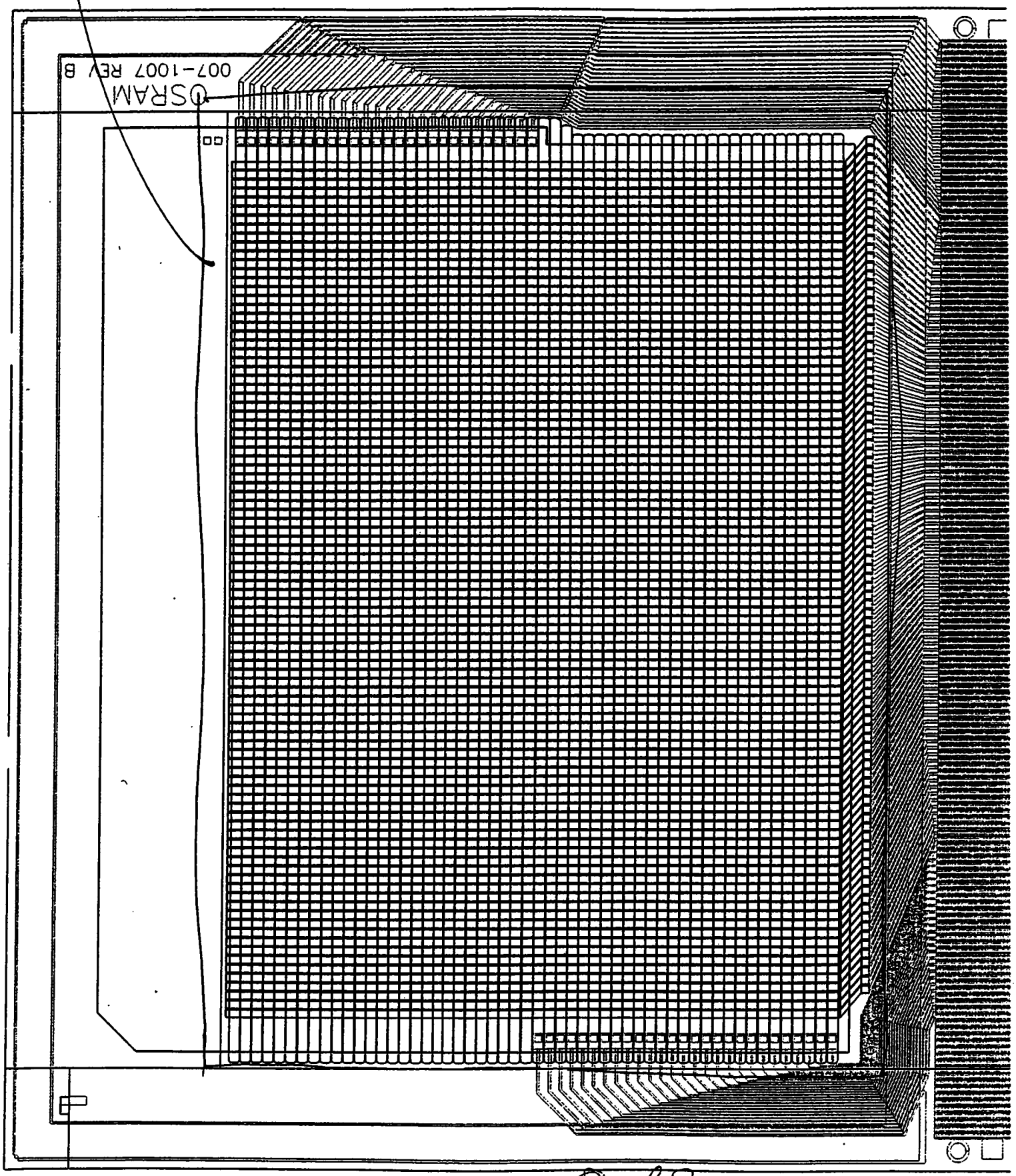
Inventor's Signature: [signature]
Date: 30 Sep 01

Witness' Signature: [signature]
Date: Oct 1, 2001

THIS INVENTION DISCLOSURE IS SIEMENS PROPRIETARY INFORMATION, AND IS CONFIDENTIAL. THIS DISCLOSURE, AND ITS SUBJECT MATTER, MAY NOT BE DISCLOSED IN WHOLE OR IN PART TO ANYONE OUTSIDE OF SIEMENS EXCEPT AS APPROVED UNDER SIEMENS CORPORATE PROCEDURES

