



Petitioner's Oral Argument Demonstratives

IPR2024-00761

U.S. Patent No. 7,487,684

Before Administrative Patent Judges

- Jennifer S. Bisk
- John A. Hudalla
- Alyssa A. Finamore

Grounds of Unpatentability



US007487684B2

(12) **United States Patent**
Gupta et al.

(54) **GLASS-MODIFIED STRESS WAVES FOR SEPARATION OF ULTRA THIN FILMS AND NANO-ELECTRONICS DEVICE FABRICATION**

(75) Inventors: **Vijay Gupta**, Sherman Oaks, CA (US);
Vassili A Kireev, Sunnyvale, CA (US)

(73) Assignee: **The Regents of the University of California**, Oakland, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 40 days.

(21) Appl. No.: **11/504,981**

(22) Filed: **Aug. 15, 2006**

(65) **Prior Publication Data**
US 2007/0039395 A1 Feb. 22, 2007

Related U.S. Application Data

(63) Continuation of application No. PCT/US2005/007304, filed on Mar. 7, 2005.

(60) Provisional application No. 60/550,803, filed on Mar. 5, 2004.

(51) Int. Cl. **G01L 1/24** (2006.01)

(52) U.S. Cl. **73/800**

(58) **Field of Classification Search** 73/777, 73/862.49; 356/35.5

See application file for complete search history.

(10) **Patent No.:** **US 7,487,684 B2**

(45) **Date of Patent:** **Feb. 10, 2009**

(56) **References Cited**
U.S. PATENT DOCUMENTS

4,353,649 A * 10/1982 Kishii 356/33

4,722,600 A * 2/1988 Chiang 356/32

5,199,304 A * 4/1993 Ferguson 73/800

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6,219,139 B1 * 4/2001 Lesniak 356/32

6,327,030 B1 * 12/2001 Ijja et al. 356/32

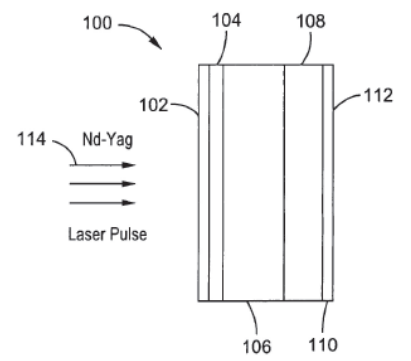
6,466,308 B1 * 10/2002 Jaing et al. 356/35.5

* cited by examiner

Primary Examiner—Edward Lefkowitz
Assistant Examiner—Octavia Davis
(74) *Attorney, Agent, or Firm*—John P. O'Banion

(57) **ABSTRACT**

A device for generating a tensile force between a substrate and a coating, wherein the substrate has a thickness defined by a first side and a second side in a first axis, and the coating is applied to the first side of the substrate such that the coating and substrate are axially spaced along the first axis in intimate facing contact with each other to form a coating/substrate interface. The apparatus has a glass element disposed on the second side of the substrate and axially spaced along the first axis. The glass element is configured to propagate a stress wave to the coating/substrate interface to generate a tensile force between the substrate and the coating.



Boeing Ex. 1001, p. 1 of 21
Boeing v. Regents Univ. Cal.

Ground	Claims	Basis for Unpatentability
1	1-22	§ 102 – Wang-Dissertation (Ex-1005)
2	4, 6, 9, 15, 17, 20, 23-24	§ 103 – Wang-Dissertation
3	1-24	§ 103 – Wang-Dissertation in view of Gupta-1992 (Ex-1011)
4	1-8, 10-19, 21-22	§ 102 – Gupta-1992
5	9, 20	§ 103 – Gupta-1992 in view of Gupta-1993 (Ex-1013)
6	4, 6, 10, 15, 17, 23-24	§ 103 – Gupta-1992
7	1-24	§ 103 – Wang-2002 (Ex-1016) in view of Gupta-1992

Ex-1001

Paper 1 (Pet.) at 3
Boeing Ex. 1057, p.2 of 46
Boeing v. Regent Univ Cal.



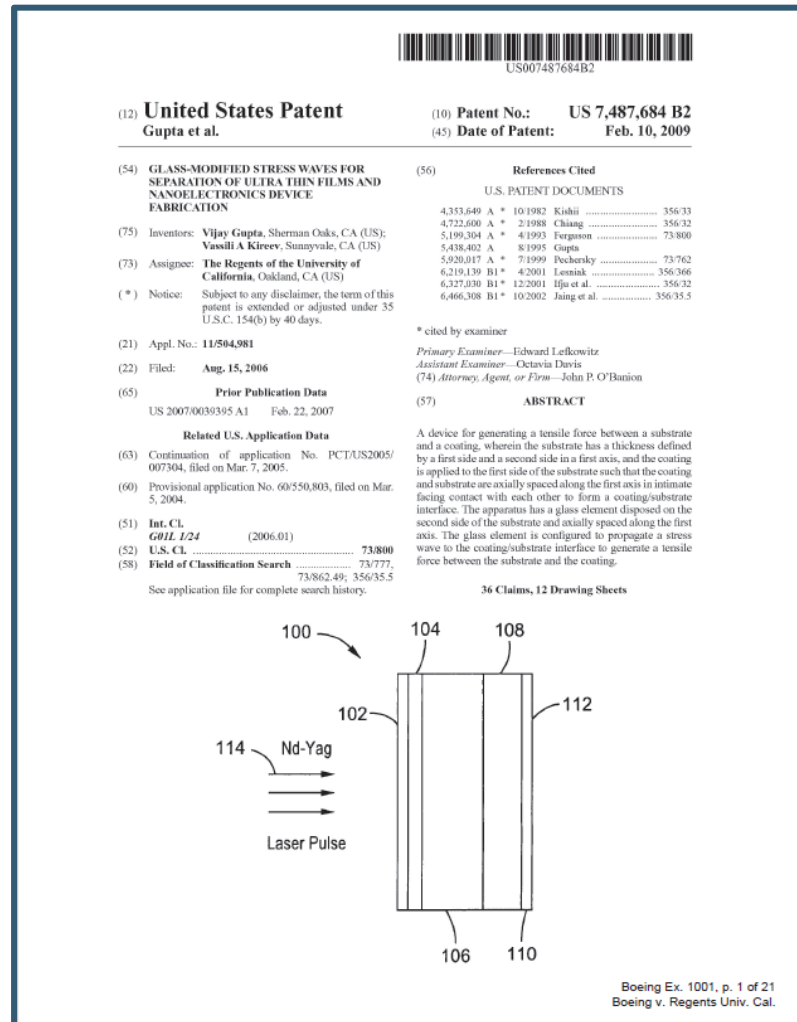
Overview

1. Technology Background

2. Wang-Dissertation is Prior Art

3. Wang-Dissertation Discloses the Challenged Claims

4. Gupta 1992 Discloses the Challenged Claims



Ex-1001



Boeing Ex. 1057, p.3 of 46
Boeing v. Regent Univ Cal.

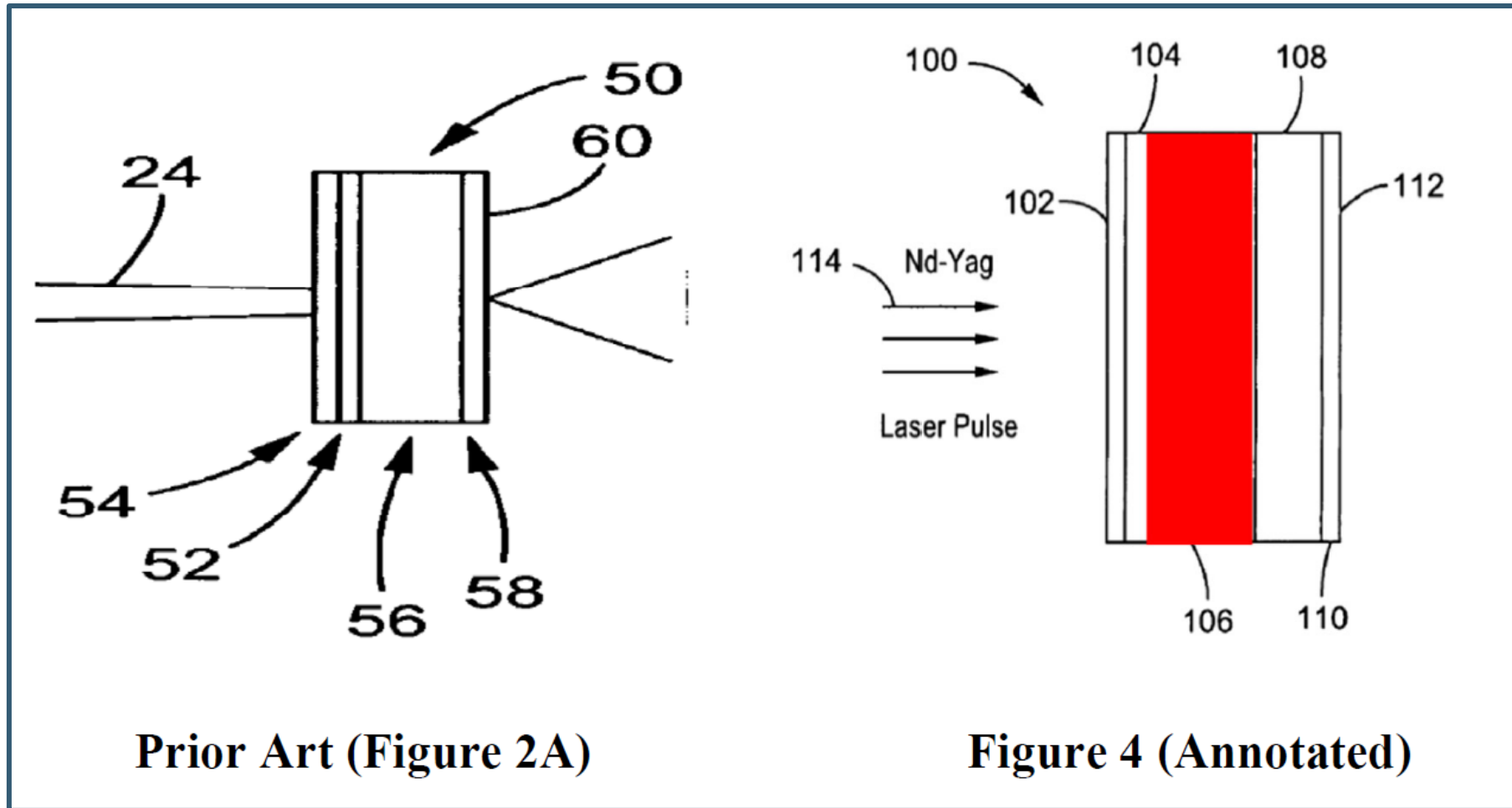
PDX-3

Background

Boeing Ex. 1057, p.4 of 46
Boeing v. Regent Univ Cal.



Background – '684 Patent



Paper 1 (Pet.) at 11 (citing Ex-1001 at Fig. 2A, Fig. 4)

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Boeing v. Regent Univ Cal.

