

The Boeing Company
v.
The Regents of the University of California

IPR2024-00761
Patent 7,487,684

Patent Owner's Demonstratives
July 14, 2025 Oral Hearing



Syllabus

1. U.S. PATENT NO. 7,487,684
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5. Wang-2002 and Gupta-1992 Fail to Render Obvious Under Ground 7
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The '684 Patent

The '684 Patent

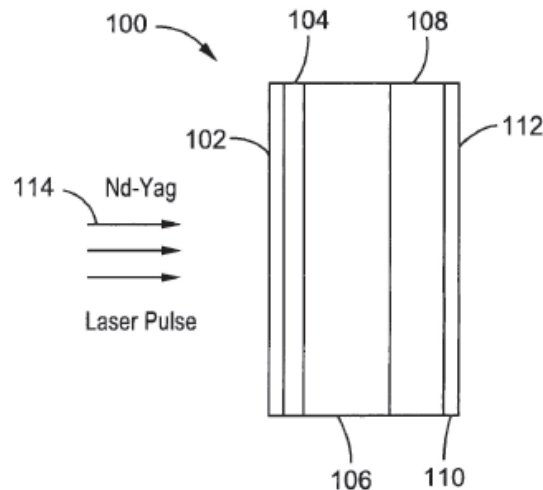


FIG. 4

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

- a substrate having a thickness, said thickness defined by a first side and a second side in a first axis;
- 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
- a glass element disposed on the second side of the substrate and axially spaced along the first axis;

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.

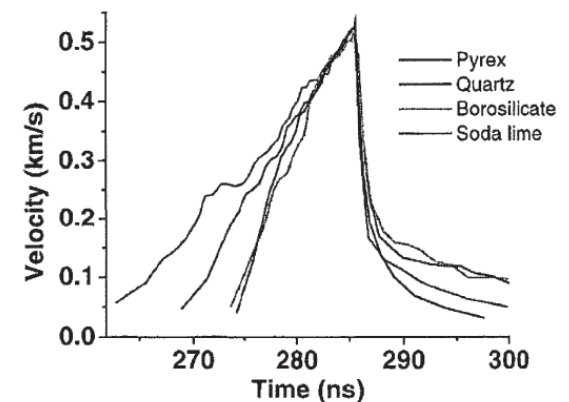


FIG. 6

Ex. 1001, Fig. 4 (left), claim 1 (center), Fig. 6 (right)

The '684 Patent

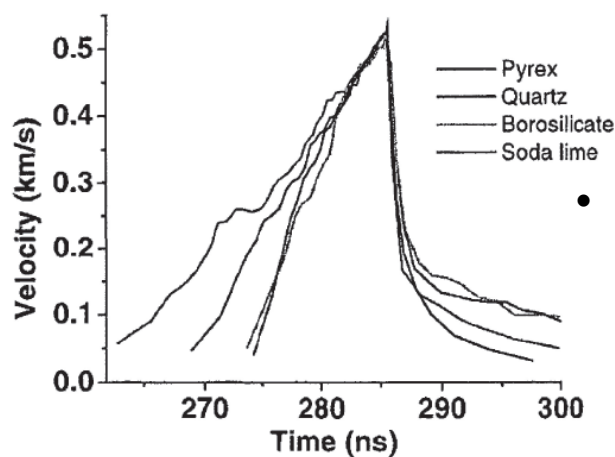


FIG. 6

Ex. 1001, Fig. 6

- "The '684 patent teaches [] to modify a laser-generated compressive stress wave profile that has a sharper rise-time and a gradual post peak stress decay"
- "This modification to the [] wave profile is done by passing it through 'a glass element' . . . , by virtue of its material non-linearity, [this] results in the formation of a rarefaction shock as higher stress amplitudes propagate with lower speeds than the lower stress amplitudes of the tail of the compression wave. After such a modification . . . the modified stress wave is transmitted into the backside of a substrate with a coating (or film) attached on its front surface."

Ex. 2011, ¶¶39-40 (citing EX-1001, 3:5-14, 8:42-52, 9:30- 58, Figs. 5A-5B and 6).

Instituted Grounds

Instituted Grounds

Ground	Claims Challenged	35 U.S.C. § ⁵	Reference(s)/Basis
1	1–22	102(b)	Wang
2	4, 6, 9, 15, 17, 20, 23, 24	103(a)	Wang
3	1–24	103(a)	Wang, Gupta-1992
4	1–8, 10–19, 21, 22	102(b)	Gupta-1992
5	9, 20	103(a)	Gupta-1992, Gupta-1993
6	4, 6, 10, 15, 17, 23, 24	103(a)	Gupta-1992
7	1–24	103(a)	Wang-2002, Gupta-1992

I.D. (Paper 8), 7, 35

The Wang Dissertation Is Not Prior Art

Petitioner Relied On The '684 Patent's Provisional Filing Date As The Critical Date



US007487684B2

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

(10) **Patent No.:** US 7,487,684 B2
(45) **Date of Patent:** Feb. 10, 2009

(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.

