

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

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Exhibit	Description
2001	“Glass-modified stress waves for adhesion measurement of ultra thin films for device applications,” Gupta et al.
2002	Subpoena for LaTonya Morris and Appendix A (December 19, 2024)
2003	U.S. Patent Trial and Appeal Board Email Authorizing Motion to Apply for Subpoena (November 12, 2024)
2004	Deposition Transcript of LaTonya Morris (January 23, 2025)
2005	LaTonya Morris’s Responses and Objections to Subpoena (December 17, 2024)
2006	IPR2024-00033 - Declaration of Heather Stewart
2007	IPR2024-00033 - Supplemental Declaration of Heather Stewart
2008	U.S. Patent Trial and Appeal Board Email Authorizing Petitioner to File Amended Declaration of Latonya Morris
2009	Deposition Transcript of Junlang Wang (January 16, 2025)
2010	ProQuest Abstract of Wang Thesis Accessed January 22, 2025
2011	Declaration of Vijay Gupta, PhD (February 3, 2025)
2012	Curriculum Vitae of Vijay Gupta, PhD

I. INTRODUCTION

The ‘684 Patent’s technology involves a *modified* wave that upon reflection from the free surface of the coating generates a much larger tensile stress at the interface compared to an *unmodified* wave. None of the documents relied on by Petitioner in all seven Grounds discloses or even hints at this approach.

A. The Wang-Dissertation Is Not Prior Art

Before reaching the merits, the record now shows that Boeing’s leading reference for Grounds 1-3, the Wang-Dissertation (Ex-1005), has not been proven to be prior art under § 102(b). Whereas the PTAB relied on testimony that the dissertation was present in a searchable database on the critical date, Boeing’s third-party witness recanted and changed her testimony, now conceding that it was not there until 6.5 years later. And, while the PTAB asserted that the witness was a “corporate representative” of the database company, both the witness and her counsel disclaimed that designation; she only testified in her personal capacity. Where, as here, a fact witness did not join the company until 15 years after the events in question, she cannot have personal knowledge as a matter of law. Grounds 1-3 fail for these and many other reasons set forth in section V, *infra*.

B. The Wang-Dissertation Contains The Substance Of Wang-2002

If the merits are reached, Grounds 1, 2, 3 and 7 rely on the Wang-Dissertation or Wang-2002 (Ex-1016). Wang testified that the substance of Wang

2002 is contained in the Wang-Dissertation and uses identical figures. *See* section V.G, *infra*.

C. Gupta-1992 Is Also Cumulative Of the Wang-Dissertation

Grounds 3-7 rely on Gupta 1992 as an anticipatory (Ground 4), primary (Grounds 5 and 6), or secondary (Grounds 3 and 7) reference. However, as with Wang-2002, the record shows that Gupta-1992 is also cumulative to the Wang-Dissertation, as again conceded by Wang. *See* section V.B, *infra*.

Gupta-1992 does not disclose, *inter alia*, a *modified* wave. Figures 10, 11, and 15 of this document conclusively demonstrate that the profile of the *unmodified* stress wave that enters and passes through the fused silica element prior to entering the carbon ribbon substrate in the experimental arrangement shown in Fig. 2 (b) remains unmodified.

D. No Claim Is Anticipated Or Rendered Obvious

As explained by Professor Vijay Gupta (“Gupta Declaration,” Ex-2011), *Wang’s own data* undermines Petitioner’s theories as to the purported teachings of the Wang-Dissertation and Wang-2002 that are set forth in the Petition.

The ‘684 patent (Ex-1001) teaches a compressive stress wave with **a modified profile to arrive to** the interface and to generate tensile stress at the interface **after reflection from the free surface of the coating** (claim 1), and the tensile stress so generated after reflection from the free surface of the coating is

increased until it exceeds the tensile strength of the interface **to separate the coating** or the film at the interface (claim 13).

What Wang refers to as a **decompression shock** (Ex-1003, ¶¶ 77, 78) is actually the unloading caused by the unmodified direct tension wave that, by Wang's own admission, is generated in her experiments from the reflection of a second layer and enters the substrate behind the main compression wave. This direct tension wave travels faster than the peak compression wave, as also acknowledged by Wang in both her deposition testimony and her statements in her Dissertation, and it completely neutralizes any decompression shock of the initial compression wave, even if one were to assume such a decompression shock were formed in the first place. In fact, a decompression shock is never formed, regardless of the presence of the tension wave, as demonstrated by Gupta's analysis.

The Wang-Dissertation fails to anticipate or render obvious any of the challenged claims because, (1) there is no **modified wave** as required by the challenged claims, and (2) the tension described in Wang is not generated by a **reflection from the free surface of the coating**, but rather directly by a direct tension wave (generated at a free surface of the confining medium from the initial compression wave being reflected from the laser side) when it first strikes the interface during its onward journey towards the free surface of the coating.

Wang’s reference to her “Future Work” at the end of her Dissertation is no more than an invitation to carry out further research and experimentation in an unpredictable field – not a disclosure that would have rendered the arrangement and method of the ’684 Patent claims obvious. In any event, Wang’s “Future Work,” *by her own admission*, was in fact already tested in Gupta-1992 (Ex-1011). *And Gupta-1992, like the data in the Wang-Dissertation , confirmed that the compression wave was not modified when it propagated inside the fused silica substrate and did not develop a rarefaction shock profile.*

These distinctions between independent claims 1 and 13 of the ‘684 Patent and the Wang-Dissertation apply to every reference relied on in the Petition. The ‘684 Patent claims should be found patentable.

II. THE WANG-DISSERTATION IS NOT PRIOR ART

Boeing offered the Declaration of LaTonya Morris (Ex-1035) to prove that the Wang-Dissertation was prior art under § 102(b), by virtue of its full text *allegedly* having been placed in a searchable online database online database on March 4, 2003—one day before the critical date. Boeing’s expert on library cataloging and classification relied on that testimony. Ex-1006, ¶ 33 (“as of March 4, 2003 ... interested users[] would be able to search ProQuest to discover Wang and access it freely”). In preliminarily finding that Boeing met the *Hulu* burden for

institution, the U.S. Patent Trial and Appeal Board (PTAB) relied on the expert's and Ms. Morris's testimony, that the "full text" of Wang was loaded into ProQuest's PQDT database as of March 4, 2003. Institution Decision (ID), Paper 8, p.12-18, citing Ex-1035, ¶¶ 8-9.

But Boeing's expert and the PTAB were misled. After the ID, Ms. Morris recanted her sworn testimony and changed the alleged date the full text of the Dissertation was in the database by over six years, from March 4, 2003 to Sept. 6, 2010. Ex-1038 (redlined), ¶ 8, Ex-1037, ¶ 8. Ms. Morris's changed testimony fails to establish, under the applicable legal standards, that the Wang-Dissertation is a "printed publication" for purposes of § 102(b).

A. Legal Standards For Public Accessibility

The determination of whether a document is a "printed publication" under 35 U.S.C. §b) "involves a case-by-case inquiry into the facts and circumstances surrounding the reference's disclosure to members of the public." *Medtronic, Inc. v. Barry*, 891 F.3d 1368, 1380 (Fed. Cir. 2018). In certain situations, particularly for manuscripts or dissertations stored in libraries, courts may inquire whether a reference was sufficiently indexed, catalogued, ***and shelved***. See, e.g., *In re Hall*, 781 F.2d 897, 898-99 (Fed. Cir. 1986); *In re Lister*, 583 F.3d 1307, 1315 (Fed. Cir. 2009) (manuscript became publicly accessible once it was placed in a searchable

database). Here, in light of the changed testimony, the Wang-Dissertation is now conceded not to have been placed in the PQDT database by the critical date.

A reference is considered publicly accessible if it was “disseminated or otherwise made available to the extent that persons interested and ordinarily skilled in the subject matter or art, exercising reasonable diligence, can locate it.”

Acceleration Bay, LLC v. Activision Blizzard, Inc., 908 F.3d 765, 772 (Fed. Cir. 2018). In *Acceleration Bay*, even where the document had been uploaded to the database at issue, and despite some indexing and search functionality on the website, the document was not publicly accessible, noting that ‘public accessibility’ requires more than ‘technical accessibility.’ 908 F.3d at 773. Thus, technical accessibility is the bare minimum fact, and is lacking here, since Boeing now admits that the Wang-Dissertation was not uploaded to ProQuest’s PQDT database until 6.5 years after the critical date. Ex-1038, ¶ 8, second table.

Moreover, in *Lister*, the Federal Circuit held that the manuscript at issue was only publicly accessible as of the date it was included in a searchable database, which permitted a researcher to locate *and examine it*. 583 F.3d at 1311-12. Wang does not meet *Lister*’s criteria.

B. Boeing's Expert And The PTAB Relied On Now-Repudiated Full-Text Searchability Before The Critical Date

Relying on now-repudiated testimony, Boeing's expert, Ingrid Hsieh-Yee, testified that interested users would have been able, as of March 4, 2003, to "access [Wang] freely from any institutions that subscribe to PQDT." Ex-1006, ¶ 33. This conclusion was expressly based on the prior testimony of Ms. Morris in Ex-1035. Ex-1006, ¶¶ 32-34. Now, the evidence establishes that this prior testimony is not true, and Dr. Hsieh-Yee's opinion testimony should be set aside and given no weight because it is based on a wrong set of facts. Further, the PTAB expressly relied on Ms. Morris's and Dr. Hsieh-Yee's testimony of full-text searchability of the Dissertation before the critical date, as meeting the *Hulu* standard for institution. ID, Paper 8, pp. 12-15, 17-18; *see* section II.C, *infra*. Those conclusions have been critically undermined by the changed testimony of Ms. Morris. A POSA could not have "located" the full text by March 4th, because it wasn't in the database; a POSA simply couldn't have accessed or read it that day. The present case is different from precedents where, *e.g.*, a Dissertation was indexed by a library, and a single copy of the Dissertation on the library shelf was readily accessible.

The Wang-Dissertation , kept by ProQuest in microfilm form (Ex-2004, 63:3-16) and not digitized and uploaded to its PDQT searchable database until

2010 (Ex-2004, 44:11-12), was not disseminated as of the critical date. So the bottom line question is: Could a POSA with access to ProQuest database have ‘accessed it,’ before March 5, 2003 with reasonable diligence? The answer is no.

The second Morris Declaration establishes that the full text of Wang was not uploaded into the PQDT database until 2010. Ex-1038, ¶ 8, second table. This testimony undermines and contradicts the first Morris Declaration on a critical fact for determining accessibility, Ex-1035, ¶ 8, and raises huge credibility questions. No explanation was provided in the second Declaration for the recantation of sworn testimony and new, replacement testimony. One sworn statement says March 4th, 2003 (Ex-1035), the other says Sept. 6, 2010 (Ex-1038). At deposition, Ms. Morris claimed this was an error being corrected. Ex-2004, 23:18-25:14. But no supporting documentation was provided, and Patent Owner’s request for additional discovery was denied. Ex-2008.

C. The PTAB Relied On The Hulu Standard, Which Is Lower Than The Standard Applied At Trial and Final Hearing

The PTAB cited to the *Hulu* standard several times in its analysis. *Id.*, pp.11-18, citing *Hulu v. Sound View Innovations, LLC*, IPR2018-01039, Paper 29 at 13 (PTAB Dec. 20, 2019) (precedential). The *Hulu* standard is lower than the preponderance of the evidence standard used at trial. *Id.* at 13-14, citing *Trivascular, Inc. v. Samuels*, 812 F.3d 1056, 1068 (Fed. Cir. 2016) (comparing §

314(a) with § 316(e)). Given the changed evidence, Boeing can no longer even meet the *Hulu* standard, as discussed below.

D. The Changed and Altered Testimony of Ms. Morris

Based on the changed testimony and cross-examination of Ms. Morris, the quality of Boeing's proof has tremendously declined since Institution, and cannot be sufficient to establish public accessibility of the Wang-Dissertation under *Hulu*, much less at trial under the higher preponderance standard.