Glass Element – '684 Patent

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No. : 11/504,981 Confirmation No.: 4584
Applicant : VIJAY GUPTA
Title : GLASS-MODIFIED STRESS WAVES FOR SEPARATION OF
ULTRA THIN FILMS AND NANOELECTRONICS DEVICE
FABRICATION
Filed : 08/15/2006
TC/A.U. : 2855
Examiner : DAVIS, OCTAVIA L.
Docket No. : UC03-126-2US
Cust. No. : 8156

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

RESPONSE TO NON-FINAL OFFICE ACTION

Dear Sir:

In response to the Non-Final Office Action mailed on November 28, 2007, please amend the above-identified U.S. patent application as follows:

Amendments to the Claims are reflected in the listing of claims, which begins on page 2 of this paper.

Remarks begin on page 9 of this paper.

Page 1
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Glass-Modified Stress Waves

The glass stress wave modification element is particularly important to this invention, as it has been found that with sufficiently high pulse pressures, glass materials tend to modify an input stress wave to where it has a virtually instantaneous post-peak drop time, resulting in a “rarefaction shock”.

It is believed that this behavior results from certain glass-like materials being “anomalous materials”, which, with sufficiently high pressure stress waves with a short enough duration, enters a regime of stress wave propagation where the velocity of the stress wave decreases with increasing pressure. This property has the effect of compressing the tail end of a propagated shock, resulting in a “rarefied shock” pulse tail.

In AMENDMENT FIG. 1, which is an annotated FIG. 4 from the present application, one sees an important principle of operation in this invention, which is that the stress wave propagates through a glass substrate, rather than merely using a glass substrate as a confinement for generating a wave launched directly into a substrate.

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Boeing v. Regent Univ Cal.

Ex-1002 at 77, 79; Paper 1 (Pet.) at 12



Wang-Dissertation Prior Art

THIN-FILM ADHESION MEASUREMENT BY LASER-INDUCED STRESS WAVES

BY

JUNLAN WANG

B.S., University of Science and Technology of China, 1994
M.E., University of Science and Technology of China, 1997

THESIS

Submitted in partial fulfillment of the requirements
for the degree of Doctor of Philosophy in Theoretical and Applied Mechanics
in the Graduate College of the
University of Illinois at Urbana-Champaign, 2002

Urbana, Illinois

Boeing Ex. 1005, p. 3 of 171
Boeing v. Regents Univ. Cal.

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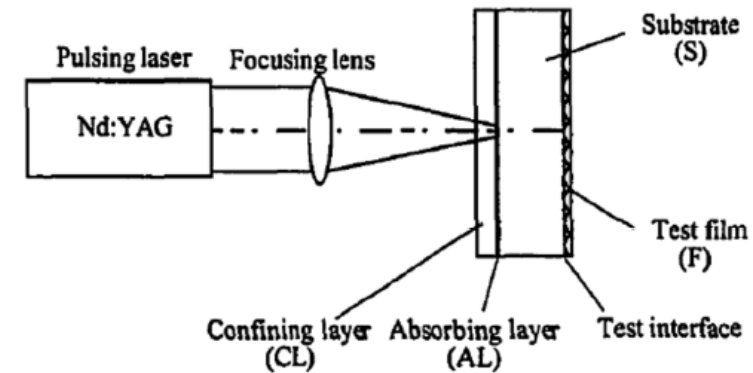


Figure 2.1: Schematic of the tensile laser-spallation technique.

strate is determined for both tensile and mixed-mode loading cases. Fused silica is found to be an ideal substrate material for launching high-amplitude shock waves (its negative nonlinear elasticity being critical for the development of a decompression shock). By inserting an extra layer of the desired substrate material between the fused silica and the thin film, the current technique can be used to test a variety of substrates and films, especially those of interest to the microelectronics industry, such as polyimide, copper (Cu), aluminum (aluminum) and polysilicon on single-crystal silicon substrates.

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Paper 1 (Pet.) at 15; Ex-1005 at Fig. 2.1; 45, 124

PDX-8

Wang-Dissertation is Prior Art

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Boeing v. Regent Univ Cal.



Wang-Dissertation Overview

THIN-FILM ADHESION MEASUREMENT BY LASER-INDUCED STRESS WAVES

BY

JUNLAN WANG

B.S., University of Science and Technology of China, 1994
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Urbana, Illinois

Boeing Ex. 1005, p. 3 of 171
Boeing v. Regents Univ. Cal.

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This dissertation investigates the feasibility of using laser-generated stress waves to produce mixed-mode failure of thin-film interfaces and to characterize quantitatively the interfacial adhesion strength.

In Chapter 2, theoretical analysis is developed to gain insights of the wave-generation mechanism following a laser pulse deposition at the interface between two adjacent materials, the subsequent geometric attenuation due to finite YAG source size, the development of a decompression shock in a fused-silica substrate, and the associated shock attenuation.

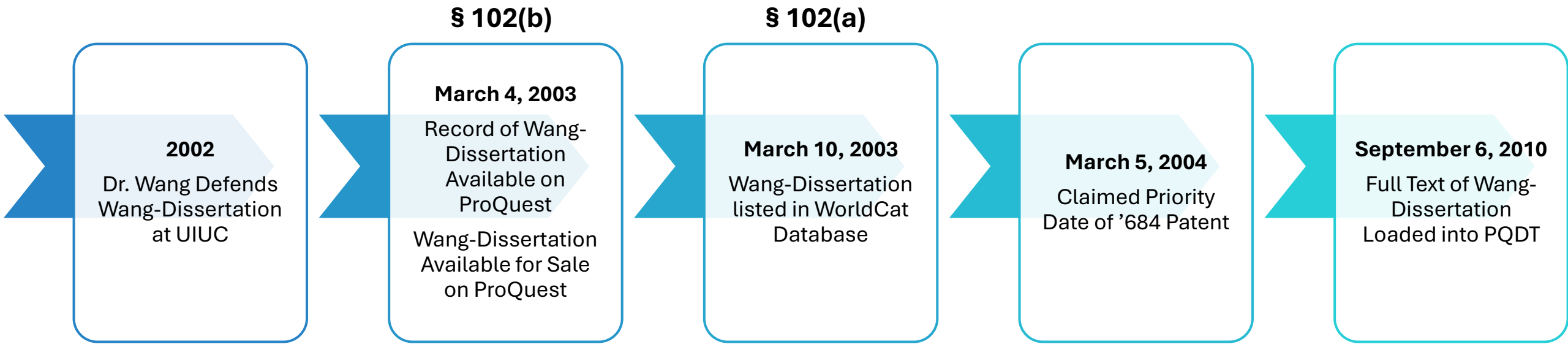
In Chapter 3, a parametric study on the tensile laser spallation was carried out. The spallation behavior of aluminum thin films was investigated as a function of substrate thickness, film thickness, confining layer thickness, laser energy, and various parameters governing the source. Two different substrate materials—single crystal silicon (100) and fused silica—were studied. The parametric study results reveal important design parameters for improving the

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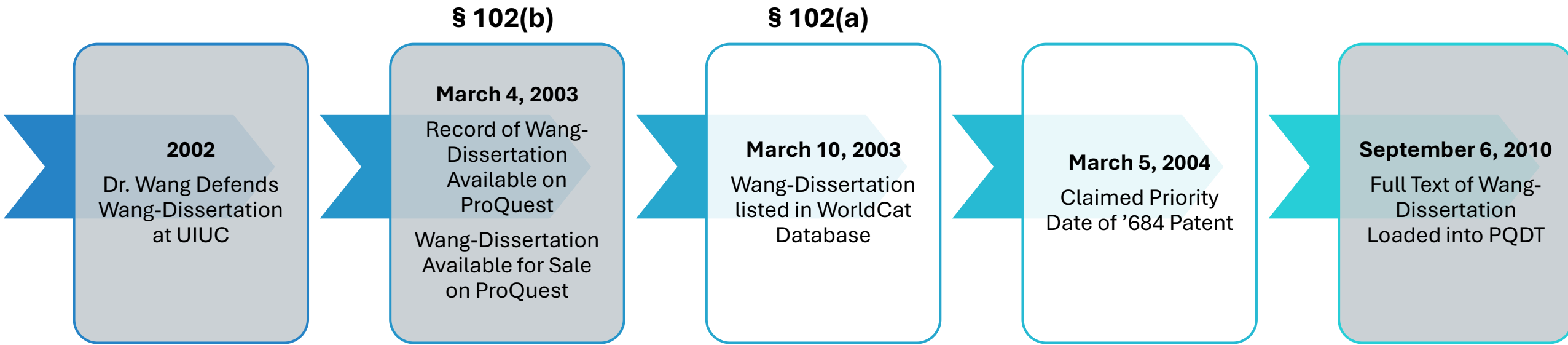
Boeing v. Regent Univ Cal.

Paper 1 (Pet.) at 13-15; Ex-1005 at 4-5

Wang-Dissertation is Prior Art Under §§ 102(a) and 102(b)



Wang-Dissertation is Prior Art Under §§ 102(a) and 102(b)



March 10, 2003 – Wang-Dissertation OCLC FirstSearch Record

7. Page 4 is the MARC record. The first six digits of Field 008 show the record was created on “030310” (*i.e.*, March 10, 2003), and the code of “s2002” following the record creation date indicates this work has a single publication date of 2002. Subfields “a” and “c” of Field 040 show “UIU” created the record and entered it into the OCLC WorldCat database. According to the *Directory of OCLC Members* (<https://www.oclc.org/en/contacts/libraries.html>), “UIU” is the OCLC library symbol for the library system of the University of Illinois, Urbana-Champaign. Fields 008 and 040 inform my opinion that the library system of the University of Illinois, Urbana-Champaign created an original record for the Wang dissertation on March 10, 2003, making it discoverable in their online catalog from that date on.

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001 991098774209705816
005 20200411094820.0
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035 ##$a6751514-01carli_network
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100 1#$aWang, Junlan, $d1971-
245 10$aThin-film adhesion measurement by laser-induced stress waves / $cby Junlan Wang
246 3#$aThin film adhesion measurement by laser induced stress waves.
260 ##$c2002.
300 ##$axiii, 154 leaves, bound : $bill. ; $c29 cm.
500 ##$aPrintout.
502 ##$aThesis (Ph. D.)--University of Illinois at Urbana-Champaign, 2002.
500 ##$aVita.
504 ##$aIncludes bibliographical references (leaves 146-153)
530 ##$aAvailable on microfilm from Pro Quest Information and Learning.
690 ##$aTheses $xUIUC $y2002 $xTheoretical and Applied Mechanics.
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March 10, 2003 – Wang-Dissertation OCLC FirstSearch Record

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Paper 25 (PR) at 12-13; Ex-1041, ¶12

Title: Thin-film adhesion measurement by laser-induced stress waves Author: Wang, Junlan Accession Number: 51821449		
Libraries with Item: "Thin-film adhesion measur..." (Record for Item Get This Item)		
<u>Location</u>	<u>Library</u>	<u>Code</u>
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US,MI	PROQUEST LLC	UMI