(56) **References Cited**

U.S. PATENT DOCUMENTS

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6,327,030 B1 * 12/2001 Ifju et al. 356/32
6,466,308 B1 * 10/2002 Jaing et al. 356/35.5

* cited by examiner

Primary Examiner—Edward J. Skowitz

Assistant Examiner—Oscar 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.

36 Claims, 12 Drawing Sheets

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

Ex. 1001, Cover.

"Petitioner assumes . . . the earliest effective filing date of the '684 Patent is March 5, 2004—the filing date of the earliest priority application."

Pet., 4 (citing Ex-1001, Cover; Ex-1027).

Petitioner Relied On The '684 Patent's Provisional Filing Date As The Critical Date Under § 102(b) Only

Wang Dissertation published on March 4, 2003, Gupta-1992 published on January 9, 1992, Gupta-1993 published on August 25, 1993, and Wang-2002 published on April 8, 2002. Ex-1006, Table 3. Each are prior art under at least pre-AIA 35 U.S.C. §102(b) and were not considered by the Office during prosecution. Ex-1001 (“References Cited”).

Pet., 4

The Wang-Dissertation Was Not Publically Accessible By The Critical Date

- A reference is publicly accessible as of date alleged 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).
- “Public accessibility’ requires more than “technical accessibility.” *Id.*, at 773
- “[W]e have considered whether the research tools available would have been *sufficient to permit an interested researcher to locate and examine the reference.*” *In re Lister*, 583 F.3d 1307, 1311 (Fed. Cir. 2009)

POR, Paper 19, 6



DEMONSTRATIVE EXHIBIT - NOT EVIDENCE

11

The Wang-Dissertation Was Not Publically Accessible By The Critical Date

Petitioner: "A Record of Wang-Dissertation was first published to the ProQuest Dissertations and Theses database on March 4, 2003."

- Pet., 13 (citing Ex. 1006, ¶¶31-33; Ex-1035.

Petitioner's Declarant (Morris) *Recanted* This Sworn Testimony

Full Text Availability

First Made Available for Sale in PDF format and placed in PQDT	2003-03-04
DAI volume issue:	B63/11
DAI publication month and year:	
Date full text is loaded into PQDT:	~~2003-03-04~~ <u>2010-09-06</u>

Ex. 1038, ¶8; POR, 10

The Wang-Dissertation Was Not Publically Accessible By The Critical Date

- Petitioner Relied On Morris Decl. (Ex.1035) at Institution Stage
- Following Institution, Petitioner Submitted Amended Morris Decl., (Exs. 1037, 1038)
 - Morris Recanted Sworn Testimony Concerning Public Accessibility
 - Morris Did Not Write Amended Decl.
 - Morris Was Unaware of Other Changes in Amended Decl.
 - Morris Confirmed That the Wang Dissertation Was Not Uploaded into Proquest Database until 2010
- Hsieh Yee Decls. (Exs. 1006, 1041) Are Not Probative of Public Accessibility
 - No Personal Knowledge – Morris Decl. is Conclusive on the Issue
 - No Evidence of Alternative Public Accessibility By The Critical Date

Ex. 1038, ¶8; POR, 10

Morris Testimony Was Substantively Changed

- A third party made other material changes to the Morris Decl. – Not Identified in Redline

Version: **Full Text Availability**

First Made Available for Sale in PDF format and placed in PQDT	2003-03-04
DAI volume issue:	B 63/11
DAI publication month and year:	
Date full text is loaded into PQDT:	2003-03-04

Ex. 1035, ¶8; POR, 10

Full Text Availability

First Made Available for Sale (print or electronic)	2003-03-04
DAI volume issue:	B 63/11
DAI publication month and year:	
Date full text is loaded into PQDT:	2010-09-06

Ex. 1037, ¶8; POR, 10

Morris Testimony Was Substantively Changed

- A third party made material other changes to the Morris Decl.:
- 9. ProQuests 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.
- 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.

Ex. 1037, ¶9-11; POR, 10, 13-14

Morris Testimony Was Substantively Changed

- A third party made other material changes to the Morris Decl.:

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.
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. 1037, ¶12, 14; POR 10-11



Morris Testimony Was Substantively Changed

- "[T]hese changes were made by ProQuest's legal department"
 - Pet.R., 11; POSR, 9

Morris Testified:

- "That's the only change that I made to my declaration, correct."
- "But it's not a change that I made or requested."
- "Q: Were you aware of the change before today? A No."
- "A: Correct. I did not make that change or any of the other changes. The only change I made was to the PQDT date in the chart, the second chart on page 3."
- "Q: And is today the first time you're made aware of that change? A That's correct."
 - Ex.2004, 28:2-31:6

Morris Lacks Personal Knowledge

Morris Testified:

"Q: Did you review the actual abstract that was available in the record in 2003?
A: No."