First, and most importantly, Ms. Morris recanted her testimony as to the date that the Dissertation was placed in the database, changing from March 4, 2003 to September 6, 2010. *Compare* Ex-1035 (original) vs. Exs.1038 (redlined), 1037 (clean, amended), ¶ 8 in the table labeled "Full Text Availability." Ms. Morris made this change. *See* Ex-2004, 28:2-17. This altered testimony fully undermines Boeing's expert's conclusion of public accessibility, and the PTAB's reliance on the same, as discussed above.

Disturbingly, all other changes in the Morris Declaration were made by someone other than Ms. Morris, and without her knowledge. Ex-2004, 28:2-17 ("That's the only change that I made to my declaration, correct."); 28:18-31:6. She doesn't know who made these changes. *Id.*, 32:11-15. Indeed, she only had input on the two tables in ¶ 8. *Id.*, 16:11-20, 17:3-5. She had no other input into the declaration. *Id.*, 17:6-8, 17:21-18:9. Thus:

(1) Someone other than Ms. Morris changed *what was allegedly for sale* in ¶

8. Compare Ex-1035, ¶ 8 in the table labeled “Full Text Availability,”

First Made Available for Sale in PDF
format and placed in PQDT

with Ex-1037, ¶ 8,

First Made Available for Sale (print
or electronic)

Although the PTAB required Boeing to file a redlined version of the Morris Declaration, this substantive, unexplained change was not reflected in the redline version, Ex-1038. This was discovered during the Morris deposition. Ex-2004, pp. 37-39.

(2) Someone other than Ms. Morris made a substantive change in ¶ 9:

9. ProQuest's records for the Dissertation, reproduced in Paragraph 8 above, show that the ~~full text of the~~ Dissertation was available for sale to the public as of 3/4/2003.

Ex-1038, p. 3.

(3) Someone other than Ms. Morris made a substantive change in ¶ 12:

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.

Ex-1038, p. 3.

4) Someone other than Ms. Morris made a substantive change in ¶ 14:

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.

Ex-1038, p. 3. Ms. Morris conceded she had no knowledge of the information in this paragraph. Ex-2004, 58:16-19.

Again, none of these unexplained, substantive changes (1)-(4) was authorized by or even known to Ms. Morris prior to her deposition. Ex-2004, 28:2-32:15. Regardless of who altered the sworn testimony, all of those edits show that Ms. Morris failed to investigate the facts before signing her original declaration, and was unaware of changes to the declaration made by others, critically impacting the credibility of the entire declaration.¹

In view of these improprieties, Boeing should withdraw reliance on the Morris Declaration, and drop reliance on the Wang-Dissertation . If it doesn't, the PTAB should accord the Declaration no weight, for lack of credibility, lack of personal knowledge and as a sanction for unknown actor(s)' altering sworn testimony. Even if the change of date by Ms. Morris was due to a mistake and not intentional, the PTAB should not condone the actions by unidentified other(s) who

¹ As shown in section II.I, *infra*, this type of after-the-fact investigation does not constitute "personal knowledge" under FRE 602 and cited authorities.

inserted substantive changes into the Declaration without her knowledge or consent. The entire doctored Declaration should be thrown out.

E. Boeing's Reliance On The Dissertation Being "On-Sale" Is Off-Base

Since the Dissertation was not in the PQDT database on March 4, 2003, the traditional manner of proving public accessibility is negated. But, commingling concepts from statutorily impermissible reliance "on-sale" bar in IPR proceedings (35 U.S.C. § 311(b)) with public accessibility of an alleged printed publication, Boeing, through Ms. Morris's phantom testimony, now asserts for the first time that something less than the "full text" of the Dissertation was "available for sale to the public" as of March 4, 2003. Ex-1038, ¶ 9 (striking "full text"). However, other than this bald assertion, Boeing failed to prove what this means, did not provide any evidence supporting the assertion, and cited no legal authority in its Petition. Most critically, given the altered testimony in Ex-1038, ¶ 9, striking "full text" of the Dissertation, *the record is devoid of precisely what was alleged to be "available for sale" as of the critical date.* There is a clear failure of proof.

Moreover, no details were proven in Boeing's Petition, such as what time the Record Dissertation was first locatable that day by a POSA; how a sales transaction could have occurred that day; what mechanism, technique or software existed at ProQuest for handling an order and payment, and whether payment could

be made the same day; what mechanism, technique or software existed at ProQuest for delivering a paper to a POSA, and how long that took.

F. Boeing Asserted No Theory Or Evidence As To How A POSA Could Have Accessed The Dissertation On March 4, 2003

As noted above, *Lister* made clear that a POSA not only had to have been able to *locate* the Dissertation on March 4th, but also had to have been able to *examine its content*: “whether the research tools available would have been sufficient to permit an interested researcher to locate and examine the reference.” 583 F.3d at 1311. Since it has now been conceded that the Dissertation itself was not in the PQDT database or searchable that day, the remaining testimony is insufficient as a matter of law as to how a POSA could have placed his or her hands on the document *on March 4th*.² For example, because Boeing did not prove what time of day the Record was placed in the database, if it was late in the day no one could have located the Record, placed an order for the Dissertation, received and “examine[d]” it that day.

Here, at most, only the Record Dissertation might have been locatable before March 5, if unproven assumptions are made and hearsay testimony credited. The Record is alleged to consist of author, title, index of terms, and abstract. Ex-1038,

² To be clear, while the law does not require proof that a POSA *actually* accessed the document on the day in question, it does require proof that a POSA *could have* examined it. That proof is lacking here.

¶¶ 10-11. But Boeing didn't prove what the index of terms, or abstract, constituted for the Wang-Dissertation . No document or print-out was provided. Nor did Boeing prove *when* on March 4 that Record Dissertation even became allegedly locatable.

There is simply no evidence that a researcher could have located and read the Dissertation *on March 4th*. That is precisely what would be required to place the content of the Dissertation in the public domain on *that day*, under *Lister* and progeny. Even if, *arguendo*, the title or abstract could have been located in the PQDT database, that does not mean that the full Dissertation was in the public domain. The Wang-Dissertation was received at ProQuest on microfilm, not in a digital form. Ex-2004, 63:3-16. If a researcher located the title or abstract on March 4th—despite a failure of proof as to the exact time of day the Record was placed in the database—and assuming there was enough time in the day and ProQuest was open, there is a void in the record as to how the researcher could have ordered, paid for, received and examined, the non-digital content that day. At deposition, Ms. Morris testified about how a sales transaction might have occurred in 2003, but she conceded that was based on her current-day knowledge learned from “training,” which is hearsay and not personal knowledge (section II.I, below). Ex-2004, 46:4-47:4. And there is *no evidence* whatsoever as to how a POSA could

have accessed and examined the full Dissertation on March 4th, since it wasn't in the database, but only on microfilm.

G. Boeing Provided No Documents Bearing A Date Of March 4, 2003

No evidence corroborates the Dissertation allegedly being “available for sale” as of the critical date, let alone deliverable by that date for a POSA’s examination. While Ms. Morris stated that she checked certain records to provide the data in the two tables in paragraph 8 (Ex-1038, ¶ 8; Ex-2004, 16:11-20, 17:6-8, 17:21-18:9 (those two tables were her only input into the Declaration)), she provided no potentially corroborating documentation purporting to show the Record’s availability on March 4th. And she had “no input” into the balance of the Declaration. *Id.* A standard for corroboration should apply, especially where 1) the credibility of the witness is in doubt due to changed testimony, 2) an unidentified person(s) altered the text without her knowledge and consent, and 3) a different ProQuest witness, Heather Stewart, changed her testimony with respect to the same date in November, 2024 in a different case—IPR2024-00033, compare Ex-2006 (original Ex-1041) with Ex-2007 (changed Ex-2013), ¶¶ 8-9. Credibility issues are rampant here.

H. Boeing Failed To Establish The Content of The Abstract Or The Document Allegedly Available For Sale

The document attached to the Morris Declarations as the Wang-Dissertation contains an abstract (Ex-1005, pp. 7-8), but Boeing adduced no proof of the content of the abstract *in the Record* as of the critical date, said to consist of title, author and abstract. Ex-1038, ¶¶ 10-11. Thus, even if the abstract was searchable on March 4th, its content remains unknown, even to Ms. Morris, as she didn't review it. Ex-2004, 51:9-11. Moreover, Ms. Morris gave conflicting testimony on the abstract's electronic searchability, on cross saying she didn't know if it was searchable (*id.*, 57:17-20), while on redirect saying that it was (*id.*, 64:4-21). And, Boeing did not rely on the Record's unknown abstract's content as prior art in its Petition. Today, the content of the abstract in PQDT does not match the abstract in the Dissertation, Ex-1005, 7-8. Ex-2011, ¶ 329 (citing Ex-2010, the Wang-Dissertation abstract pulled from the Proquest PQDT database).

For example the PQDT Wang-Dissertation abstract contains 100 fewer words than what is contained in the abstract in the Wang-Dissertation itself. Ex-2011, ¶ 320.

Similarly, Boeing adduced no proof of the content of the less-than-full-text Dissertation allegedly available for sale as of March 4th. Ms. Morris did not make the change in paragraph 9 striking "full text," was unaware of it until the

deposition, and didn't know who did it. Ex-2004, 28:2-32-15. This strikeout undermines her original testimony that the full-text document was available for sale on March 4th. The "on-sale" document's content remains unknown, even to Ms. Morris (*id.*), and unproven by Boeing. All we know is that its content is different than the Dissertation itself. Again, there is a failure of proof as to the precise material alleged to be on sale on March 4th.

I. Ms. Morris Lacks Personal Knowledge Of The Facts

The ID argued that Ms. Morris was testifying as a "corporate representative" of ProQuest, "to describe ProQuest's business practices relating to how it receives and publishes documents." Paper 8, p. 16. However, her objections to the subpoena state that: "Morris objects to the Subpoena to the extent information or testimony is sought that is outside the confines of her personal knowledge." Ex-2005, p. 1, ¶ 2. Second, her declaration states she "ma[d]e this Declaration on personal knowledge." Ex-1035 and Ex-1038, p. 4, first paragraph. And, at deposition Ms. Morris confirmed she was testifying in her personal capacity. Ex-2004, 13:12-15, 21:9-14. She is not a "corporate representative" as the PTAB alleged, nor a FRCP 30(b)(6) witness as her counsel insisted. Ex-2005, p. 1, ¶ 2.

Patent Owner has no issue with testimony concerning ProQuest's *present* practices, since she joined ProQuest in 2018. However, her testimony about practices in 2003 are necessarily based on speculation and hearsay, as is any

testimony specific to the Wang-Dissertation . Thus, her testimony should be given no weight as to alleged historical “facts,” backed up with nothing. It is hearsay based on hearsay.

The PTAB stated that “Patent Owner cites to no authority for the proposition that first-hand knowledge is required” to prove a document’s public accessibility. ID, p. 16. But in *Dish Network L.L.C. v. Dragon Intellectual Property, LLC*, IPR2015-00499, Paper 7 (PTAB July 17, 2015), this tribunal used a declarant’s lack of personal knowledge as grounds to find a document was not a printed publication, despite his employment at the relevant time:

Mr. Bender’s testimony lacks personal knowledge as to when and how the Truog thesis was made available to the public, and his testimony also is insufficient evidence of the library’s specific practices as to indexing and cataloging papers in the relevant time... .

Id. at pp. 10-11.

Ms. Morris conceded she lacks first-hand knowledge of the events set forth in 2003 (Ex-2004, 35:2-6), and none of it is corroborated. Under Fed. R. Evid. 602, “A witness may testify to a matter only if evidence is introduced sufficient to support a finding that the witness has personal knowledge of the matter.” Personal knowledge means that the witness must have directly perceived the event or facts they are testifying about through their own senses (such as seeing, hearing, or otherwise experiencing the event). *See Asahi Glass Co. v. Guardian Indus. Corp.*,

2011 U.S. Dist. LEXIS 164886, *2-3 (D. Del. Oct. 13, 2011). This requirement helps to ensure that the testimony is based on actual, firsthand experience rather than speculation, assumption, or hearsay. It is a fundamental aspect of ensuring the reliability and credibility of evidence presented.