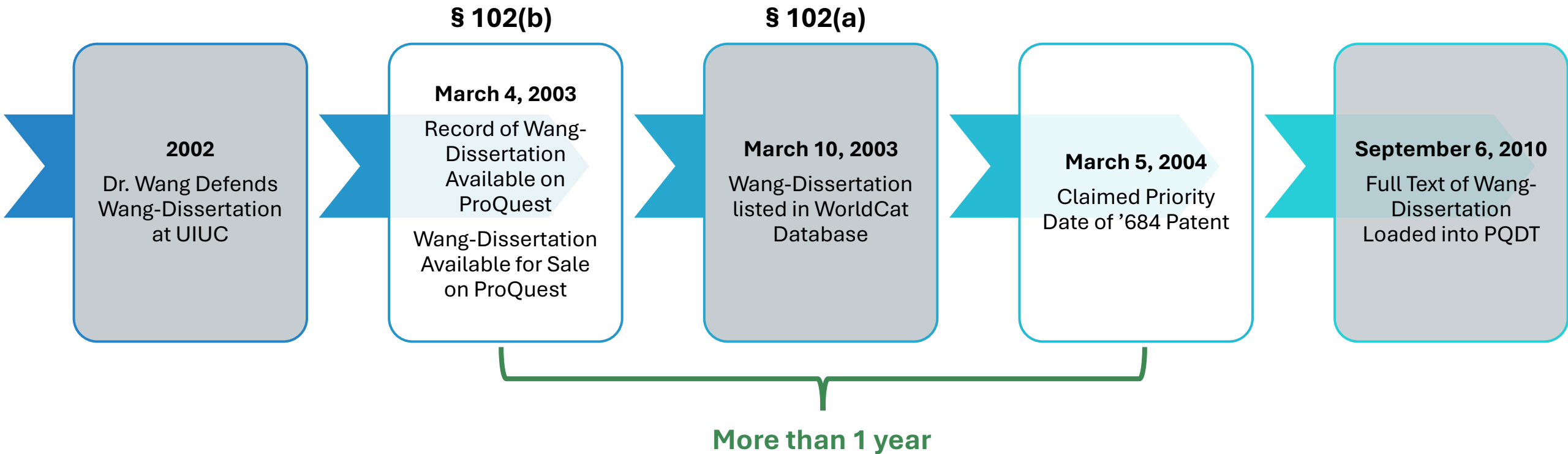
Title: Thin-film adhesion measurement by laser-induced stress waves / Author(s): Wang, Junlan, 1971- Year: 2002 Description: xiii, 154 leaves, bound : illustrations ; 29 cm Dissertation: Ph. D.; University of Illinois at Urbana-Champaign; 2002 Language: English Access: Materials specified: ProQuest, Abstract http://gateway.proquest.com/openurl?url_ver=Z39.88-2004&rft_val_fmt=info:ofi/fmt:kev:mtx:dissertation&res_dat=xri:pqm&rft_dat=xri:pqdiss:3070468

Note(s): Printout./ Vita./ Includes bibliographical references (leaves 146-153)./ Available on microfilm from Pro Quest Information and Learning. Class Descriptors: Dewey: 620.1 Responsibility: by Junlan Wang. Material Type: Thesis/dissertation (deg); Manuscript (mss) Document Type: Book; Archival Material Date of Entry: 20030310 Update: 20231128 Accession No: OCLC: 51821449 Database: WorldCat

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Paper 25 (PR) at 12-13; Boeing v. Regent Univ. Cal. Ex-1043, ¶12, Ex-1045

Wang-Dissertation is Prior Art Under §§ 102(a) and 102(b)



March 4, 2003 – Wang-Dissertation “Record” Publishes

Record Contents

Abstracts International Database ("Abstract Database").¹ A “Record” consists of an abstract, index record, and citation information including title, author name, degree granting institution and degree date.

Paper 25 (PR) at 7; Ex-1037 at 1-2

OCLC. In 1987, ProQuest began to offer the Abstract Database on CD ROM. In 1997, ProQuest made available the contents of the Abstract Database in its ProQuest® Digital Dissertations and Theses database (“PQDT”), which is accessible via the world wide web to authenticated subscribers. The Abstract Database allows for text searching of the Records, including the title, author, index terms and the abstract.

Paper 25 (PR) at 7; Ex-1037 at 2

monthly basis. Once a Record is published on the Abstract Database, the Record is available to the students, faculty, staff and/or patrons of any institutions that subscribe to the Abstract Database. At the time of publication the Abstract Database was

Paper 25 (PR) at 7-8; Ex-1037 at 2

Record Availability

10. As of 03/04/2003, the title, author, granting institution, and degree date of the Dissertation, as shown in Paragraph 8 above, were available digitally on PQDT, as part of the Record for the Dissertation.
11. Also, as of 03/04/2003, the Abstract of the Dissertation was available digitally on PQDT, as part of the Record for the Dissertation.
12. As of 03/04/2003, PDQT could be searched electronically for the Record of the Dissertation, so that, for example, the Dissertation Record could be found in PDQT by searching for words and phrases from the title.

Paper 25 (PR) at 7; Ex-1037 at 3

14. At the time of the Dissertation’s publication on 3/4/2003, the Record of the Dissertation was made available directly from ProQuest in electronic format and online via third party vendors, possibly including Dialog, as part of the Abstract Database which was made available via such vendors in the ordinary course of business.

Paper 25 (PR) at 7; Ex-1037 at 3

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Full Text Availability

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DAI volume issue:	B 63/11
DAI publication month and year:	
Date full text is loaded into PQDT:	2010-09-06

Paper 25 (PR) at 7; Ex-1037 at 3; Ex-1035 at 3

7 A In ProQuest's system a sales transaction,
8 when work is published, it would follow the same
9 process as any other user, librarian or patron or
10 anyone interested in purchasing that document.
11 This was a paper submission that came in, and it
12 was not digitized until 2010, but anyone wanting
13 to purchase that document could do so as of the
14 date of publication which was in March 2003.

Paper 25 (PR) at 7-8; Ex-2004 at 44:7-14

20 Q So you referred now to publishing a
21 document. What do you mean by publishing a
22 document?

1 A There is a record of it in our system, and
2 that means it's published. When it's published,
3 there is the opportunity for anyone finding that
4 record to purchase a copy of the full text
5 dissertation or theses.

6 Q I see.

7 A So this was available for purchase in
8 March of 20 -- of 2003.

Paper 25 (PR) at 8; Ex-2004 at 41:20-42:8

Boeing Ex. 1057, p.17 of 46
Boeing v. Regent Univ Cal.



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12 A If someone wished to purchase a
13 dissertation in 2003, they could do so in multiple
14 ways. They could obtain one of our order forms
15 and submit it to us by sending it to
16 dispub@proquest.com, or they can send us an e-mail
17 directly and request assistance with ordering it,
18 or they could call our 800 number to place an
19 order over the phone with a credit card, or they
20 could go to the website, PQDT, and within that
21 database search for this title and click on a
22 button in that site that says "order a copy."

Paper 25 (PR) at 8-9; Ex-2004 at 46:12-22

1 Q And your knowledge as to that, that
2 procedure in 2003 is based on what?
3 A Training that I've had regarding works
4 published at that time.

Paper 25 (PR) at 9; Ex-2004 at 47:1-4



Full Text Searchability Not Required

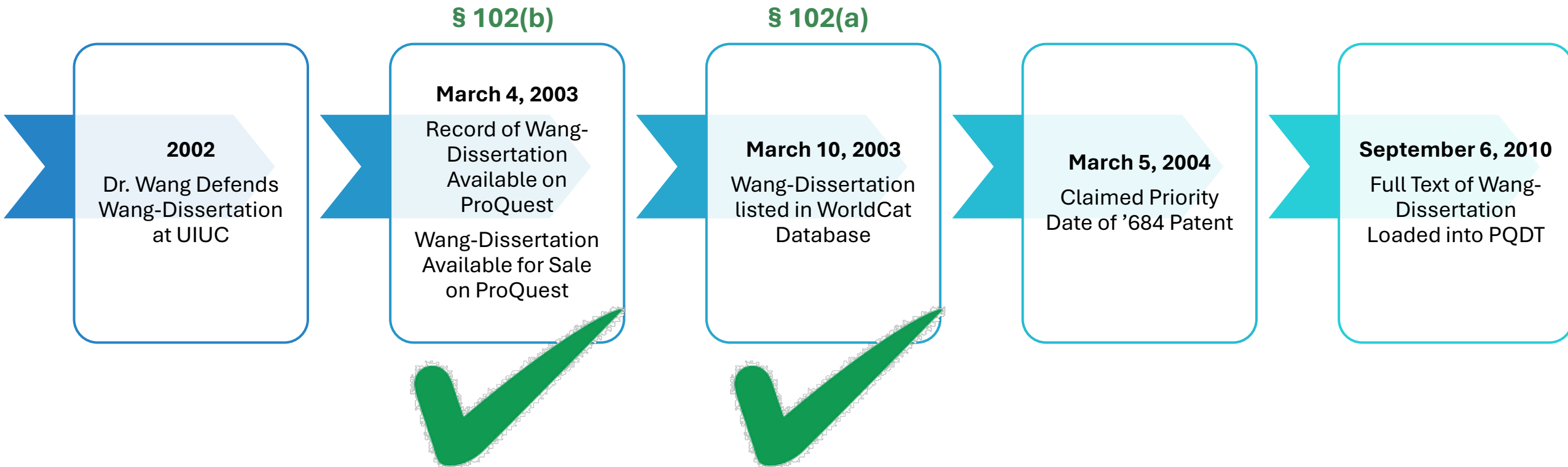
In re Lister, 583 F.3d 1307, 1315 (Fed. Cir. 2009)

- “Users of the Westlaw and Dialog databases could perform keyword searches of the titles, **but not the full texts**, of the works.”
- “A reasonably diligent researcher with access to a database that permits the **searching of titles by keyword** would be able to attempt several searches using a variety of keyword combinations.”
- “Accordingly, we conclude that **the Lister manuscript was publicly accessible as of the date that it was included in either Westlaw or Dialog, the databases that permitted keyword searching of titles.**”

M & K Holdings, Inc. v. Samsung Elecs. Co., 985 F.3d 1376, 1382 (Fed. Cir. 2021)

- “M&K's argument emphasizing the lack of full-content-search capability on the JCT-VC website also misses the mark. **A factor relevant to public accessibility is whether a repository indexes its documents or otherwise categorizes them by subject matter.** See *Blue Calypso*, 815 F.3d at 1349. The Board found that the documents in question on the meeting pages of the JCT-VC website were **effectively indexed by subject matter in light of the title-search functionality and the fact that Park and Zhou featured descriptive titles.** That finding supports the Board's conclusion that Park and Zhou were publicly accessible. See *In re Lister*, 583 F.3d 1307, 1314–17 (Fed. Cir. 2009) (concluding that a reference with a descriptive title was publicly accessible as of the date it was posted to an Internet database on which users “could perform keyword searches of the titles, but not the full texts, of the works”).”

Wang-Dissertation is Prior Art Under §§ 102(a) and 102(b)



Wang-Dissertation Discloses the Challenged Claims

Boeing Ex. 1057, p.21 of 46
Boeing v. Regent Univ Cal.



Overview of Wang-Dissertation

THIN-FILM ADHESION MEASUREMENT BY LASER-INDUCED STRESS WAVES

BY
JUNLAN WANG

B.S., University of Science and Technology of China, 1994
M.E., University of Science and Technology of China, 1997

THESIS

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Urbana, Illinois

Boeing Ex. 1005, p. 3 of 171
Boeing v. Regents Univ. Cal.