Cover with escaps. or pure & dielectric (or metal)

Pip 1



Homer [signature]
10/1/01

P 8 of 9
[signature], 30 8/01

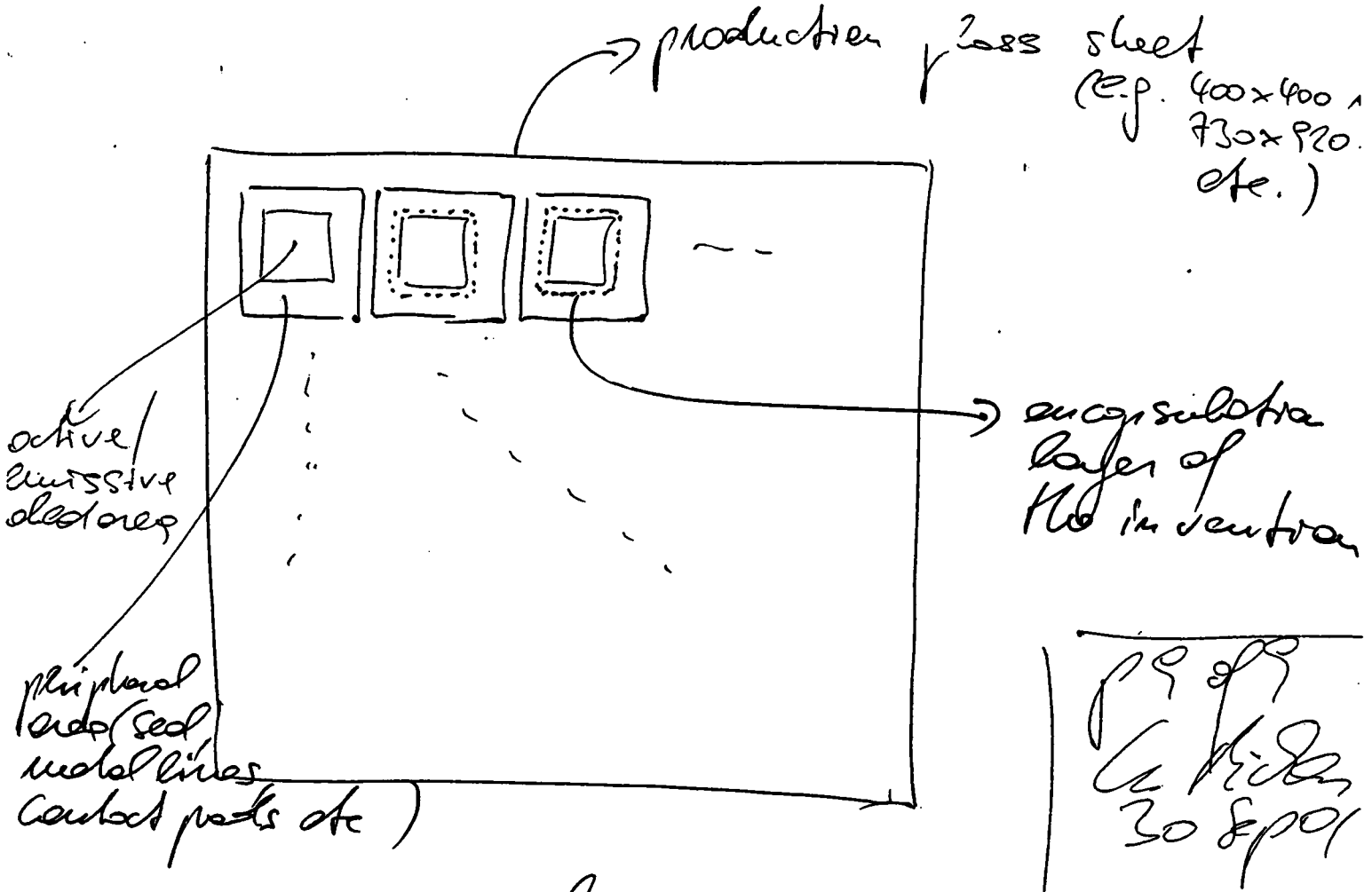


Fig 2

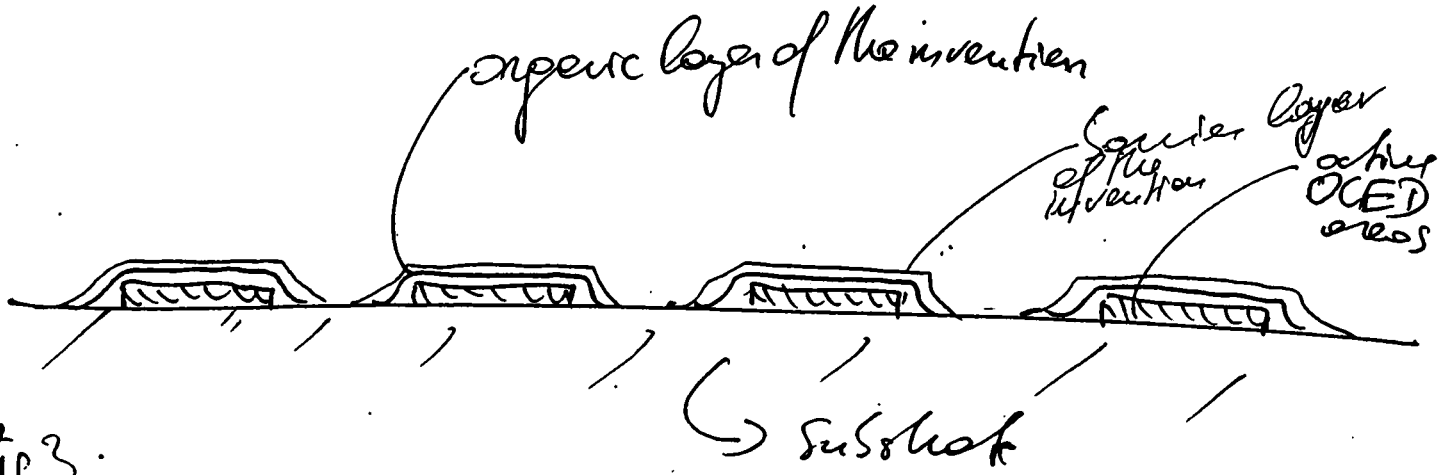


Fig 3:

10/1/01

PROJECT

Notebook No. 67

Continued From Page

IDEA: 14 Aug 01 (during Tanny Pines (i.j. seminar))

Problem: cost effective, efficient, simple — Oled encap

apparently: high throughput / fast / cheap industrial ink-jet printing of liquid monomers that are UV-cross-linkable is well known (acc. to Tanny Pines, Heidelberger Druckmaschinen make/use such machines)

acc. to Tanny Pines

Oled field: encaps. is a big issue

→ one of the solutions → use of PTL

but: PTL NOT simple (vac flash evap process)

→ temp control problems

→ heat from source

→ not patterned (e.g. cathode also contact pads etc.)

NOTE: I had this idea quietly during the seminar → NOT discussed with any one

idea/invention: → use ↓ to ink jet liquid mono in patterned fashion over active oled area → x-link → patterned (e.g. shutter through shadow mask) dielectric (metal dep (can reject))

Continued on Page

Read and Understood By

[signature] 14 Aug 01 [signature] 1/10/01

Signed Date Signed Date

Pictiva EX2006-p. 52
Samsung v Pictiva
IPR2024-01222

PROJECT

Notebook No. 07

Continued From Page

~~Idea~~ IDEA: 15 Aug 01

↳ BUT: have been "carrying" this idea around with me for ~ 2.5 y (told Kyle, & others) → see e.g. (8 ket

→ issue: use of PTL to encapsulate OLED

→ problem: liquid monomer (to be x-linked by UV) goes everywhere (also where not wanted, e.g. on contact pads, seal frame, etc.)

idea/solve: → PTL → coat monomer liquid film (flash evap)

↳ UV-cross-link through Mask

→ remaining liquid film gets evaporated/washed etc off

→ Sputter encapsulating film on (evap.) top also through mask → may repeat.

→ achieve: encaps OLED active area but leave contact pads etc free

Continued on Page

Read and Understood By

K. Pfeifer — Signed — 15 Aug 01 — Date — Signed — 01/10/01 — Date

Pictiva EX2006-p. 53
Samsung v Pictiva
IPR2024-01222