Ms. Morris fails the personal knowledge requirement miserably, since she didn't join the company until 15 years after the events in question. Any records she allegedly reviewed are hearsay to her, since she did not create or receive them, and they are not in the record to be tested. *See Daedalus Blue, LLC v.*

Microstrategy Inc., 2023 U.S. Dist. LEXIS 111009 *30-31 (E.D. VA April 11, 2023), *report adopted* 2023 U.S. Dist. LEXIS 127544* (E.D. VA July 24, 2023) ("But given that Mr. Raczko never worked in the 'Tools' division ...[the court] believes that it may be more likely that Mr. Raczko acquired via hearsay that [*sic* – than] based on his personal observation.") Not a single contemporaneous document in the record bears a date of March 4, 2003, and Ms. Morris could point to none. Ex-2004, 49:10-21. Any "knowledge" about the Wang-Dissertation that Ms. Morris purported to acquire for this IPR does not constitute "personal knowledge." *Daedalus Blue*, 2023 U.S. Dist. LEXIS 111009 *31-32 (E.D.Va. Apr. 9, 2023) (citing *McLaren v. Wheaton College*, 194 F. Supp. 3d 743, 752 (N.D. Ill. 2016)) (knowledge gained during litigation does not constitute personal

knowledge), and *U.S. v. Denton*, 944 F.3d 170 (4th Cir. 2019) (after-the-fact investigation is not personal knowledge).

For the foregoing reasons, Boeing hasn't proven that the Wang-Dissertation is a printed publication.

III. CLAIM CONSTRUCTION

Patent Owner agrees with Petitioner that no terms of the challenged claims require any special constructions. That is, each term in the challenged claims should be interpreted in accordance with their plain and ordinary meaning.

Consistent therewith, the phrase “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” as recited in claim 1, and similarly recited in claim 13 (“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”) means changing the profile of the laser generated compressive wave and propagating the wave profile as modified to the free surface of the coating, which upon reflection from the free surface as a tension wave generates a tensile stress at the coating/substrate interface. *See* Ex-2011, ¶25.

IV. A PERSON OF ORDINARY SKILL IN THE ART

Petitioner argues that a person of ordinary skill in the art at the time of the alleged invention (“POSITA”), would have had an M.S. in Mechanical Engineering or a related field, and at least five years of experience using laser systems to characterize and test mechanical behavior in materials. More education may supplement practical experience or vice versa. Pet., 5.

In addition to these qualifications, a POSITA developing new laser-based methodologies for mechanical behavior of materials would also have had education or training in wave mechanics and shock physics. Ex-2011, ¶¶21-22.

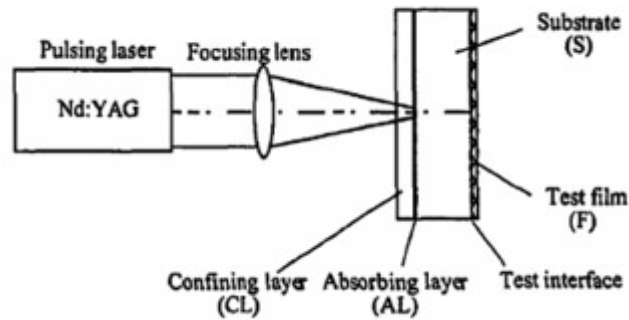
V. PETITIONER HAS FAILED TO SHOW A REASONABLE LIKELIHOOD OF PREVAILING WITH RESPECT TO ANY GROUND

For at least the following reasons, Petitioner has failed to establish that any of the challenged claims are invalid.

A. The Challenged Claims Are Not Anticipated by the Wang-Dissertation (EX-1005) (Ground-1)

Petitioner contends that claims 1-22 are anticipated by the Wang-Dissertation .

The Wang-Dissertation is not prior art, as shown in Section II *supra*. If considered, Chapter 3 details experiments using laser-spallation to remove film coatings. Ex-1005, iii, 6. Chapter 2 details “theoretical analysis of the stress-wave” involved therein. *Id.*, 6. The apparatus used is shown below.



EX-1005, 7.

From the laser impingement side, disposed is a constraining layer, absorbing layer, substrate, and film. A test interface lies between the absorbing layer and the film. Ex-1005, p. 7-8. In each experiment, fused silica, “with [] nonlinear elasticity”³ was used as the substrate. *See id.*, 7. Wang theorized that the “nonlinear properties [of fused silica could] develop a shock in the [stress wave caused by the laser pulse deposition in the] substrate”, and “enhance[] the loading at the film interface.” *Id.*, 5, 7. That is, “a short fall time in the substrate stress” could apply “sufficient stress [] at the interface in order to initiate interface failure” of the film at the substrate interface. *Id.*, 7.

³ Wang did not herself measure any material properties of the fused silica, *e.g.*, non-linear stress strain curves. Ex-2009 176:9-21. The non-linearity of fused silica is highly dependent on the manufacturing process and impurities. *See* Ex-2011, ¶87.

Wang's experiments did not align with her theory. In fact, all her experiments failed to show shock in the waveform. *See* EX-2011, ¶¶49-84. Wang erroneously interprets the unloading due to the un-modified stress of a direct tension wave as a "decompression shock." Ex-1003, ¶77; EX-2011, ¶¶50, 65-66.

In Wang's experiments, two compression waves are generated at the laser impingement point: compression-wave-1 which directly travels toward the substrate in the forward axial direction of the laser, and compression wave-2 (same magnitude) travels in the opposite direction into the constraining layer. EX-2011, ¶53; Ex-1005, 66. The compression wave-2 that goes toward the constraining layer is then *reflected* from the free surface of the constraining layer as a *tension* wave (direct-tension-wave/tension-wave-1) of the same amplitude and travels back into the substrate, chasing compression-wave-1.⁴ EX-2011, ¶¶53-55.

The Wang-Dissertation presents no evidence of modification of compression-wave-1 by the fused silica. EX-2011, ¶¶63-64, and 94. Wang agreed that it is impossible to tell from her data whether compression-wave-1 is modified to include a shock profile. Ex-2009 152:17-153:1.

⁴ In the '684 Patent technique, there is no reflected tension-wave-1 because a laser fluence is used that results in instantly vaporizing the laser absorption layer, creating a physical gap between the constraining layer and the substrate, preventing the transmission of tension-wave-1 into the substrate. Ex-2011, ¶55.

Even if the Wang-Dissertation disclosed a stress wave, *e.g.*, a rarefied compression wave, modified by the fused silica material, it would not propagate to the substrate interface, and therefore fail to generate a tensile stress (through reflection off the free-end of the coating) at the interface. This is because the reflected tension-wave-1 would catch-up and overtake compression-wave-1, neutralizing it before it reached the interface. EX-2011, ¶¶62, 64, 115, 123.

i. Claim 1

a) The Wang-Dissertation Fails to Disclose [1.c]⁵ “a glass element disposed on the second side of the substrate and axially spaced along the first axis”

The Wang-Dissertation fails to disclose a single embodiment where an additional element — glass or otherwise — is “disposed on the second side of the substrate and axially spaced along the first axis.” In Wang’s experiments, the absorbing layer is directly on the analogous “second side of the substrate. *See* Ex-10005, Fig. 2.1.

While the Wang-Dissertation briefly, (single paragraph), discusses “Future Work” wherein an “extra layer of the desired substrate material” could be “inserted” “between the fused silica substrate and coating . . . to test a variety of substrates and films”, Wang never attempted this “Future Work” before the filing

⁵ Herein, Patent Owner uses Petitioner’s claim element numbering scheme.

date of the '684 patent. Ex-2009, 157-160. Moreover, Gupta did attempt this arrangement, years before the Wang-Dissertation, and found that this arrangement, like those described in the Wang-Dissertation, did not produce a modified stress wave that is propagated to the interface. Ex-2009, ¶¶182-192. Wang's suggested arrangement of using an addition fused silica element would frustrate the purpose of the experiments discussed in the Wang-Dissertation — thin film removal. *Id.*, ¶137.

Moreover, the '684 Patent does not disclose "fused silica" as a material suitable for the "glass element" recited in claim 1. *See* Ex-1001, 3:18-20 ("The glass element may comprise Pyrex, Soda lime, quartz, borosilicate or similar material.")

Fused silica is not a "similar material" because it: allows for significant stress attenuation, (beyond geometrical attenuation), and does not propagate a modified stress wave to the interface. Ex-2011, ¶¶138, 166, 185.

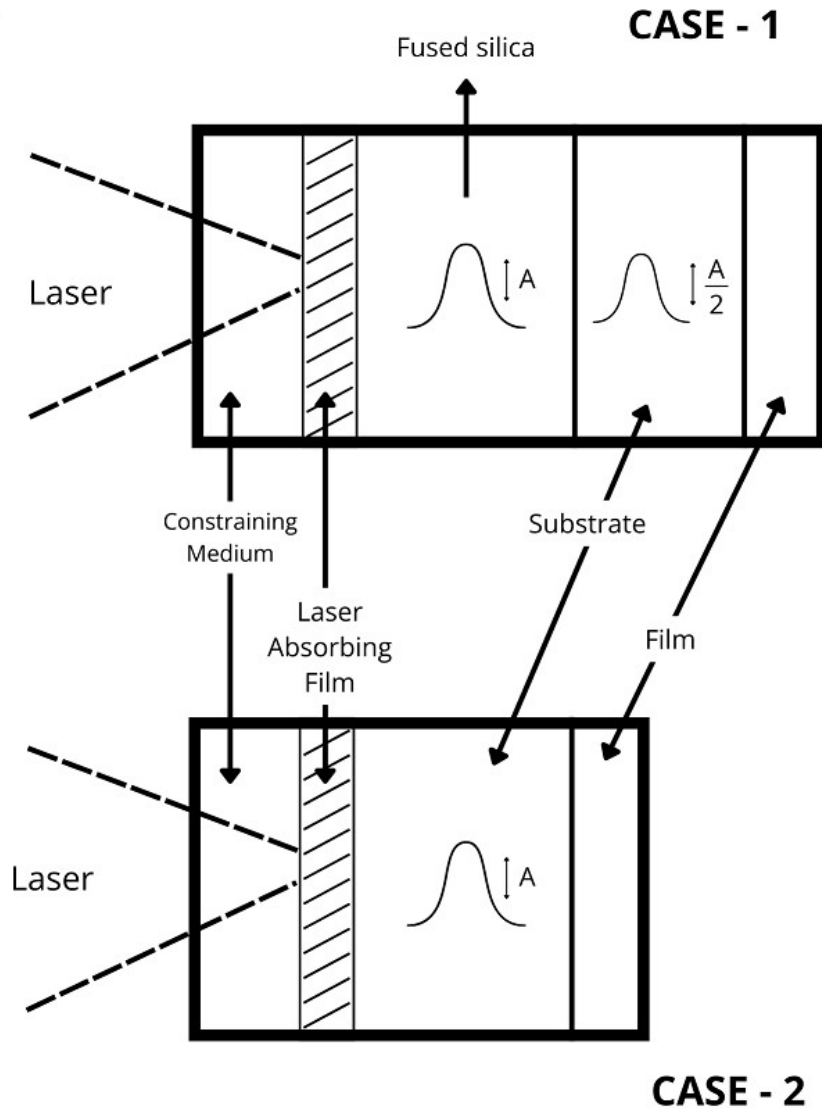
Laser generated stress waves in fused silica, even if they were to develop a decompression shock profile, lose 50% to 90% of their amplitudes through the substrate. EX-2011, ¶¶60, 94, 177; Ex-1005, p. 25 (testing thicknesses up to 10mm).