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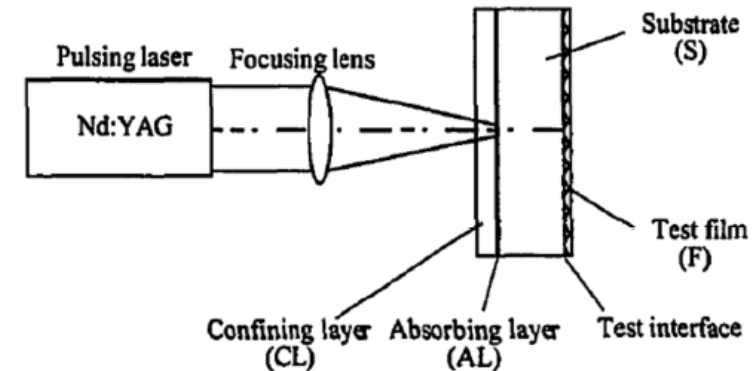


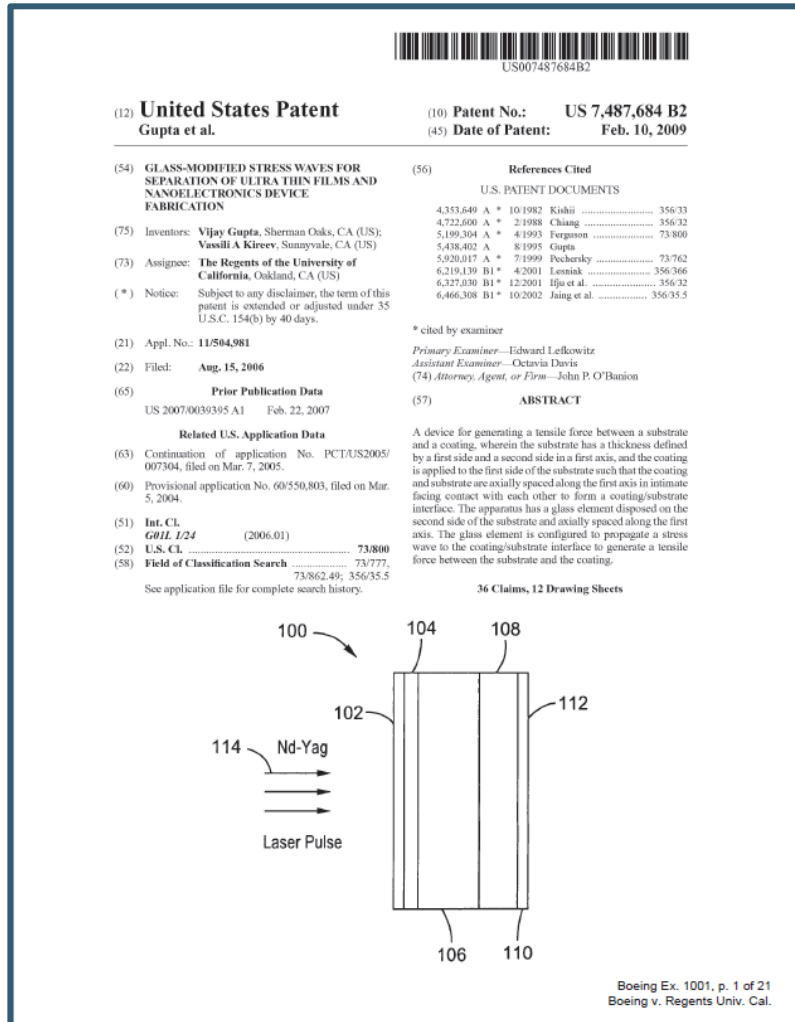
Figure 2.1: Schematic of the tensile laser-spallation technique.

strate is determined for both tensile and mixed-mode loading cases. Fused silica is found to be an ideal substrate material for launching high-amplitude shock waves (its negative nonlinear elasticity being critical for the development of a decompression shock). By inserting an extra layer of the desired substrate material between the fused silica and the thin film, the current technique can be used to test a variety of substrates and films, especially those of interest to the microelectronics industry, such as polyimide, copper (Cu), aluminum (aluminum) and polysilicon on single-crystal silicon substrates.

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Boeing v. Regent Univ Cal.

Paper 1 (Pet.) at 15; Ex-1005 at 45, 124

Wang-Dissertation Discloses the Challenged Claims



1[pre]. An apparatus for generating a tensile stress between a substrate and a coating, comprising:

1[a]. a substrate having a thickness, said thickness defined by a first side and a second side in a first axis;

1[b]. a coating applied to the first side of the substrate such that the coating and substrate are axially spaced along the first axis in intimate facing contact with each other such to form a coating/substrate interface; and

1[c]. a glass element disposed on the second side of the substrate and axially spaced along the first axis;

1[d]. wherein the glass element is configured to propagate and modify a stress wave to the coating/substrate interface to generate a tensile stress between the substrate and the coating.

Wang-Dissertation Discloses Limitation 1[Pre]

1[pre]. An apparatus for generating a tensile stress between a substrate and a coating, comprising:

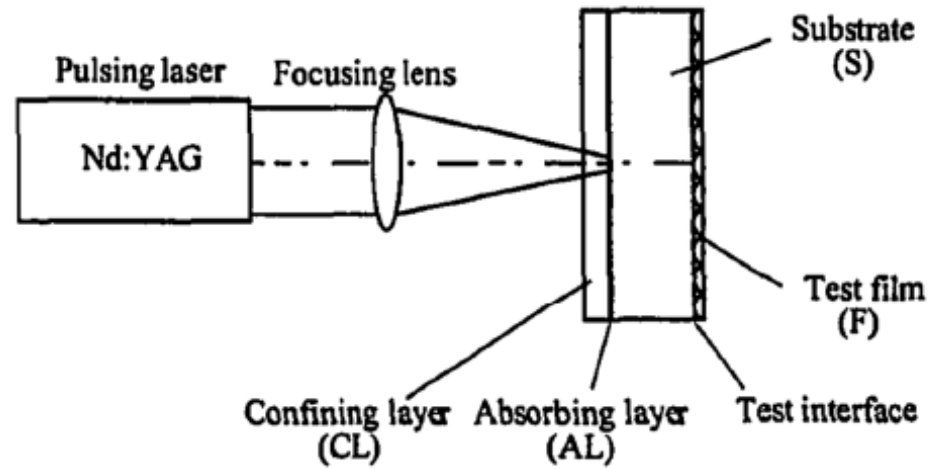
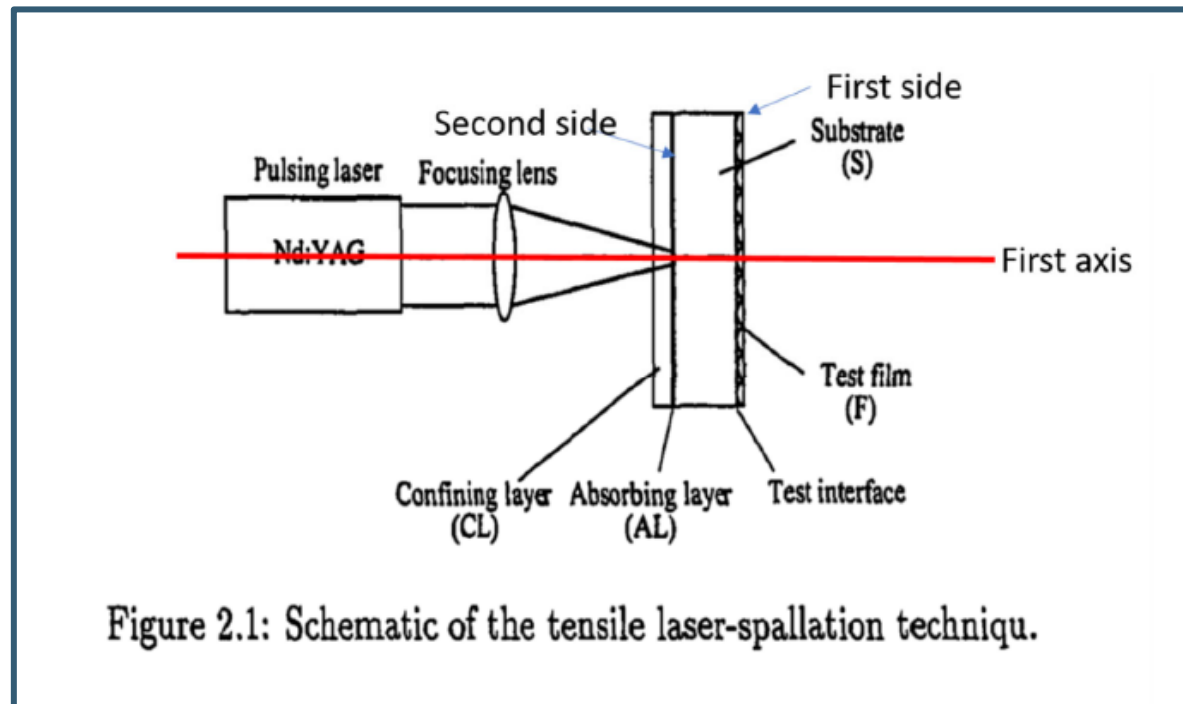


Figure 2.1: Schematic of the tensile laser-spallation technique.

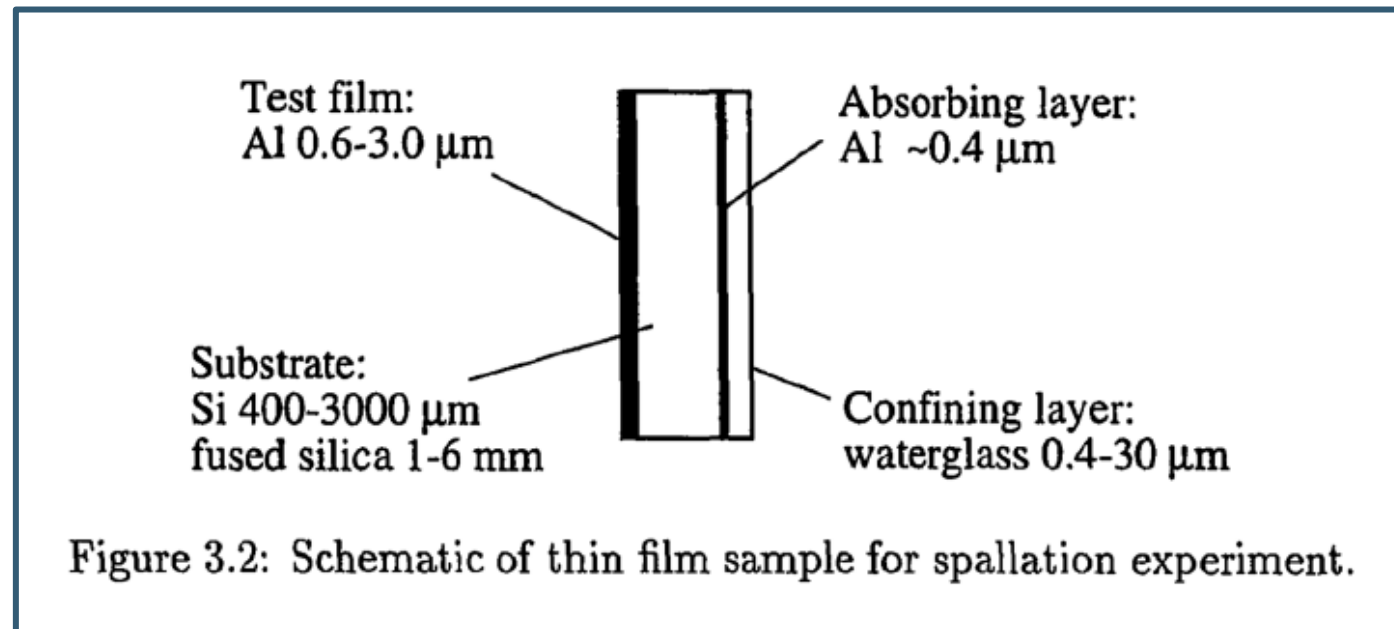
Wang-Dissertation Discloses Claim Limitation 1[a]

1[a]. a substrate having a thickness, said thickness defined by a first side and a second side in a first axis;



Wang-Dissertation Discloses Claim Limitation 1[b]

1[b]. a coating applied to the first side of the substrate such that the coating and substrate are axially spaced along the first axis in intimate facing contact with each other such to form a coating/substrate interface; and



Wang-Dissertation Discloses Claim Limitation 1[c]

1[c]. a glass element disposed on the second side of the substrate and axially spaced along the first axis;

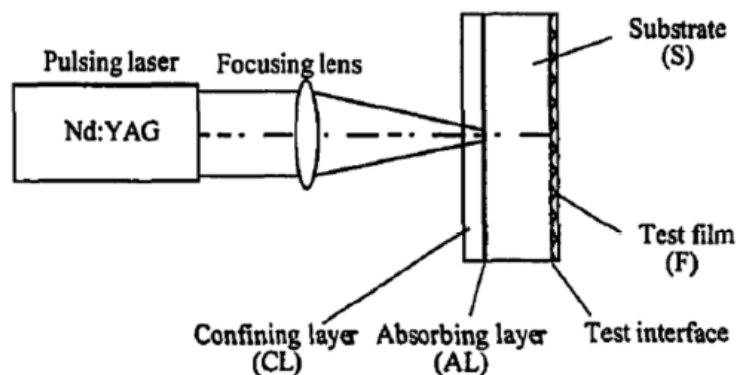


Figure 2.1: Schematic of the tensile laser-spallation technique.

strate is determined for both tensile and mixed-mode loading cases. Fused silica is found to be an ideal substrate material for launching high-amplitude shock waves (its negative nonlinear elasticity being critical for the development of a decompression shock). By inserting an extra layer of the desired substrate material between the fused silica and the thin film, the current technique can be used to test a variety of substrates and films, especially those of interest to the microelectronics industry, such as polyimide, copper (Cu), aluminum (aluminum) and polysilicon on single-crystal silicon substrates.

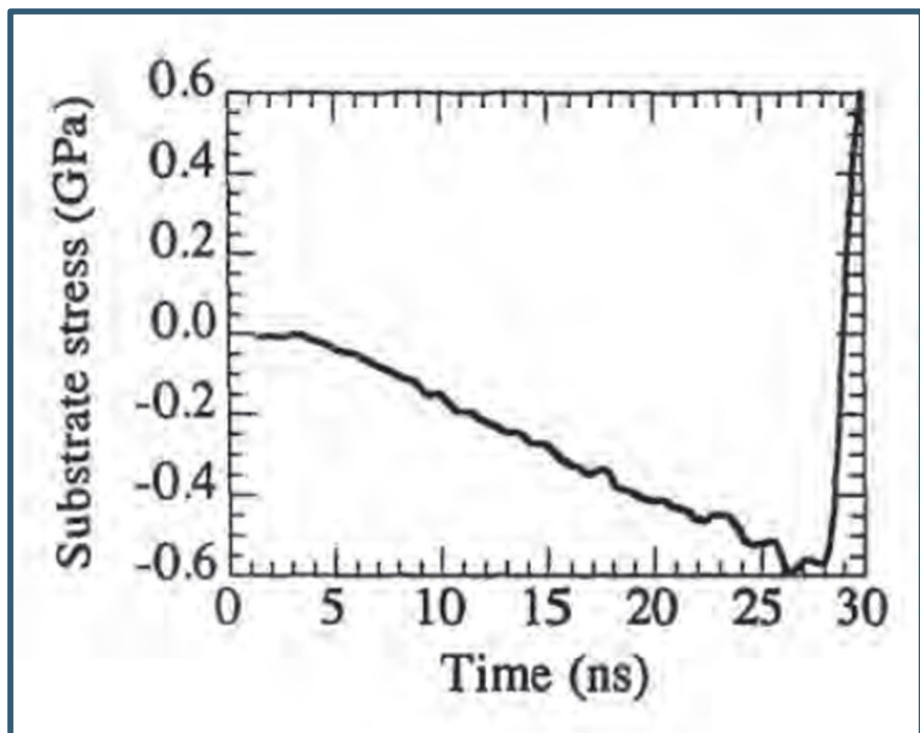
Boeing Ex. 1057, p.27 of 46
Boeing v. Regent Univ. Cal.

Paper 1 (Pet.) at 15, 23-24; Ex-1005 at 45, 124

Wang-Dissertation Discloses Claim Limitation 1[d]

1[d]. wherein the glass element is configured to propagate and modify a stress wave to the coating/substrate interface to generate a tensile stress between the substrate and the coating.

Wang-Dissertation Fig. 3.15(c)



Paper 1 (Pet.) at 25; Paper 15 (PR) at 15; Ex-1005 at 64 (Fig. 3.15(c))

2. As expected from the shock analysis, the initial Gaussian stress pulse evolves into a shock long before it reaches the test film. The rising part of the initial compression pulse thus evolves into a linear ramp, a classic acceleration wave. This ramp is precisely what is seen in Fig. 3.15c. The slope of that ramp (in units of stress per time/thickness) is a material

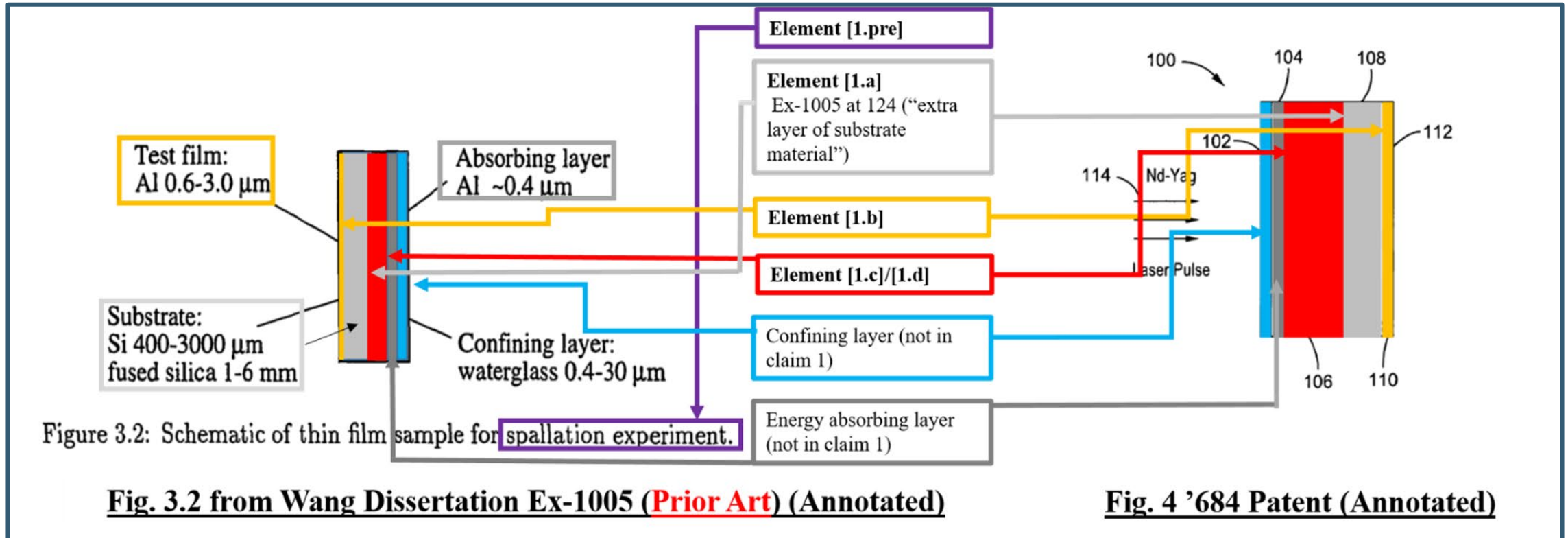
Paper 1 (Pet.) at 15, 25; Ex-1005 at 65

In fused silica substrates, the compressive pulse evolved into a decompression shock. The existence of a shock created a large stress at the film interface, promoting failure. The development of the shock is due to the nonlinear elastic properties of fused silica [51]. This shock mechanism is advantageous in the design of laser-spallation tests of thin-film interface adhesion. Moreover, fused silica is an ideal material for studying the mechanics of the spallation test in that it is intrinsically strong and no substrate damage occurs before the interfacial failure. Although shock development in fused silica was demonstrated in the 1970s by Barker and Hollenbach using a gas-gun facility, the usefulness of such shocks in applications to laser spallation has not been reported.

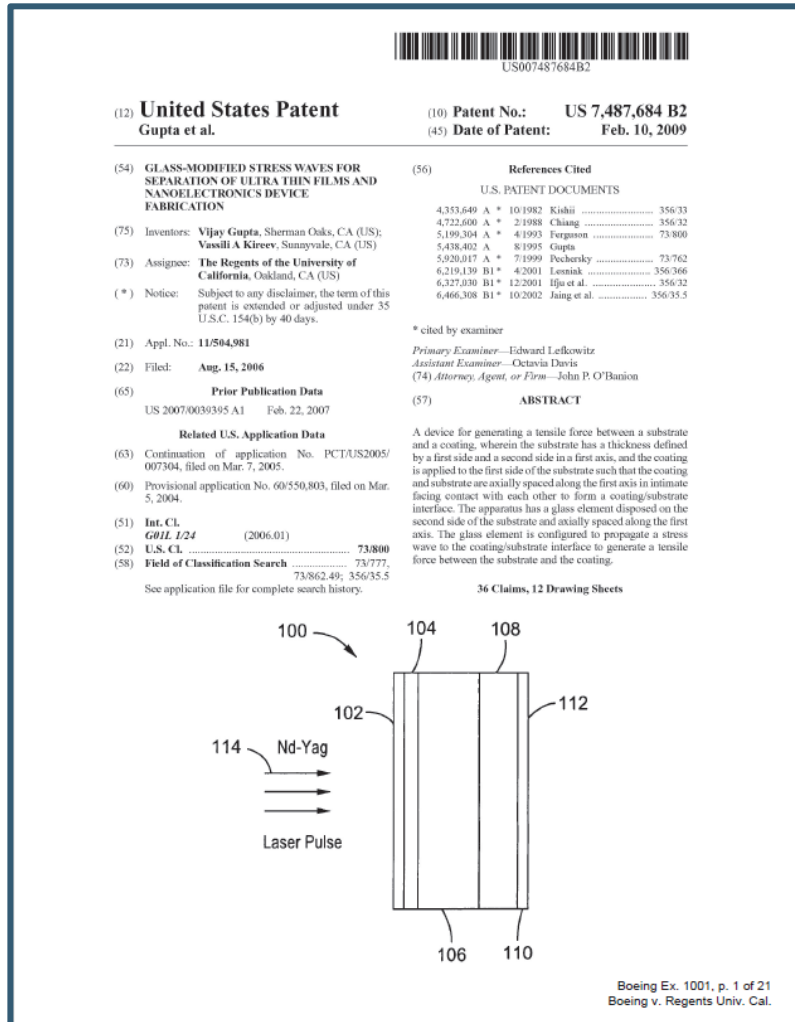
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Paper 1 (Pet.) at 15, 25; Ex-1005 at 81

Wang-Dissertation Discloses Claim 1



Wang-Dissertation Discloses Claim 13



13[pre]. A method for separating a coating from a substrate, the substrate having a first side and a second side transversely disposed in a first axis, the coating applied to the first side of the substrate such that the coating and substrate are axially spaced along the first axis in intimate facing contact to form a coating/substrate interface, the method comprising:

13[a]. positioning a glass element along the first axis on the second side of the substrate;

13[b]. directing a laser pulse in the first axis at the glass element;

13[c]. propagating and modifying a stress wave through the glass element to the coating/substrate interface to generate a tensile force between the substrate and the coating; and

13[d]. separating the coating from the substrate as a result of the stress wave-generated tensile force.