As the amplitude of the stress wave decreases due to this attenuation, the fused silica would no longer be subject to volumetric compression, which could potentially enable any hypothetical shock profile. EX-2011., ¶¶94, 138-139.

In contrast to fused silica, the “glass element” materials listed and described in the ‘684 Patent, *e.g.*, quartz (not fused quartz), do not exhibit such attenuation and both allow for modification and subsequent propagation of a stress wave to the interface. *Id.*

Even if one were to use another fused silica element “on the second side of the substrate” as argued by Petitioner, such a modification would frustrate Wang’s purpose of “test[ing] a variety of substrates and films” because the additional fused silica element would ***reduce*** stress at the interface. Ex-, 1005, 124.

Compared below is the Wang-Dissertation experimental set-up actually used (Case 2), and the version contemplated in Wang’s “Future Work” (Case 1).



EX-2011, ¶130.

In Case 1, the amplitude A of compression-wave-1 will undergo significant attenuation due to geometrical and (assuming a shock were to even develop) shock attenuation effects. EX-2011, ¶131.

Gupta calculated comparison values for Cases 1 and 2, using a fused silica thicknesses substrate/additional element in the range of 1.5-6 mm range, and a

maximum substrate stress in the range of 1.1 to 1.2 GPa (ranges Wang used in her experiments in the Wang-Dissertation). EX-2011, ¶¶131-132.

In Case 1, assuming *arguendo* that a shock were to develop in compression-wave-1 in the additional element, attenuation would drop the amplitude A at least between $0.45A$ to $0.6A$ (for 1.5-3 mm thickness, even more so for 6 mm). *Id.*. Geometrical dispersion would result in even further attenuation — approximately another 14% for a 3mm thick fused silica additional element. *Id.*; see Ex-1005, p. 25 (Fig. 2.9). Considering these dissipation effects, would yield an amplitude of between $0.38A$ to $0.51A$ when compression-wave-1 arrives at the substrate. EX-2011, ¶¶131-132.

In Case 2, since the stress is generated directly in the substrate, the amplitude would simply stay as A . EX-2011, ¶133.

As explained below, the Wang-Dissertation experiments failed to show shock in compression-wave-1 in the fused silica substrate. Even if developed, shock would attenuate long before the interface. As demonstrated in the comparison above, even assuming a shock in compression-wave-1 were to (1) develop in the additional element in Case 1, and (2) were to propagate to the substrate, its much lower amplitude would result in either the shock being destroyed when entering the substrate, or shortly thereafter due to attenuation. EX-

2011, ¶¶134-136. That is, the proposed “Future Work” of Wang would result in decreased, not increased, stress at the interface. EX-2011, ¶137.

b) The Wang-Dissertation Fails to Disclose [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”

Not only does the Wang-Dissertation fail to disclose a “glass element,” but the fused silica used in the Wang-Dissertation is not “configured to propagate and modify a stress wave to the coating/substrate interface to generate a tensile stress between the substrate and the coating.” There is no evidence in the Wang-Dissertation that a stress wave is modified, let alone that it is propagated to the coating/substrate interface, or that it generates a tensile stress between the substrate and the coating.

(1) No Evidence of a Modified Stress Wave

Petitioner contends that the Wang-Dissertation “discloses in fused silica, the initial stress pulse generated at the absorbing layer evolves into a shock after traveling a short distance.” Pet., 25 (citing Ex-1005, 30, 38, 65, 81). Tellingly, Petitioner does not rely on Wang’s Declaration (Ex-1003) for support, likely because Wang agrees her Dissertation fails to include experimental evidence that

fused silica allows for, or is otherwise configured to modify a stress wave, *e.g.*, to “evolve[] into a shock.” Ex-2009 152:17-153:1.

As explained above in the Wang-Dissertation arrangement, two compressive waves of equal magnitude are generated at the laser impingement site: one which initially travels toward the interface (compression-wave-1), and one which initially travels in the opposite direction toward the constraining layer (compression-wave-2). EX-2011, ¶53; Ex-1005, 66. The compression-wave-2 reflects from the constraining layer free surface and travels back toward the substrate as a tension wave of equal magnitude (tension-wave-1). EX-2011, ¶53; Ex-1005, 65 (“tensile pulse of comparable magnitude”) (“The experimental picture is complicated somewhat by the presence of a tensile wave, reflected from the back of the constraining layer.”) The Wang-Dissertation provides no evidence that either compression-wave-1 or tension-wave-1 is “modified.” The “shock” Wang refers to is actually due to tension-wave-1, not any modification of compression-wave-1.

Since tension-wave-1 is reflected from the constraining layer, it delayed from compression-wave-1. EX-2011, ¶54. The delay varies from test to test as “the surface properties of the constraining layer are not well controlled.” Ex-1005, 65. This delay is between 13 ns and 30 ns. *Id.* However, because tension-wave-1 is “tensile, it propagates faster than the peak compressive stress, and faster than the

low stress tail of the main pulse. It eventually overtakes the [compression-wave-1].” Ex-1005, 65.

As tension-wave-1 overtakes portions of compression-wave-1, including its peak compressive portion, it neutralizes the stress from the ramp to 0, then continues to build up in tension. Soon thereafter tension-wave-1 arrives at the interface to load it in tension. *See* Ex-2011, ¶¶72-84. Gupta confirms this by marching the stress wave shown in Fig. 3.15(d) to that of the tension-wave-1. *Id.* Therefore AB and BC comprise the rise time of the stress wave. Like compression-wave-1, tension-wave-1 is not modified. *Id.*, ¶63.

Fig. 3.15(c) of the Wang-Dissertation details experimental results of substrate stress over time.

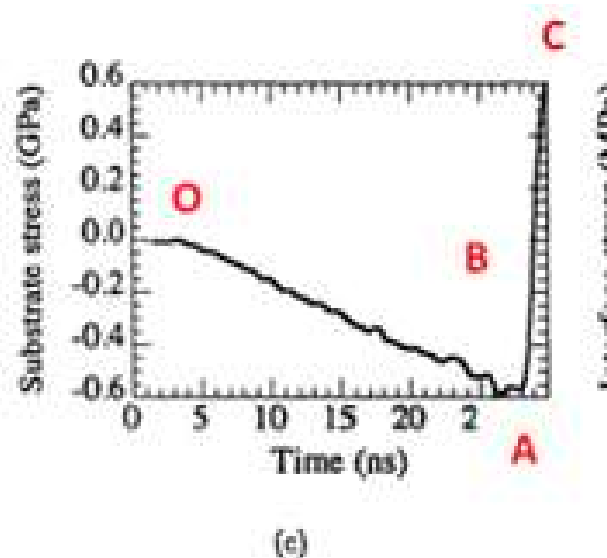


Fig. 15(c) (Annotated by Gupta). Ex-1005, 64; EX-2011, ¶¶57-58.

Wang opined that “[m]y dissertation discloses a stress wave between 10 to 30 ns . . . [as] can also be seen in the following figures of my dissertation: Figure 3.15c, 3.16, 3.17, 3.18, 3.19, 3.20b, 3.21b and 3.22.” Ex-1003. At her deposition, Wang initially contended that Fig. 15(c) depicted a shock, where the stress changes from a maximum compression (-0.6GPa) to 0 (line A-B). Ex-2009 90:4-8. However, Wang could not confirm whether stress change (-0.6GPa to 0) was due to compression-wave-1 being modified *or* to tension-wave-1 overtaking compression-wave-1. Ex-2009 92:3-4 (“this part is not a straightforward answer”). Surprisingly, Wang initially took the position that only the tensile portion of the stress wave shown in Fig. 15(c) (B-C) was due to tension-wave-1, implying that tension-wave-1 otherwise did not affect compression-wave-1. Ex-2009, 91:9-14, 20-92:9; 94:5-20. Gupta disagrees with this analysis, and Wang eventually conceded that her initial analysis was incorrect (c). EX-2011, ¶¶58-59; Ex-2009 152:17-153:1.

Here, the portion of the stress wave B-C is part of the same line as A-B. Since the delay between tension-wave-1 and compression-wave-1 depends on the thickness and properties of the constraining layer, (which vary significantly and as admitted by Wang, were not controlled), it would be an extraordinary coincidence

for tension-wave-1 to arrive at the substrate calculated stress point⁶ at the moment compression-wave-1 allegedly developed a shock. EX-2011, ¶58.

Wang's "shock" depicted in Fig. 3.15(c) is in fact a stress drop caused by tension-wave-1. EX-2011, ¶59. Wang confirmed that tension-wave-1 is of "comparable magnitude" to compression-wave-1. Ex-1005, 65. Line portions AB and BC depicted in Fig. 3.15(c) represent the sharp rise-time of tension-wave-1, which, unlike the compression wave, does not elongate because fused silica exhibits non-linear stress-strain behavior only under compression. EX-2011, ¶63.

In Wang's experiments, compression-wave-1 loses nearly 50% of its amplitude as it propagates to the interface. EX-2011, ¶60; Ex-1005, 37, Fig. 6. In contrast, tension-wave-1, retains nearly the same amplitude, as confirmed by Wang. EX-2011, ¶60; Ex-1005, p. 37. Thus, near the interface, tension-wave-1's amplitude is nearly double that of compression-wave-1, explaining the sharp increase in stress in Fig. 3.15(c). EX-2011, ¶¶61-62.

Moreover, the A-B stress change in Fig. 3.15(c) taking 2 ns is not instantaneous, and Wang confirmed that the measurement instrumentation used is capable of recording optical fringes with 0.2 ns resolution. EX-2011, ¶84; Ex-

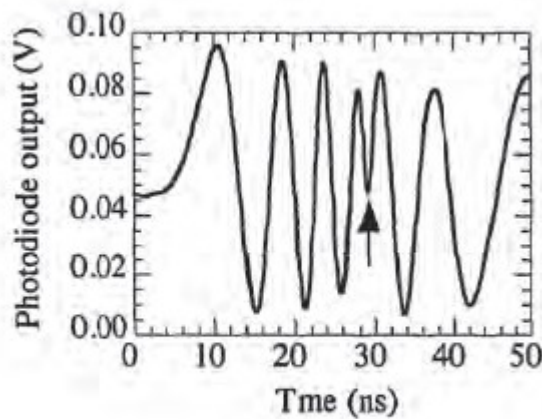
⁶ Wang calculated the stress in the substrate at a theoretical point both infinitely far from the interface and laser impingement point. Ex-2009 72:12-19.

2009, 155:11-19. Thus, if an instantaneous stress change occurred (shock), Wang's measurement instrument would have detected it. EX-2011, ¶84.

Wang's other cited figures also fail to show a shock in compression-wave-1. In Figs. 3.15-3.18, and 3.20-22, the tension portion (+0 GPa) is depicted immediately after the waveform goes from compressive stress to 0 stress. Extraordinary coincidence does not explain this timing given that the delay between tension-wave-1 and compression-wave-1 depends on the thickness and properties of the constraining layer, which vary significantly and were not controlled. EX-2011, ¶58. Ex-1005, 65. For example, in Fig. 3.20-21, tension-wave-1 clips compression-wave-1 at 13 ns and 22 ns, respectively. EX-2011, ¶65; Ex-1005, 74 and 77. This difference in arrival time is due to the difference in thickness of the constraining layer and matches the expected arrival time of tension-wave-1. *Id.*

Referring to Fig. 3.15(c), the slope of (AC) is consistent with the slope of waveforms in all of Wang's figures, because the rise-time of tension-wave-1 in fused silica is controlled by the laser pulse's rise-time. EX-2011¶67; Ex-2009 30:18-31:1. As explained in the '684 Patent, increasing laser pulse energy increases stress wave amplitude but leaves rise-time slope unchanged. *See* Ex-1001, Fig. 3A; EX-2011, ¶67.