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Wang-Dissertation Discloses Claim Limitation 13[d]

13[d]. separating the coating from the substrate as a result of the stress wave-generated tensile force.

Observations of damage revealed both substrate and film failure in silicon substrate samples but only film failure in fused silica substrate samples. Interferometric measurements confirmed the difference in stress development for the two kinds of sample. In fused-silica-substrates, the compressive pulse evolved into a decompression shock. The existence of a shock created a large stress at the film interface, promoting failure. The development of the shock was due to the nonlinear elastic properties of fused silica. This shock mechanism was advantageous for failing thin-film interfaces on thick substrates. The experimental parametric study revealed important design variables for improving the tensile spallation test and developing the mixed-mode loading experiments.

current project is 3.5 mm. In order to increase the laser fluence, the laser beam is focused onto a 1-2 mm diameter spot on the energy-absorbing layer. The laser energy is increased until a longitudinal wave is generated with an amplitude sufficient to fail the film/substrate interface. Interferometric measurements of out-of-plane displacement are made at the surface

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Paper 1 (Pet.) at 33, 26; Ex-1005 at 120, 42

Wang-Dissertation Discloses Claims 7/18

“wherein the glass element is bonded to the second side of the substrate.”

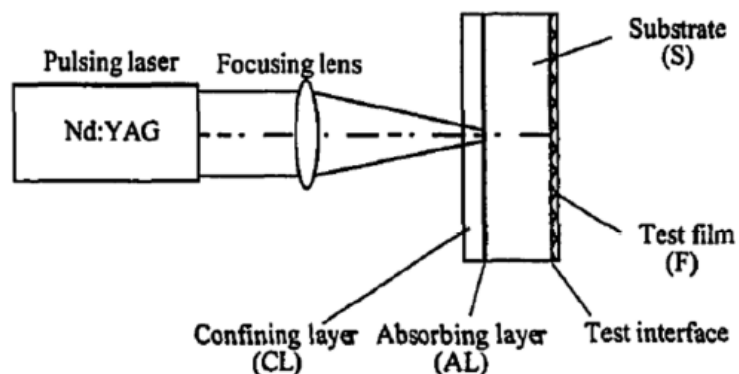


Figure 2.1: Schematic of the tensile laser-spallation technique.

strate is determined for both tensile and mixed-mode loading cases. Fused silica is found to be an ideal substrate material for launching high-amplitude shock waves (its negative nonlinear elasticity being critical for the development of a decompression shock). By inserting an extra layer of the desired substrate material between the fused silica and the thin film, the current technique can be used to test a variety of substrates and films, especially those of interest to the microelectronics industry, such as polyimide, copper (Cu), aluminum (aluminum) and polysilicon on single-crystal silicon substrates.

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Boeing v. Regent Univ. Cal.

Paper 1 (Pet.) at 29; Ex-1005 at 45, 124

PDX-32

Wang-Dissertation Discloses Claims 8/19

“wherein the glass element comprises one of the following: Pyrex, soda lime, quartz, or borosilicate.”

claim 1. Instead, fused quartz is, the “same” or “equivalent” to the fused silica material described in the Wang-Dissertation , and differentiated above. Ex-2009 186:7-9; Ex-1003, ¶200 (“fused quartz, i.e., fused silica”).

Both fused quartz and fused silica are identical materials as far as wave propagation is concerned. EX-2011, ¶188. “Both are amorphous solids. Quartz

Paper 19 (POR) at 52

columns 3 and 6 of the table). They are identical, meaning that the fused quartz, fused silica, and piezo-electric quartz are identical materials as far as wave propagation is concerned. Furthermore, Dr. Wang has taken the position in her

Paper 19 (POR) at 52 (citing Ex-2011, ¶188)

15	Q	What's fused silica?
16	A	So fused silica would be equivalent
17		to fused quartz.

Paper 25 (PR) at 24 (citing Ex-1039, 85:15-17)

7. Both quartz, a type of silica glass, and fused silica have a chemical composition of SiO₂.

Paper 25 (PR) at 22 (citing Ex-1038, ¶17)

Wang-Dissertation Discloses Claim 10

“wherein the substrate comprises silicon.”

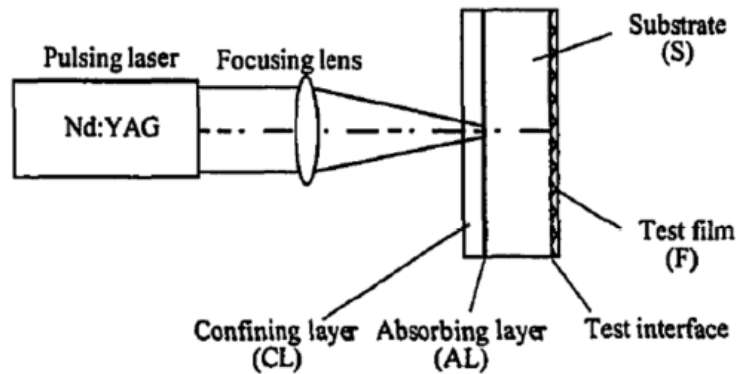


Figure 2.1: Schematic of the tensile laser-spallation technique.

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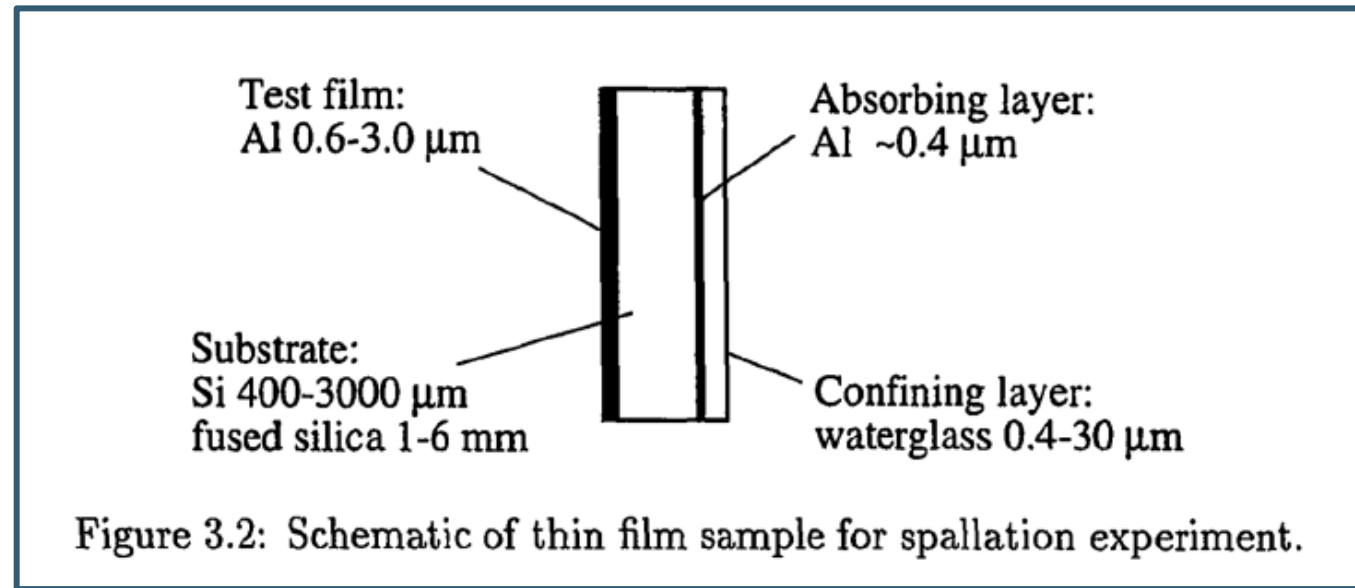
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Paper 1 (Pet.) at 30; Ex-1005 at 45, 124

PDX-34

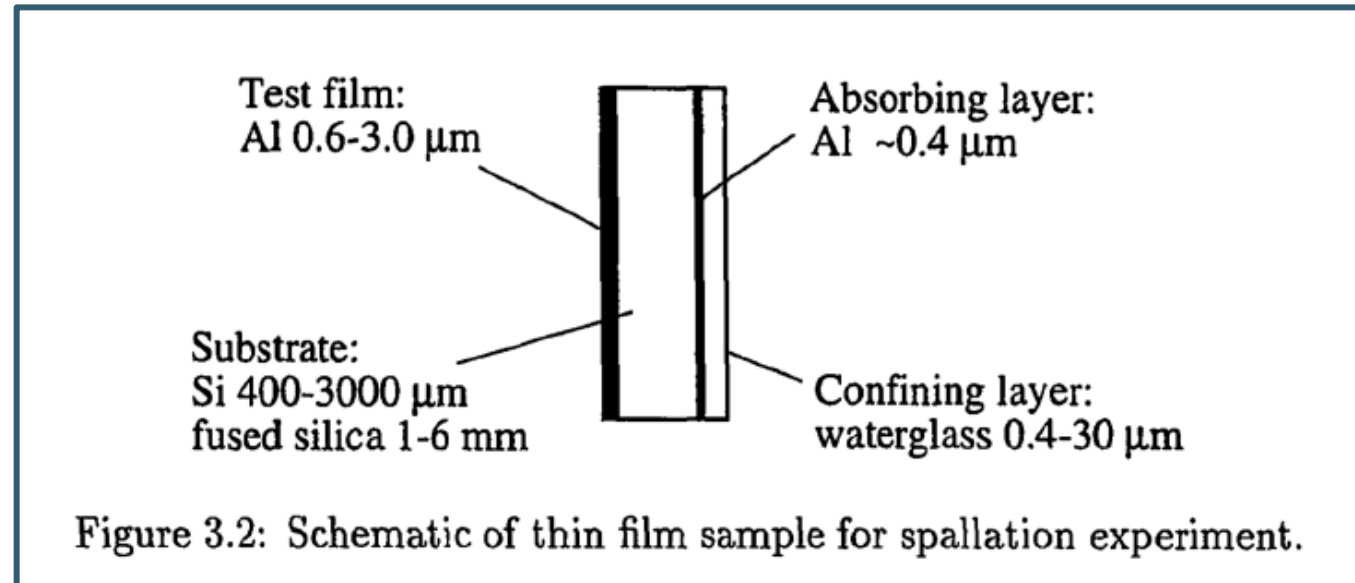
Wang-Dissertation Discloses Claims 11/21

“[a]n apparatus as recited in claim 1, further comprising a constraining element disposed adjacent to the glass element.”



Wang-Dissertation Discloses Claims 12/22

“[a]n apparatus as recited in claim 1, further comprising a constraining element disposed adjacent to the glass element.”



Gupta-1992 Discloses the Challenged Claims

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Overview of Gupta-1992

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MEASUREMENT OF INTERFACE STRENGTH BY A LASER SPALLATION TECHNIQUE

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(Received 24 September 1990)

ABSTRACT

A laser spallation experiment has been developed to measure the strength of planar interfaces between a substrate and a thin coating (in the thickness range of 0.3–3 μm). In this technique a laser pulse of a high enough energy and a pre-determined duration is converted into a pressure pulse of a critical amplitude and width that is sent through the substrate toward the free surface with the coating. The reflected tensile wave from the free surface of the coating pries-off the coating. The critical stress amplitude that accomplishes the removal of the coating is determined from a computer simulation of the process. The simulation itself is verified by means of a piezo-electric crystal probe that is capable of mapping out the profile of the stress pulse generated by the laser pulse. Interface strength values ranging from 3.7 to 10.5 GPa were determined for the Si/SiC system. For the interfaces between pyrolytic graphite and SiC coatings an average strength of 7.2 GPa was measured, while the corresponding interface strength between a Pitch-55 type ribbon with a fiber-like morphology and SiC coatings was found to be 0.23 GPa. Intrinsic strengths of SiC coatings and Si crystal were also determined using this technique. These were, on the average, 8.6 GPa for Si crystals and 11.9 GPa for a SiC coating. Furthermore, the potential of the laser technique to determine the interface toughness was also demonstrated, provided well-characterizable flaws can be planted on the interface.

1. INTRODUCTION

It is now widely recognized that considerable toughness in composites with brittle, but strong reinforcing fibers, can be achieved by controlled debonding of the fibers from the matrix to prevent premature fiber fracture. In composites with brittle matrices, such as, ceramics and glass, this is often the only means of obtaining toughness (EVANS, 1989). In metal matrix composites, an additional problem of a possible interface reaction is often present between the matrix and the fiber, which can degrade the strength of the fiber and can lead to premature failure. To neutralize this problem, it is now a standard practice to protect the fibers with a less reactive sacrificial coating (GUPTA *et al.*, 1989). This also permits controlled delamination of the coating from the fiber along the fiber-coating interface to prevent cracks external to the fiber, or residual reaction products on the fiber from damaging the latter. Thus, it has been suggested (GUPTA *et al.*, 1989; ARGON *et al.*, 1989) that such fiber-coating interfaces with tailored strength and toughness properties can be used as mechanical fuses to decouple the undamaged fibers from their damaged surroundings to prevent

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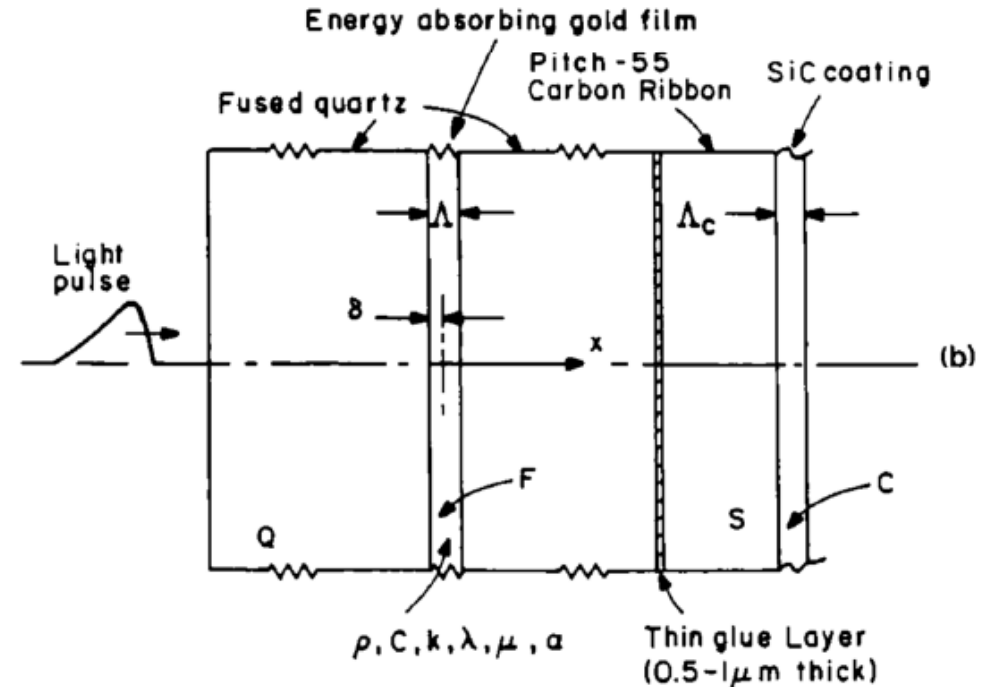


FIG. 2. (a) Configuration of the laser spallation probe with a homogeneous substrate. (b) Configuration for testing the Pitch-55 Ribbon/SiC system.

Gupta-1992 Discloses a “Glass Element”

IPR2024-00761
Patent 7,487,684

BEFORE THE PATENT TRIAL AND APPEAL BOARD

THE BOEING COMPANY
Petitioner,

v.

THE REGENTS OF THE UNIVERSITY OF CALIFORNIA
Patent Owner.

Case IPR2024-00761
Patent 7,487,684

PATENT OWNER'S RESPONSE

Under Ground 3, Petitioner contends that claims 1-24 of the '684 Patent are rendered obvious in view of the Wang-Dissertation and Gupta-1992. As explained above, the Gupta-1992 reference is cumulative of the Wang-Dissertation — relevant disclosures in the Gupta-1992 reference are all also present in the Wang-Dissertation, which is addressed above. Ex-2011. ¶¶247-250. Gupta-1992 does not cure any of the deficiencies in the Wang-Dissertation discussed above. *Id.*

Paper 19 (POR) at 64

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Fused Quartz is Equivalent to Fused Silica

claim 1. Instead, fused quartz is, the “same” or “equivalent” to the fused silica material described in the Wang-Dissertation , and differentiated above. Ex-2009 186:7-9; Ex-1003, ¶200 (“fused quartz, i.e., fused silica”).

Both fused quartz and fused silica are identical materials as far as wave propagation is concerned. EX-2011, ¶188. “Both are amorphous solids. Quartz

Paper 19 (POR) at 52

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7. Both quartz, a type of silica glass, and fused silica have a chemical composition of SiO₂.

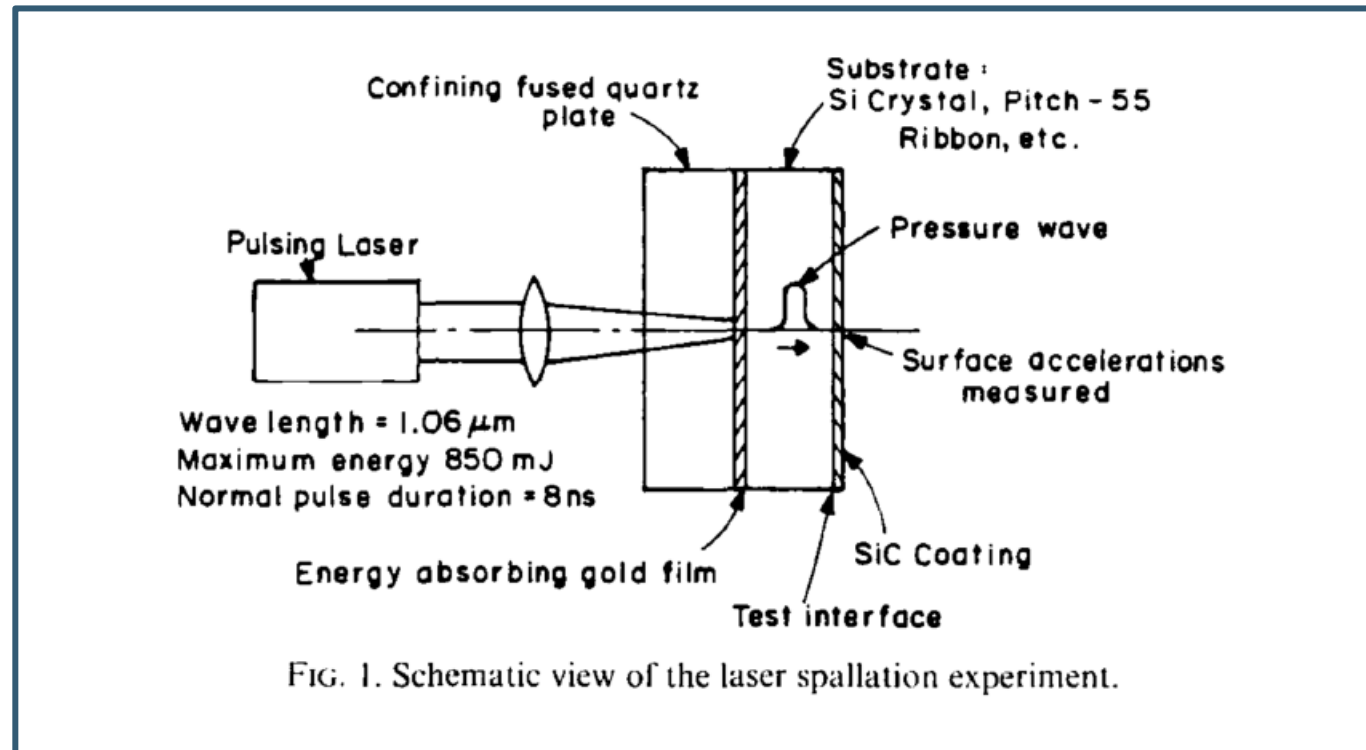
Paper 25 (PR) at 22 (citing Ex-1038, ¶17)

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Gupta-1992 Discloses Limitation 1[Pre]

1[pre]. An apparatus for generating a tensile stress between a substrate and a coating, comprising:



Gupta-1992 Discloses Claim Limitation 1[a]

1[a]. a substrate having a thickness, said thickness defined by a first side and a second side in a first axis;