Wang's fringe data also fails to demonstrate a shock in compression-wave-1. In attempting to relate the recorded fringes to a decompression shock, Wang misinterprets the change in the direction of the free surface velocity. Ex-1005, 64-65; EX-2011, ¶¶110-112. Fig. 3.15(a) of the Wang-Dissertation depicts measured a interferometric signal (only experimentally measured value in the Wang-Dissertation) from a Michelson interferometer, where each complete fringe “corresponds to a displacement of the film surface of half of the wavelengths of the [laser] light.” Ex-2009 36:14-11.



(a)

Ex-1005, Fig.315(a).

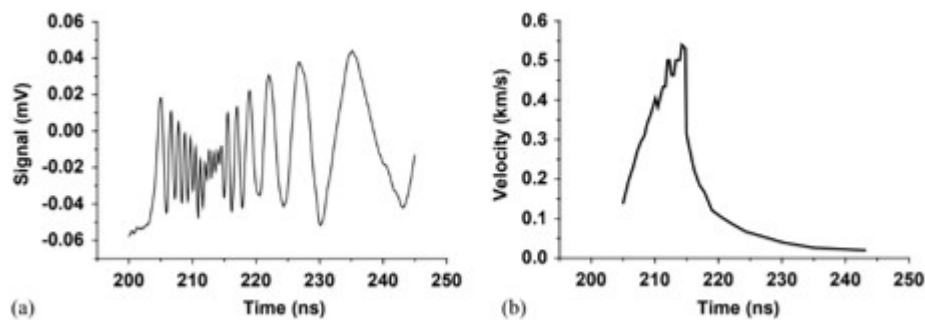
The arrow in Fig. 3.15(a) depicts a “turning point” — “the fastest changing point of the fringe is the highest stress point.” Ex-2009 63:18-19. Assuming compression-wave-1 were to reach the interface (without being neutralized or fully attenuated), its compressive force would pull the free surface of the film inward as

compression builds slowly. This inward motion would be recognized by interferometer recording by a change in light intensity at the photodiode. EX-2011, ¶109. Instead Fig. 3.15(a) shows is a stress change due to the arrival of tension-wave-1. *Id.* This is also shown in Fig. 3.15(c), and is consistent with what would be expected from a stress change due to tension-wave-1. *See* EX-2011, ¶1117. That is, Fig. 3.15(a) depicts a stress change consistent with the arrival of tension-wave-1, with its short rise time of about 2 ns. *Id.* Here, tension-wave-1 immediately pushes the film surface outward away from the interface, reversing the direction of surface movement. EX-2011, ¶109.

Wang's Dissertation records fringes up to 50 ns but only resolves the interface stress and the substrate stress to 30 ns. Ex-1005, 64. In fact, as shown in the last 20 ns of fringe data, the fringes are of much lower frequency and related to a regular compression stress pulse with no shock profile. Ex-2011., ¶109. Wang does not resolve those fringes. *Id.* Indeed, Wang acknowledged the presence of these extra fringes, but claimed the stress would be much lower and was of no interest to her. *Id.* Had Wang attempted to fully resolve the fringe data, including the initial portion of the fringe where the reversal occurs, the data would show that stress would keep increasing in tension until the film separates from the interface. EX-2011, ¶110. To be clear, none of these unresolved fringes correspond to a

shock in compression-wave-1 as fringe frequency is the lowest in that region. EX-2011, ¶111.

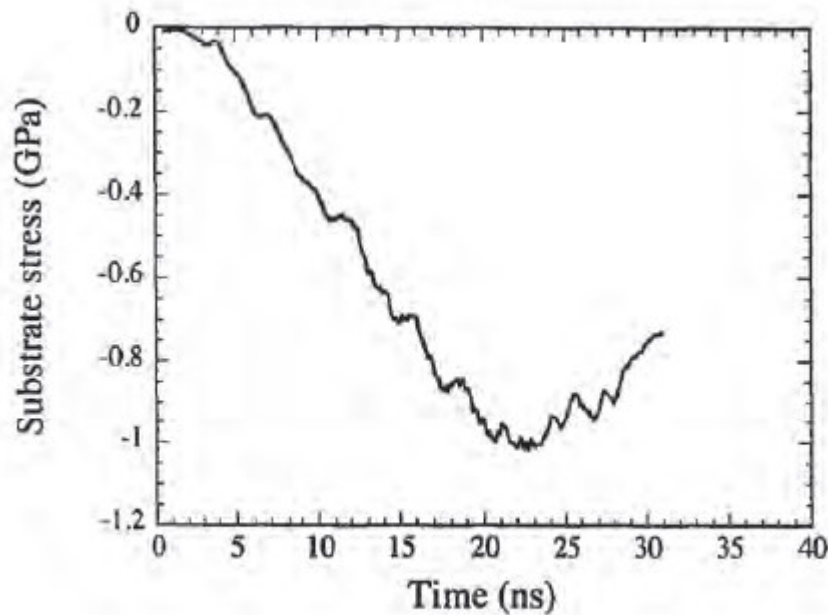
Compare the difference in fringe patterns from those in Wang's Dissertation to those in Figs. 3(a)-(b) of the '684 Patent.



Ex-1001, Fig. 3(a)-(b).

Fig. 3(a) shows the fringe pattern recorded from an experiment using a soda lime “glass element.” The shock develops around 215 ns (same in Fig 3(b)). EX-2011, ¶¶112-115. Between 210-215 ns there are about 7-8 fringes in just 5 ns, demonstrating rapid deceleration/acceleration of the free surface — a shockwave hallmark. *Id.* This is not shown in the fringe record in Wang's Dissertation. In Fig. 3.15(a), there are far too few fringes. *Id.*, ¶¶115-116.

Further proof that compression-wave – 1 never develops a shock is shown through Fig. 3.19, the only Wang-Dissertation figure not depicting a tension stress spike in the substrate.



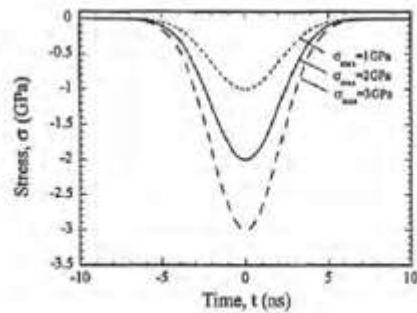
(b)

Ex-1005, 74 (Fig. 3.19(b)).

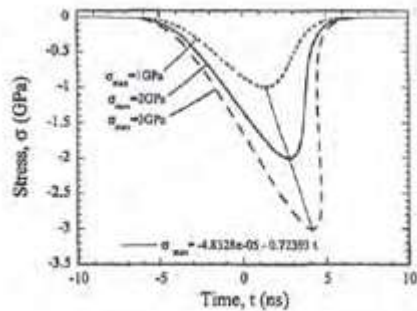
Because the confining layer was damaged after laser impingement, compression-wave-2 was unable to reflect off of the free surface of the confinement layer, and tension-wave-1 was never able to reflect and travel toward the substrate. (Ex-2009, 109:20-110:3); Ex-1005, 70; *see* EX-2011, ¶¶88-89, 118-119. Thus, only compression-wave-1 developed. *see* EX-2011, ¶¶88-89, 118-119. Without the influence of tension-wave-1, the lack of a shock profile in compression wave-1 is clearly visible. *Id.*

Thus, Wang's speculation that compression-wave-1 develops into a shock (discussed in Chapter 2 of her Dissertation) is shown to be false *by her own experimental data*.

As Wang theorized in Chapter 2, compression-wave-1 was expected to develop a decompression/shock profile in the fused silica. Ex-1005, 33; EX-2011, ¶¶69-70. Wang predicted that the timing of shock development would depend on the amplitude of the initial stress wave. *See id.*



(a)



(b)

Ex-1005, 33.

Wang predicted that, for 1, 2, 3 GPa, peak amplitude compression waves, it would take 54ns, 26ns, and 17ns, respectively, for the waves to form the

decompression shocks. Ex-1005, 33; EX-2011, ¶¶69-60. These theoretically predicted shocks never formed, and certainly not at Wang's predicted timing. *See id.*

(2) Even if the Wang-Dissertation Disclosed a Modified Stress Wave, it Would Not Propagate to the Interface

As explained above, the experiments performed in the Wang-Dissertation show that neither compression-wave-1 or tension-wave-1 is modified.

Even assuming *arguendo* that compression-wave-1 were modified to develop a shock, since the wave would attenuate and/or be neutralized, any shock profile thereof would not “propagate . . . to the coating/substrate interface,” let alone “generate a tensile stress between the substrate and the coating” as per claim 1. EX-2011, ¶71.

Wang acknowledges the attenuation effect on compression-wave-1. Ex-1005, 69-70 (“If the [confining layer] is too thin, no shock is detected [] because no shock is developed at all or because the shock is so weak that it is attenuated before reaching the film interface. Little or no damage occurs on the film.”).

Based on the theory presented in Chapter 2, laser generated stress waves with shock profiles in fused silica lose approximately 50%-90% of their stress

amplitudes by travelling merely 1.5-3mm of distance. Ex-1005, 32 (Fig. 2.12); EX-2011, ¶94.

This attenuation would fail to produce sufficient volumetric compression to maintain any shock profile. EX-2011, ¶¶89, 94, 138-139. As the wave amplitude decreases, the profile of the stress wave will revert back to an ordinary wave with no shock profile. *Id.* This phenomena can be observed in Fig. 3.19 of Wang's Dissertation, where, as explained above, no tension-wave-1 is present, and compression-wave-1 failed to develop into a shock. EX-2011, ¶ 74; Ex-1005, 74 (Fig. 3.19)

The inability of a shock to be formed in compression-wave-1 in fused silica at lower stresses is confirmed by Wang's own measurements of wave velocity in her fused silica samples reported in Table 2.1. EX-2011, ¶¶95, 134.

In Table 2.1, wave velocity, c , is reported by Wang to be 5940 m/s. Ex-1005, 14 (table 2.1). This is the elastic wave velocity. EX-2011, ¶95. It would take a certain minimum stress to maintain a shock profile in fused silica material. *Id.*

Figure 2.12 demonstrates how quickly the peak pressure or amplitude of the stress wave decreases as it travels through the fused silica substrate. *See* Ex-1005, 32 (Fig. 2.12); EX-2011, ¶¶69, 95, 146. At pressure levels that are generated by techniques taught by the '684 Patent, *e.g.* greater than 1.0 or 2.0 GPa (Ex-1001, 3:55-59), the Wang-Dissertation experiments demonstrate that a mere 1.5mm

(Wang considers 1.5, 3, and 6 mm thick substrates) of travel in fused silica will result in an amplitude reduction of 70% to 80% before the stress wave would even reach the test interface. EX-2011, ¶96. This drop in amplitude would destroy the wave's ability to maintain a shock profile, if it were to even be generated. *Id.*

Further evidence of this reduction in interface stress is provided in the Wang-Dissertation. Table 3.4 shows that as the thickness of the fused silica is increased from 1500 to 6000µm, the maximum substrate stress drops from -1.2 to 0.3 GPa in the substrate.

This results in a dramatic decrease in stress at the interface, *e.g.* from 370 to 50 MPa. In Table 3.4, a shock profile cannot be maintained at such low stress amplitudes in fused silica. Ex-1005, 69; EX-2011, ¶¶.

Assuming *arguendo* that a shock profile were to develop in compression-wave-1 per the Wang-Dissertation, it would undergo a dramatic reduction in amplitude as it travels towards the substrate/coating interface via the aforementioned attenuation. *See* EX-2011, ¶¶89, 94, 138-139. As shown in Fig. 2.15 (b) in the Wang-Dissertation, the theoretical shock wave amplitude in compression would be nearly halved over a propagation distance of 3 mm. EX-2011, ¶71; Ex-1005, 37 (Fig. 2.15(b)).

Experimental data in the Wang-Dissertation confirms this attenuation — Fig. 3.15c demonstrates that a -0.6 GPa compression-wave-1 stress corresponds to

a stress amplitude of about -1.2 GPa when first generated near the laser absorbing point. EX-2011, ¶71; Ex-1005, 64 (Fig. 3.15(c)). Here, tension-wave-1 would likewise have a comparable amplitude of about 1.2 GPa when first generated. EX-2011, ¶71. Since tension-wave-1 does not undergo significant reduction in amplitude as it travels through the substrate, tension-wave-1 with an amplitude of near 1.2GPa will arrive at the point in the substrate where the stress profile in Fig. 3.15c is calculated and neutralize compression-wave-1. EX-2011, ¶¶72. 73. Thus, data in Wang's Dissertation confirms that tension-wave-1 will neutralize the stress of compression-wave-1 by canceling the ramp compression, then account for the stress spike by building the peak tension stress following its rise-time. EX-2011, ¶74-¶75.

Assuming for argument's sake that the Wang-Dissertation describes a tension generated between the substrate and the film, this tension would be caused by tension-wave-1.

That is, because tension-wave-1 outruns the slower moving compression wave-1, tension-wave-1 is responsible for any tension at the interface. EX-2011, ¶¶79-85. This is consistent with the interface stress calculated by Wang in Fig. 3.15(d), where the tensile stress created by the front shallow ramp of compression-wave-1 resulted in zero stress, and the tension spike (due to tension-wave-1) comes when the direct tension wave strikes the interface on its journey towards the free

surface of the coating. *Id.* This tension-wave-1 would then reflect into a compression wave-3 from the free surface of the coating and start to reduce/neutralize the remaining tension from tension-wave-1, as shown in Fig.

3.15(d). *Id.* None of the interfacial failures described in Wang's Dissertation are related to the glass-modified (compression) stress wave. EX-2011, ¶85.

Further proof that the film failures in the Wang's Dissertation are from tension-wave-1, is found in the Al/fused silica interface strength data in Tables 3.4 and 3.7. Ex-1005¶¶97-99, 100-105.

In Table 3.4, the maximum compressive stress is shown to be 1.2 GPa. Compression-wave-1 generates a maximum tensile stress of 370 MPa at the interface between a 1.1 μm thick Al coating and fused silica substrate. *Id.*; Ex-1005. In Table 3.7, the maximum substrate stress is the same as in Table 3.4, even though the Al film is substantially thinner (0.5 μm) compared to the film in Table 3.7 (1.1 μm). Ex-1005¶¶97-99, 100-105.

In Table 3.4, the maximum interface stress is shown to be 370 GPa for a 1500 μm substrate. Remarkably, for the thinner film in Table 3.7, the interface stress is higher: 583 MPa, 502 MPa, 420 MPa, 547 MPa, and 435 MPa respectively. EX-2011, ¶105.

These results are contrary to what one would expect if compression-wave-1 were to be responsible for the stress.). Ex-1005¶¶97-99, 100-105. Indeed, Wang acknowledged that as the Al film thickness is reduced, the interface stress should be less for a thicker film. *Id.*; Ex-1005, 80. The reason for the greater interface stress values in Table 3.7 is simple: the film failures Wang observed are due to tension-wave-1. Ex-2011, ¶105.

Even Wang acknowledges that her experimental data is insufficient to establish that a reflected tension wave caused by the compression wave—1 reflecting off of the free surface of the film caused the tensile stress at the interface:

Q: Is it possible to tell, from your experimental data, whether the tensile stress shown in the interface is from the tensile wave, itself [*i.e.*, tension-wave-1], or the reflected compression waves [*i.e.*, compression-wave-1]?

A I don't think so. So either way, there is a very high tensile stress reached in the interface.

Ex-2009 152:17-153:1.

Therefore, since the Wang-Dissertation 's use of fused silica is insufficient to disclose, teach, or suggest “a glass element disposed on the second side of the substrate and axially spaced along the first axis”, let alone one that 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”, the Wang-Dissertation does not anticipate claim 1. Ex-2011, ¶152.

ii. Claim 13

Similar to the Wang-Dissertation ’s failure to disclose [1.c] “a glass element disposed on the second side of the substrate and axially spaced along the first axis” and [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”, the reference likewise fails to disclose [13.a] “positioning a glass element along the first axis on the second side of the substrate” and [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” as similarly recited in claim 13, for similar reasons. Ex-2011, ¶¶153-159.

Additionally, the Wang-Dissertation fails to disclose [13.d] “separating the coating from the Substrate as a result of the stress wave-generated tensile force”, because (1) as explained above with respect to claim 1, no modified wave was propagated to the interface which would generate a tensile stress between the substrate and the coating, and (2) any tensile stress felt at the substrate and the coating, *i.e.*, from tension-wave-1 would be of insufficient strength to separate the

coating from the substrate. *See* Ex-2011, ¶158. Thus, the Wang-Dissertation does not anticipate claim 13.

iii. Dependent Claims

a) Claim 2

In the Wang-Dissertation, no modified wave is disclosed as being propagated to the interface which would generate a tensile stress between the substrate and the coating, and any tensile stress felt at the substrate and the coating, *i.e.*, from tension-wave-1 would be of insufficient strength to separate the coating from the substrate. Ex-2011, ¶160.

b) Claims 3 and 14

The Wang-Dissertation fails to disclose the additional element of “wherein the glass is configured to propagate the stress wave as a result of impingement by a Nd-Yag laser beam directed in the first axis” because the reference, including the “Future Work” section does not show the presence of a glass element configured to propagate and modify the stress wave to the coating interface. Ex-2011, ¶161. The reference fails to anticipate claim 14 for similar reasons. Ex-2011, ¶171.

c) Claims 4 and 15

The Wang-Dissertation fails to disclose the claimed length of the wave range because, the glass modified wave, as already discussed, is not disclosed anywhere in the Wang-Dissertation . Ex-2011, ¶¶162, 172.

d) Claims 5 and 16

The Wang-Dissertation fails to disclose generating a shock formation, let alone a “rarefaction shock formation”, wherein the post-peak decay time is reduced to zero. Thus, the Wang-Dissertation fails to anticipate claims 5 and 16. Ex-2011, ¶¶163, 173.

e) Claims 7 and 18

The Wang-Dissertation fails to disclose the additional element of “wherein the glass element is bonded to the second side of the substrate” (in claim 7 and similarly recited in claim 18) because the “Future Work” section of the Dissertation describes adding an additional fused silica element “between the fused silica and the thin film”, which is analogous to the “first side” of the substrate, not the “second side.” Ex-2011, ¶¶165, 175.

f) Claims 8 and 19

The Wang-Dissertation fails disclose the additional element of “wherein the glass element comprises one of the following: Pyrex, Soda lime, quartz, or

borosilicate” because “fused silica is not one of the claim materials or an equivalent thereof. Ex-2011, ¶¶166, 176

g) Claims 9 and 20

The fact that the Wang-dissertation does not disclose the formation of rarefaction shock, as required by claim 1, the thicknesses she uses in her experiments for the fused silica substrates fall outside the scope of those disclosed in claim 9. Ex-2011, ¶¶167, 177.

h) Claim 10

The Wang-Dissertation fails “wherein the substrate comprises silicon” because Si was not tested in the arrangement that was discussed in the “Future Work” section. Ex-2011, ¶168. Even if it were, claim 10 requires that silicon be a part of an apparatus where a glass modified wave enters its thickness from the side opposite to where the test coating interface is located. That would be the side attached to the fused silica. Since fused silica is not a glass element it cannot propagate and modify a wave into the Si substrate. For all these reasons the Wang-Dissertation does not anticipate claim 10. *Id.*

i) Claims 11 and 21

The Wang-Dissertation fails to teach “a constraining element disposed adjacent to the glass element” because in the “Future Work” section, the additional

fused silica element is disposed between the substrate and the film interface, not the adjacent to the constraining layer. Ex-2011, ¶¶169, 178.

j) Claims 12 and 22

For similar reasons why the Wang-Dissertation does not anticipate claim 11, the reference cannot anticipate claim 12 or claim 22 because the “Future Work” section describes positioning the additional fused silica element between the substrate and the thin film. Ex-2011, ¶¶ 170, 179. The “Future Work” section of the Dissertation describes adding an additional fused silica element “between the fused silica and the thin film”, which is analogous to the “first side” of the substrate, not the “second side.” *Id.*

B. The Challenged Claims Are Not Anticipated by Gupta-1992 (Ex-1011) (Ground 4)

Under Ground 4, Petitioner contends that claims 1-8, 10-19, and 21-22 of the '684 Patent are anticipated by Gupta-1992.

Gupta-1992 presents the early work of inventor Gupta on the Measurement of Interface Strength by a Laser Spallation Technique. Ex-1011, Abstract. According to Wang, “[t]his is the same idea. [F]used silica [(as proposed by Wang in the “Future Work” section of her Dissertation)] or fused quartz [(as per Gupta-1992)], yes. I think you can consider them as equivalent, or the same.” Ex-2009,

186:7-9. Moreover, the substance of Gupta 1992 is also coextensive with U.S.

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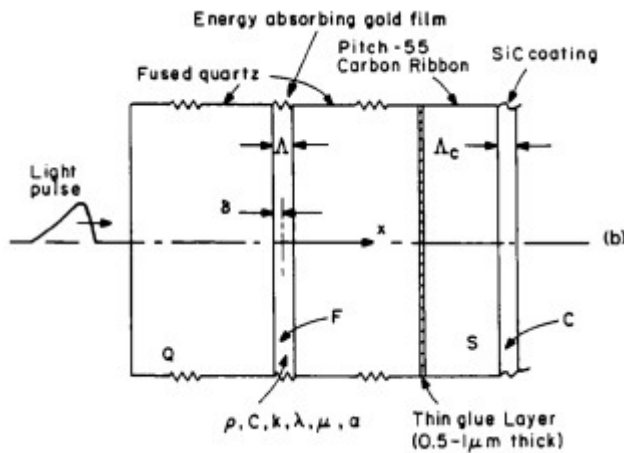
Gupta '402 patent and therefore the USPTO examiner after thoroughly reviewing this reference during my interview granted the '684 claims. No tension wave is transmitted in any of the Gupta-1992 experiments and therefore all interface failures are caused by the reflection of the unmodified wave from the free surface of the coating.

i. Claim 1

a) Gupta-1992 Fails to Disclose [1.c]² “a glass element disposed on the second side of the substrate and axially spaced along the first axis”

Here, Petitioner relies on Gupta-1992 Fig. 2(b) which depicts “an additional layer of fused quartz (‘a glass element’) [] glued to the second side of the P-55 substrate.” Pet., 47 (citing Ex-1011, Fig. 2(b) and Ex-1003, ¶195).

² Herein, Patent Owner uses Petitioner’s claim element numbering scheme.



Gupta-1992, Fig. 2(b)

Fused quartz however, is not equivalent to the “glass element” recited in 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 (without the word fused) on the other hand is a totally different material with [a] pure crystalline phase.” EX-2011, ¶185.

As explained in detail above in Section VA, fused silica is not equivalent to the “glass element” recited in claim 1. For the same reasons, fused quartz, as disclosed in Gupta-1992, is not equivalent to the “glass element” recited in claim 1.