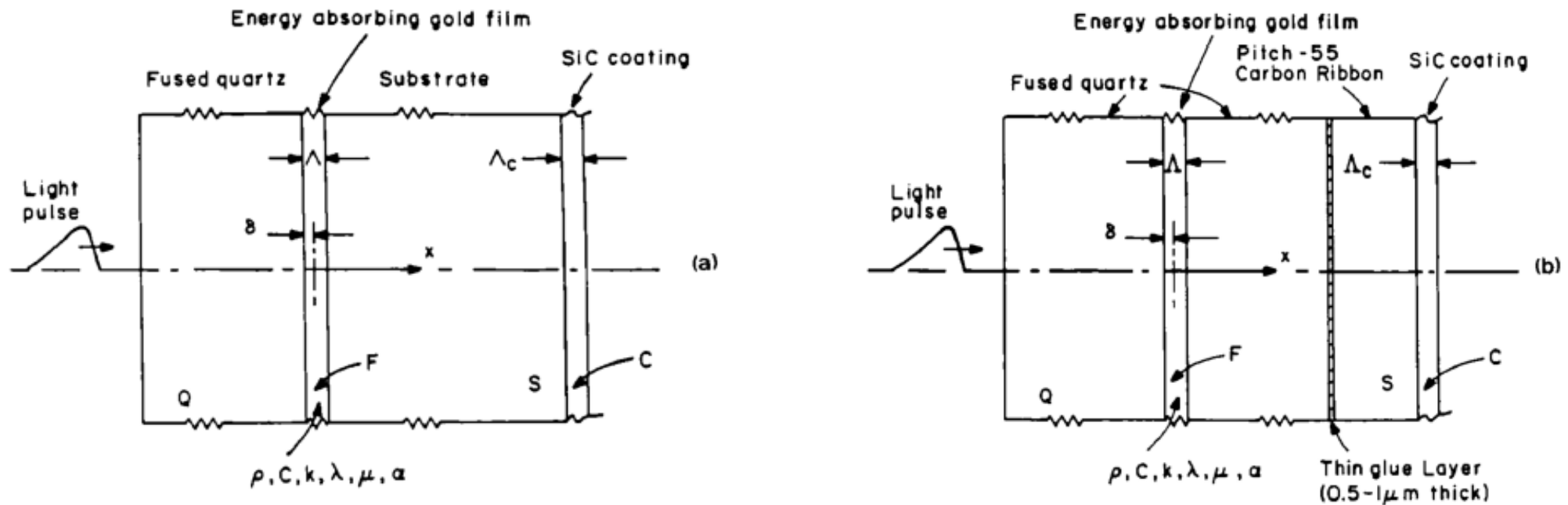
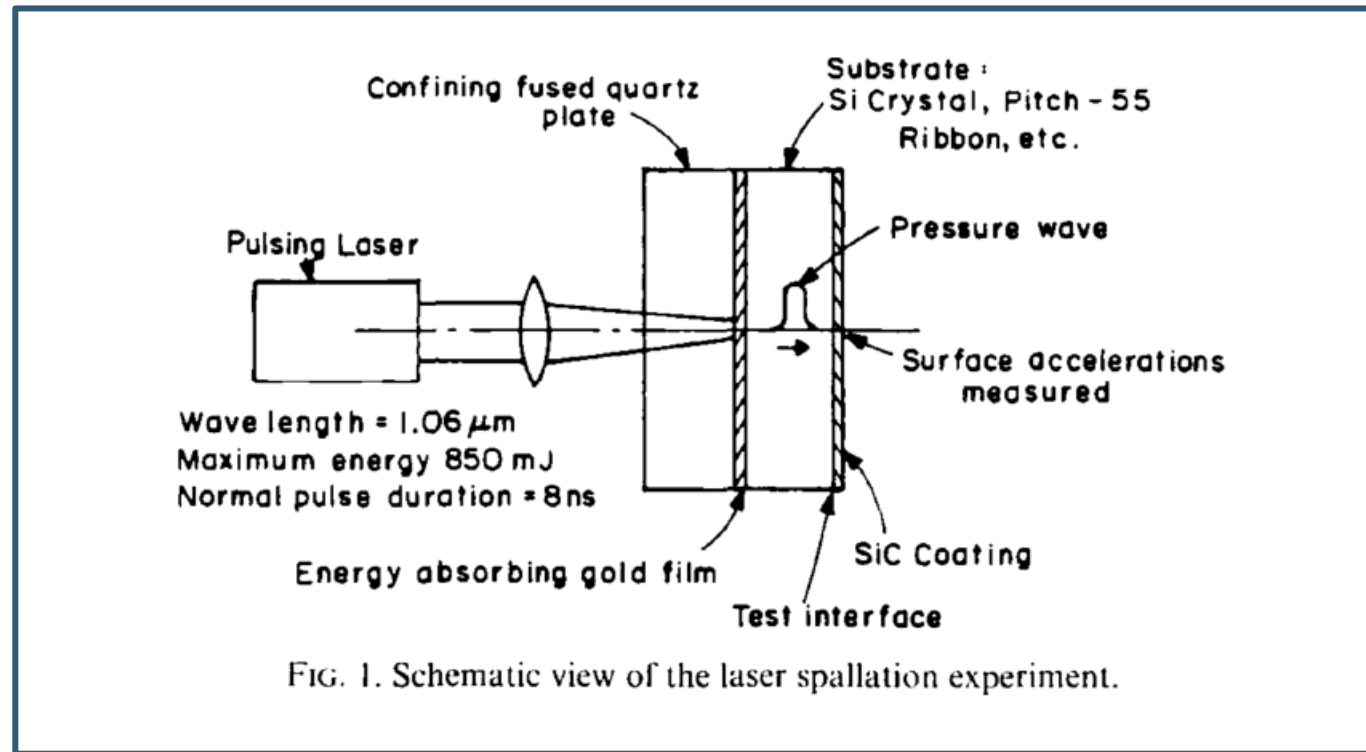


FIG. 2. (a) Configuration of the laser spallation probe with a homogeneous substrate. (b) Configuration for testing the Pitch-55 Ribbon/SiC system.

Gupta-1992 Discloses Claim Limitation 1[b]

1[b]. a coating applied to the first side of the substrate such that the coating and substrate are axially spaced along the first axis in intimate facing contact with each other such to form a coating/substrate interface; and



Gupta-1992 Discloses Claim Limitation 1[c]

1[c]. a glass element disposed on the second side of the substrate and axially spaced along the first axis;

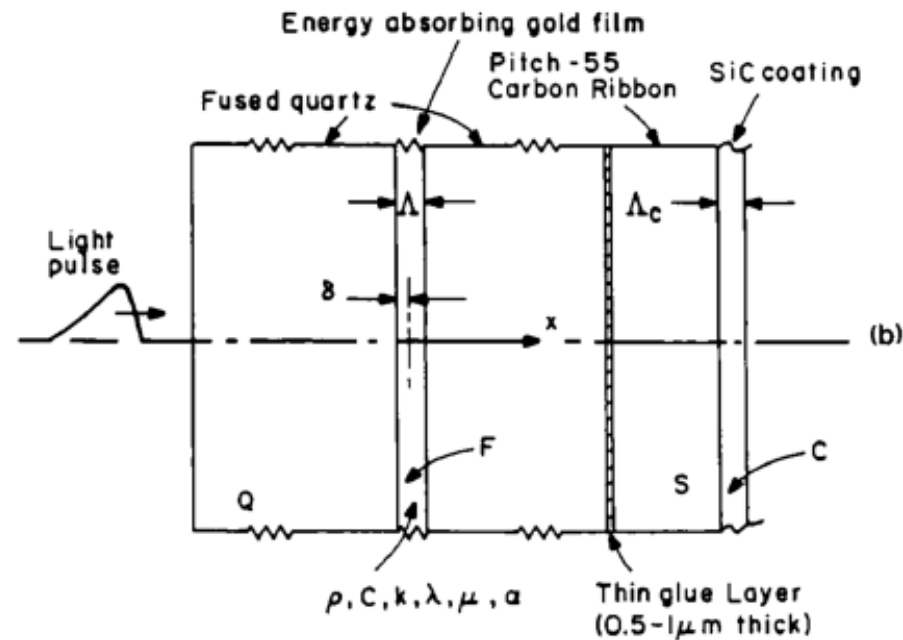
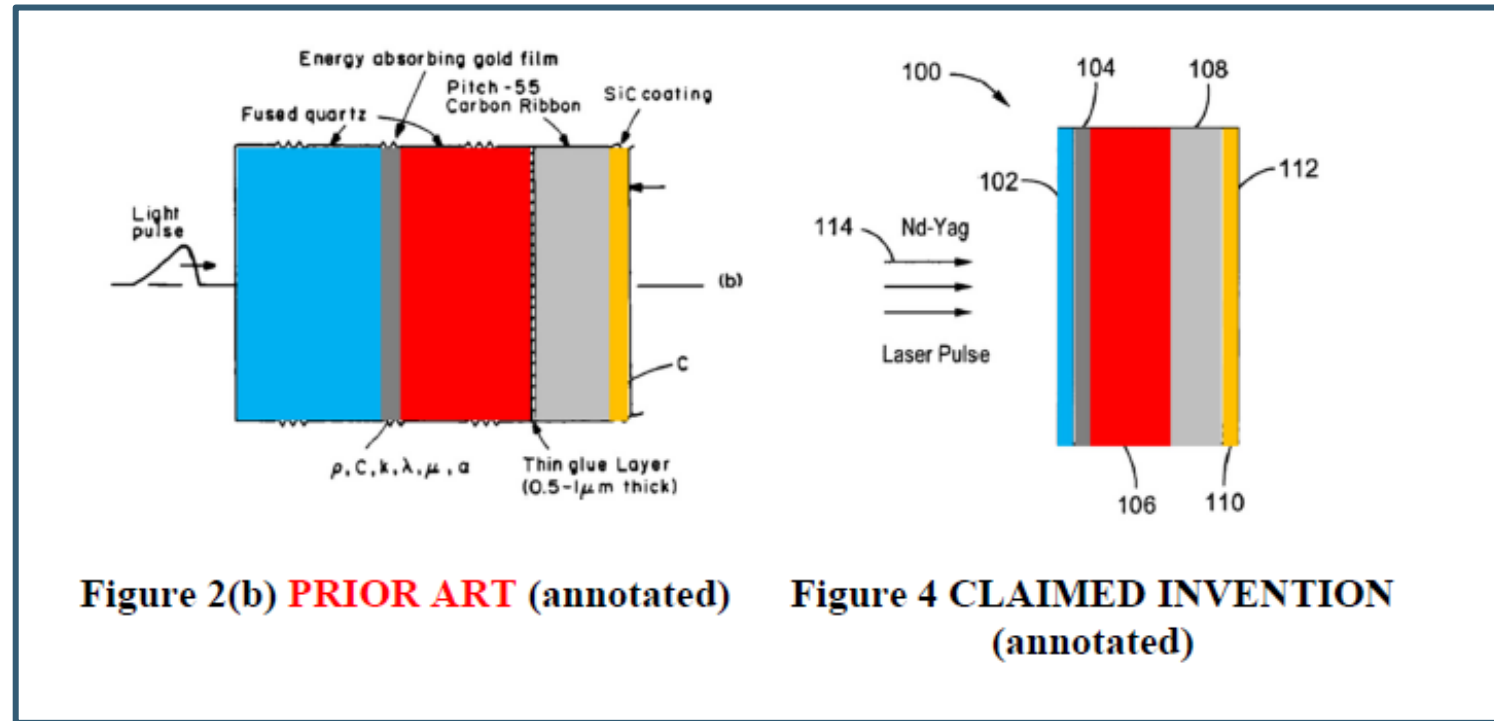


FIG. 2. (a) Configuration of the laser spallation probe with a homogeneous substrate. (b) Configuration for testing the Pitch-55 Ribbon/SiC system.

Gupta-1992 Discloses Claim Limitation 1[d]

1[d]. wherein the glass element is configured to propagate and modify a stress wave to the coating/substrate interface to generate a tensile stress between the substrate and the coating.



Fused Quartz is Equivalent to Fused Silica

claim 1. Instead, fused quartz is, the “same” or “equivalent” to the fused silica material described in the Wang-Dissertation , and differentiated above. Ex-2009 186:7-9; Ex-1003, ¶200 (“fused quartz, i.e., fused silica”).

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Paper 25 (PR) at 24 (citing Ex-1039, 85:15-17)

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