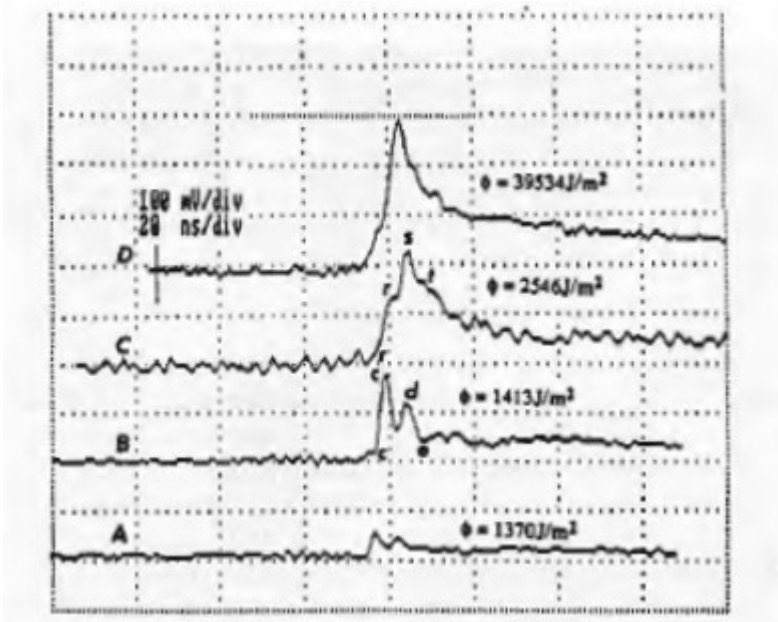
b) Gupta-1992 Fails to Disclose [1.d] “wherein the glass element is configured to propagate and modify a stress

wave to the coating/substrate interface to generate a tensile stress between the substrate and the coating”

Because Gupta-1992 fails to disclose the use of a “glass element” as described in element 1.c, the reference necessarily fails to disclose element 1.d. Indeed, because fused quartz as used in Gupta-1992 is, for purposes of wave propagation, the same material as fused silica used in the Wang-Dissertation , Gupta-1992 failed to disclose, teach, or otherwise suggest element [1.d] for the same reasons that the Wang-Dissertation fails to do so, described above.

That is, Gupta-1992 fails to disclose any modified stress wave, let alone one that it is propagated to the coating/substrate interface, or that it generates a tensile stress between the substrate and the coating. Further evidence of that failure is discussed below.

In the experimental arrangement depicted in Gupta Fig. 2(b), Gupta measured the stress wave profiles at points just before, and just after the compression wave propagated through to the Pitch-55 substrate. EX-2011, ¶183. The stress wave profile that Gupta measured closely resembled what Wang herself recorded in Fig. 3.19 of her Dissertation. *Id.* In both Fig. 3.19 of the Wang-Dissertation , and in Gupta-1992, no shock (*e.g.*, decompression/rarefaction) was observed. *Id.*

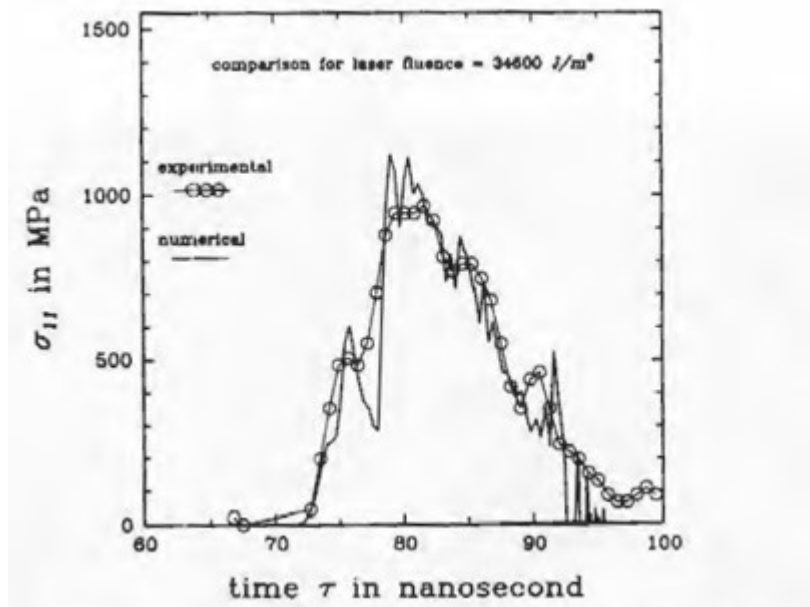


Ex-1011, 157 (Fig. 11)

Fig. 11 of Gupta-1992 (reproduced above) depicts stress wave profiles of experiments performed according to the Gupta-1992 methods measured in the substrate. None of the stress wave profiles shown have a shock (*e.g.* rarefaction) profile. See EX-2011, ¶210.

This is because, similar to the problems in the Wang-Dissertation, in Gupta-1992, by the time the stress wave has arrived at the surface of the substrate, after travelling 2-3 mm through the fused quartz additional element, the wave had either lost its shock profile or it never obtained a shock profile in the first place. EX-2011, ¶190.

Figure 15 of the Gupta-1992 reference, shows additional stress waveforms measured using experimental procedures performed and described in Gupta-1992, including the embodiment relied on Petitioner, and shown in Fig. 2(b) thereof.

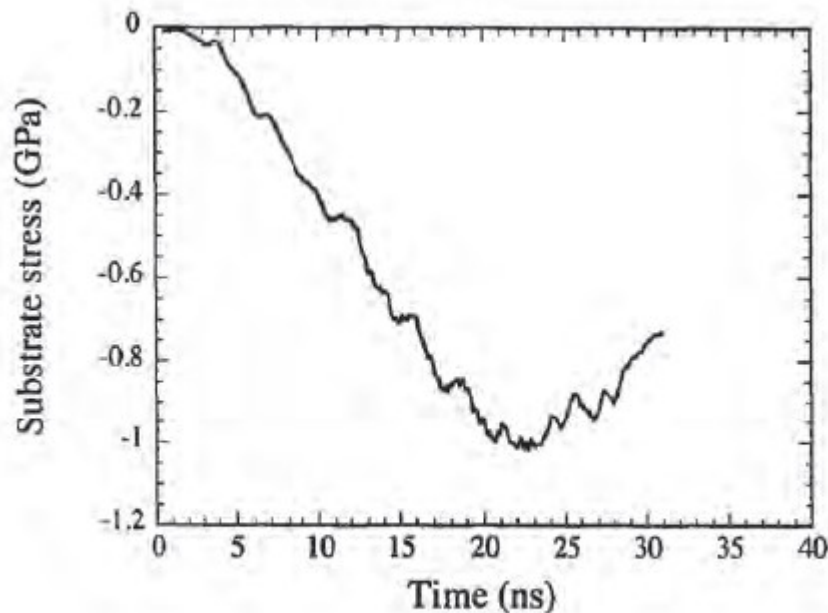


Ex-1011, 157

Here, again there is no shock wave profile shown. *See* EX-2011, ¶210.

Wang agrees. Ex-2009 188:22-189:2 (Q: Is a shock shown in any of the waveforms depicted in Figure 15? A: Doesn't look like [it].")

Indeed, the shock wave profiles depicted in Fig. 15 of Gupta-1992, closely match the shock wave profile in Fig. 3.19 of the Wang-Dissertation (reproduced below).



(b)

Ex-1005, 74 (Fig. 3.19(b)).

In both experiments, there is no reflected tension-wave-1 effect⁸, and no shock profile for the compression wave.

Tellingly, neither Petitioner nor Wang are able to identify any shock profiles present in Gupta-1992. Ex-2009 187:14-15 (Q: Is a shock depicted in these waveforms? A: I can't tell"); 188:13-17, 22-189:2 (Q. Is a shock shown in any of these waveform depicted in Figure 15? A: Doesn't look like [it].") Contrary to

⁸ Similar to the techniques used in the '684 Patent (see Footnote 2, *supra*), Gupta was able to avoid the reflected tension wave-1 in Gupta-1992 by instantly vaporizing the laser absorption layer, creating a physical gap between the constraining layer and the substrate, thereby preventing the transmission of the tension wave into the substrate. Ex-2011, ¶55.

Petitioner's attorney's argument, it is not an inherent property of fused quartz to "to propagate and modify a stress wave, and for the specific application to generate tensile stress between a coating and substrate." Pet., 50.

Therefore, since Gupta-1992's use of fused quartz is insufficient to disclose, teach, or suggest "a glass element disposed on the second side of the substrate and axially spaced along the first axis", let alone one that 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", Gupta-1992 does not anticipate claim 1. Ex-2011, ¶202.

ii. Claim 13

Similar to the Gupta-1992's failure to disclose [1.c] "a glass element disposed on the second side of the substrate and axially spaced along the first axis" and [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", the reference likewise fails to disclose [13.a] "positioning a glass element along the first axis on the second side of the substrate" and [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” as similarly recited in claim 13, for similar reasons. Ex-2011. ¶¶203-214.

Additionally, the Gupta-1992 fails to disclose [13.d] “separating the coating from the Substrate as a result of the stress wave-generated tensile force”, because (1) as explained above with respect to claim 1, no modified wave was propagated to the interface which would generate a tensile stress between the substrate and the coating, and (2) any tensile stress felt at the substrate and the coating, *i.e.*, from tension-wave-1 would be of insufficient strength to separate the coating from the substrate. *Id.* Thus, Gupta-1992 does not anticipate claim 1.

iii. Dependent Claims

The remaining challenged claims are dependent claims. Because Gupta-1992 fails to anticipate independent claims 1 and 13, the reference necessarily fails to anticipate the remaining challenged claims. Additionally, the reference fails to disclose certain additional elements recited in these claims. For example:

a) Claim 2

In Gupta-1992, no modified wave is disclosed as being propagated to the interface which would generate a tensile stress between the substrate and the coating, and any tensile stress felt at the substrate and the coating, *i.e.*, from

tension-wave-1 would be of insufficient strength to separate the coating from the substrate. Ex-2011, ¶¶215.

b) Claims 3 and 14

Gupta-1992 fails to disclose the additional element of “wherein the glass is configured to propagate the stress wave as a result of impingement by a Nd-Yag laser beam directed in the first axis” because Petitioner’s alleged “glass” element in Gupta-1992 does not modify a compression wave into shock wave. Ex-2011, ¶¶216, 225.

c) Claims 4 and 15

Gupta-1992 fails to disclose the claimed length of the wave range because, the glass modified wave, as already discussed, is not disclosed anywhere therein. Ex-2011, ¶¶217, 226.

d) Claims 5 and 16

Gupta-1992 fails to disclose generating a shock formation, let alone a “rarefaction shock formation”, wherein the post-peak decay time is reduced to zero. Thus, the Wang-Dissertation fails to anticipate claims 5 and 16. Ex-2011, ¶218, 227.

e) Claims 8 and 19

Gupta-1992 fails disclose the additional element of “wherein the glass element comprises one of the following: Pyrex, Soda lime, quartz, or borosilicate” because “fused silica is not one of the claim materials or an equivalent thereof. Ex-2011, ¶¶221, 230.

f) Claim 10

Gupta-1992 fails “wherein the substrate comprises silicon” because Si was not tested in the arrangement relied upon by Petitioner. Ex-2011, ¶222.

C. The Challenged Claims Are Not Obvious in view of the Wang-Dissertation (Ex-1005) (Ground 2)

Under Ground 2, Petitioner contends that claims 4, 6, 9, 15, 17, 20, and 23-24 are obvious in view of the Wang-Dissertation . Patent Owner disagrees.

First, as explained above, Petitioner has failed to establish anticipation of independent claims 1 and 13, from which the claims challenged under Ground-2 depend. Petitioner does not allege that these independent claims are obvious in view of the Wang-Dissertation , and offers no alternative obviousness argument for claims 1 and 13. Thus, for this reason alone the reference cannot render claims 4, 6, 9, 15, 17, 20, and 23-24 obvious. Additional reasons are presented below.

i. Claims 4 and 15

The Wang-Dissertation fails to disclose, teach, or otherwise suggest the claimed range of the length of the wave. Petitioner has failed to show that the

reference describes an overlapping range (in fact none exists because the Wang-Dissertation fails to disclose a modified wave), and as such Petitioner has failed to demonstrate that the wavelength range would be a result-effective variable. Ex-2011, ¶¶237, 241.

A POSITA has no basis to even imagine the profile of the modified wave for optimization in length because a POSITA would not know what modified wave profile is sought, or have seen a modified wave profile to modify. *See id.*

ii. Claims 6 and 17

The Wang-Dissertation fails to disclose, teach, or otherwise suggest the claimed coating thickness range. Petitioner has failed to demonstrate that the range would be optimizable. *See* Ex-2011, ¶¶239, 242.

As explained above, a POSITA would not have observed a modified wave in the Wang-Dissertation. Without knowing the profile of the glass modified wave, it is unclear as to how a POSITA would have sought to reduce the thickness of the film with predictable results. *See id.* In the Dissertation, there are several tests where the failure is in the substrate. *Id.* In some instances, a thicker film could not be separated but a thinner film could. *Id.* Ability to separate a film depends upon numerous interdependent parameters. *Id.* Interface tension is controlled not only by the thickness of the film but by its elastic constant that depends upon its atomic

structure, the intrinsic tensile strength of the interface, the dispersion characteristics of the wave that is formed by the laser pulse, the rise time of the laser pulse, the energy of the laser pulse and the thickness and properties of the constraining waterglass layers. *See* Ex-2011, ¶¶239, 242. There would simply be no basis for a POSITA to find claims 6 or 17 obvious in view of the Wang-Dissertation . *See id.*

iii. Claims 9 and 20

The Wang-Dissertation fails to disclose, teach, or otherwise suggest the claimed glass element thickness range. Petitioner has failed to demonstrate that the range would be optimizable. *See* Ex-2011, ¶¶240, 243.

Indeed, as explained above, no glass-modified wave was obtained from the Wang-Dissertation experiments, and its theory was proved incorrect.

Even if such a modified wave profile were known based on the Wang-Dissertation , as explained above, such a modified wave would not reach the substrate interface according to the Wang-Dissertation , as explained above. Since the Wang-Dissertation experiments did not align with Wang’s predicted theory, a POSITA would have had no basis to find that the fused silica element is sufficient to establish that the physical parameters of the glass element” are result-effective variables. *See id.* Modification of the fused silica according to the Wang-

Dissertation experiments would be a non-trivial exercise, with unpredictable results. *See Id.*

iv. Claims 23-24

The Wang-dissertation does not render obvious the claimed stress ranges. One of ordinary skill in the art would not have found it obvious to (1) generate a modified stress wave, or (2) increase the resultant stress. *See* Ex-2011, ¶¶245-246.

At most, A POSITA would arguably focus on enhancing the amplitude of tension-wave-1 that caused the film failures observed. However, enhancement of the interface stress amplitude is not merely dependent upon laser fluence, as other parameters, such as length of the stress wave, thickness of the film, etc., also govern the amplitude of the stress wave. Additionally, if one were to simply increase the laser energy, there comes a point when the efficiency to the stress wave energy conversion decreases as the vaporized plume of laser absorbing material is ionized and its entire energy is not deposited into the laser absorbing layer. These are fairly sophisticated laser-material interaction effects governed by material's ionized states and as such not amenable to routine experimentation with predictable results for the generation of stress wave amplitude. *Id.*

D. The Challenged Claims Are Not Obvious in view of the Wang-Dissertation (Ex-1005) and Gupta-1992 (Ex-1011) (Ground 3)

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.*

Petitioner only explicitly relies on Gupta only to support the argument that “it would have been obvious to a POSITA at the time of the invention to implement Wang’s fused silica glass element and sample configuration with a desired substrate as discussed in Gupta-1992”, *i.e.*, to put “fused silica . . . on the second side of the substrate.” Pet., 40. Patent Owner disagrees.

First, it would not have been obvious to combine the teachings of the Wang-Dissertation with those of Gupta 1992. Ex-2011, ¶¶251-256. Throughout the Wang-Dissertation, failures were not shown to be at the interface but rather inside the substrate. *Id.* The Gupta-1992 reference demonstrates that interfacial tension exceeding 1 GPa could be routinely achieved prior to Wang’s Dissertation, even though the Wang-Dissertation was only able to achieve 0.6GPa; and the thinnest

film tested was 0.3 micrometers thick. *Id.* A POSITA would not have sought to increase interfacial tension when the Wang-Dissertation disclosed premature substrate failures at lower stresses. *See id.* Furthermore, as explained above, the fused quartz used in Gupta-1992 does not modify the stress wave, so even if a POSITA knew to look to modify the stress wave, Gupta-1992 would have been no more helpful in that regard than the Wang-Dissertation itself. *See id.*

i. Claims 1 and 13

Under Ground 3, Petitioner relies on Gupta-1992 to the extent that “Wang does not disclose or suggest fused silica (“glass element”) on the second side of a substrate,” stating “Gupta-1992 is directed to tensile laser spallation techniques for thin films (Ex-1011, Abstract), so a POSITA would have had reason to look to Gupta-1992’s teachings when implementing tensile laser spallation techniques and using fused silica to increase interfacial stress for testing thin films as taught by Wang. Ex-1003, ¶171.” Pet., 40. However, as explained above, Gupta-1992 does not disclose the use of a glass element as claimed, and does not disclose a glass element or equivalent material capable of modifying a stress wave as claimed. Ex-2009, ¶¶247-250. Thus, even if one were to look at Gupta-1992 for guidance, the combination would still fail to disclose the claim 1 features of “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” as recited in claim 1, and similarly recited in claim 13 (“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”). Ex-2011, ¶¶257-270.

ii. Dependent Claims

The remaining challenged claims are dependent claims. Because as explained above, neither the Wang-Dissertation nor Gupta-1992, whether taken alone or in combination, disclose all of the elements of claims 1 and 13; and because Petitioner has not articulated any rationale² as to why any of the elements of the dependent challenged claims would be obvious in view of the combination of Wang-Dissertation nor Gupta-1992, where a reference alone fails to disclose these elements, the challenged dependent claims are not obvious in view of the Wang-Dissertation and Gupta-1992. *See* Ex-2011, ¶¶271-298.

² To the extent Petitioner relies on the combination of the Wang-Dissertation and Gupta-1992 for rendering obvious claims 7 and 18 (see Pet., 41-43), Patent Owner has explained above why this combination would not have been obvious and how Gupta-1992 does not disclose the use of a “glass element.” *See* Section V.D., *supra*.

E. The Challenged Claims Are Not Obvious in view of Gupta-1992 (Ex-1011) and Gupta 1993 (Ex-1013) (Ground 5)

Under Ground 5, Petitioner contends that claims 9 and 20 are obvious in view of Gupta-1992 and Gupta 1993. Patent Owner disagrees.

Here, Petitioner relies on Gupta 1993 only for the specific thickness range recited in claims 9 and 20 for the “glass element.” Pet., 56-57.

As explained above in Section VB however, Gupta-1992 fails to disclose, teach, or otherwise suggest all of the features of independent claims 1 and 13, including the “glass element”. Petitioner does not rely on Gupta-1993, or any other reference to cure the failures of Gupta-1992 in this regard. For this reason alone Ground 5 must fail. Ex-2011, ¶298.

Moreover, as also explained above, since a POSITA would not have observed a glass-modified wave per the Gupta-1992 disclosure, a POSITA would not have sought to optimize that waveform and looked elsewhere, including Gupta-1993. *See* Ex-2011, ¶¶299-303.

F. The Challenged Claims Are Not Obvious in view of Gupta-1992 (Ex-1011) (Ground 6)

Under Ground 6, Petitioner contends that claims 4, 6, 10, 15, 17, and 23-24 are obvious in view of Gupta-1992. Patent Owner disagrees.

As explained above, Gupta-1992 is cumulative of the “Future Work” section of the Wang-Dissertation , and fails to disclose all of the features of the challenged

claims, including independent claims 1 and 13. *See* Section V.B., *supra*. Petitioner does not allege that Gupta-1992 renders obvious any of the features of claims 1 and 13. Since Gupta-1992 does not disclose all elements of the independent claims, the reference cannot render obvious the challenged dependent claims under this ground. Ex-2011, ¶305. Additional reasons for why the reference does not render obvious the challenged dependent claims are presented below.

i. Claims 4 and 15

Gupta-1992 fails to disclose the claimed length of the wave range because, the glass modified wave, as already discussed, is not disclosed anywhere therein. Ex-2011, ¶¶306-314. Moreover, a POSITA would not have found it obvious to modify an unobserved wave — they would have no basis to even imagine the profile to attempt optimize, which would be a non-trivial exercise with a low probability of success. *See id.*

ii. Claims 6 and 17

Gupta-1992 fails to disclose, teach, or otherwise suggest the claimed coating thickness range. Petitioner has failed to demonstrate that the range would be optimizable. *See* Ex-2011, ¶¶309, 312.

As explained above, a POSITA would not have observed a modified wave in Gupta-1992. Without knowing the profile of the glass modified wave, it is unclear

as to how a POSITA would have sought to reduce the thickness of the film with predictable results. *See id.* In Gupta-1992, there are several tests where the failure is in the substrate. *Id.* In some instances, a thicker film could not be separated but a thinner film could. *Id.* Ability to separate a film depends upon numerous interdependent parameters. *Id.* Interface tension is controlled not only by the thickness of the film but by its elastic constant that depends upon its atomic structure, the intrinsic tensile strength of the interface, the dispersion characteristics of the wave that is formed by the laser pulse, the rise time of the laser pulse, the energy of the laser pulse and the thickness and properties of the constraining waterglass layers. *Id.* There would simply be no basis for a POSITA to find claims 6 or 17 obvious in view of Gupta-1992. *See id.*

iii. Claim 10

Gupta-1992 fails “wherein the substrate comprises silicon” because Si was not tested therein. Ex-2011, ¶310. Even if it were, claim 10 requires that silicon be a part of an apparatus where a glass modified wave enters its thickness from the side opposite to where the test coating interface is located. That would be the side attached to the fused quartz. Since fused quartz is not a glass element it cannot propagate and modify a wave into the Si substrate. For all these reasons Gupta-1992 does not render obvious claim 10. *Id.*

iv. Claims 23-24

Gupta-1992 does not render obvious the claimed stress ranges. One of ordinary skill in the art would not have found it obvious to (1) generate a modified stress wave, or (2) increase the resultant stress. *See* Ex-2011, ¶¶313-314.

At most, a POSITA would arguably focus on enhancing the amplitude of the unmodified compression wave that caused the film failures observed. *See id.* However, enhancement of the interface stress amplitude is not merely dependent upon laser fluence, as other parameters, such as length of the stress wave, thickness of the film, etc., also govern the amplitude of the stress wave. Additionally, if one were to simply increase the laser energy, there comes a point when the efficiency to the stress wave energy conversion decreases as the vaporized plume of laser absorbing material is ionized and its entire energy is not deposited into the laser absorbing layer. These are fairly sophisticated laser-material interaction effects governed by material's ionized states and as such not amenable to routine experimentation with predictable results for the generation of stress wave amplitude. *See id.*

G. The Challenged Claims Are Not Obvious in view of Wang-2002 (Ex-1016) and Gupta-1992 (Ex-1011) (Ground 7)

Under Ground 7, Petitioner contends that claims 1-24 are obvious in view of Wang-2002 and Gupta-1992. Patent Owner disagrees.

Wang-2002 discusses “experiments with the same setup” used in the Wang-Dissertation (Ex-1005). Ex-2009, 190:16-19. In fact, Wang-2002 is only a portion of the Wang-Dissertation (Ex-1005). Ex-2009, 190:20-191: 6 (“It's one section of the dissertation. It's -- yeah, it's part of the dissertation work.”) All information in Wang-2002 is included in the Wang-Dissertation (Ex-1005), and Wang-2002 does not include any additional information. Ex-2009 191:7-9 (“Q But everything in this paper is included in the dissertation? A Think so. Most part, yes.”)

That is, Wang-2002 is completely cumulative of the Wang-Dissertation (Ex-1005). Gupta agrees. Ex-2011, ¶¶315-219

For the same reasons that the combination of the Wang-Dissertation and Gupta-1992 fail to render the challenged claims obvious under Ground 3, so too does the combination of Wang-2002 and Gupta-1992 fail to render the challenged claims obvious under Ground 7. *Id.*

VI. CONCLUSION

For the foregoing reasons, Petitioner has failed to show that any of the challenged claims are anticipated or obvious in view of the cited references.

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