Ex. 2004, 51:9-11; POSR (Paper 33), 8

Dr. Gupta Testified:

320. I have obtained the version of the abstract of the Wang Dissertation that is listed on ProQuest's PQDT database on January 22, 2025. See Ex. 2010. This version is inconsistent with the version of the abstract that appears on the face of the Wang Dissertation. 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; POR, 16

The Wang-Dissertation Not Digitized By Proquest By The Critical Date

Morris Testified:

21 | Q You stated that because this document was
22 | not digitized at the time that it was on
1 | microfilm; is that correct?

4 | A We accepted submissions, either paper
5 | submission or microform [sic]. I don't know
6 | exactly how this one came in but it wasn't
7 | digital.

Ex. 2002, 62:21-63:7

The Wang-Dissertation Not Digitized By Proquest By The Critical Date

Morris Testified:

15 So we do not digitize documents until
16 there is an interest in it, so, or purchase when
17 they are submitted by paper submission or
18 microfiche and not uploaded to our electronic
19 theses and dissertation site like we have today.

Ex.2004, 44: 15-19

Morris's Testimony is Conclusive: The Wang Dissertation Was Not Publically Accessible by the Critical Date

Morris Testified:

14 A At ProQuest a record of the public, of the
15 work that we receive, whether paper, microfiche or
16 electronic nowadays, it's considered published.
17 The full text was not available. The full text
18 PDF was not available until September of 2010.

Ex.2004, 36: 14-18

Morris Testified In Her Personal Capacity

Morris Objected To Her Subpoena:

2. Morris objects to the Subpoena to the extent information or testimony is sought that is outside the confines of her personal knowledge. Morris further objects to the extent Patent Owner seeks to treat Morris's deposition as a FRCP 30(b)(6) deposition. Ex. 2005, ¶2; POR, 17

"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."

POR, 18 (*citing Dish Network L.L.C. v. Dragon Intellectual Property, LLC*, IPR2015-00499, Paper 7 (PTAB July 17, 2015))



Morris Testified In Her Personal Capacity

Morris Testified:

Q. [D]o you understand that you are here today pursuant to the subpoena to depose -- to testify in your personal capacity?

A Yes.

Ex.2004, 13:12-15; POSR, 10

Morris Testified:

Q. So with respect to both your first and second declaration, the statements there are based on personal knowledge. ~~You're not testifying—~~
~~and~~ you're testifying in your personal capacity; is that correct, in both of those declarations?

A Yes.

Ex.2004, 21:9-14; POSR, 10



Petitioner Failed To Allege That The Wang Dissertation Is Prior Art Under §102(a)

An IPR Petition must identify “*with particularity, each claim challenged, the grounds on which the challenge to each claim is based, and the evidence that supports the grounds for the challenge to each claim.*”

- 35 U.S.C. § 312(a)(3); POME, 5

“It is of the utmost importance that petitioners in the IPR proceedings adhere to the requirement that the initial petition identify 'with particularity' the 'evidence that supports the grounds for the challenge to each claim.’”

- *Intelligent Bio-Sys., Inc. v. Illumina Cambridge Ltd.*, 821 F.3d 1359, 1369 (Fed. Cir. 2016); POME, 5

“Any marked departure from the grounds identified with particularity in the petition would impose ‘unfair surprise’ on the patent owner and, consequently, violate both the Administrative Procedure Act and the inter partes review statute.”

- *Intel Corp. v. Besang, Inc.*, IPR2023-00991, Paper 39, 32 (PTAB Dec. 11, 2024) (citing *Arthrex Inc. v. Smith & Nephew, Inc.*, 935 F.3d 1319, 1328 (Fed. Cir. 2019)).; POME, 5

Petitioner Failed To Allege That The Wang Dissertation Is Prior Art Under §102(a)

"Petitioner chose not to assert in the Petition that Favrat is prior art under § 102(a). **If Petitioner had asserted both § 102(a) and § 102(e), perhaps Patent Owner would have chosen a different response and the evidence in this proceeding would have developed differently.** In the particular circumstances of this case, adding consideration of § 102(a) at this late date **would deprive Patent Owner of due process.** Consequently, we do not consider Petitioner's contention that Favrat is prior art under § 102(a)."

- *Maxlinear, Inc. v. Cresta Tech. Corp.*, IPR2015-00594, Paper 90, 29-30 (PTAB Aug. 15, 2016)

Claim Construction

Claim Construction

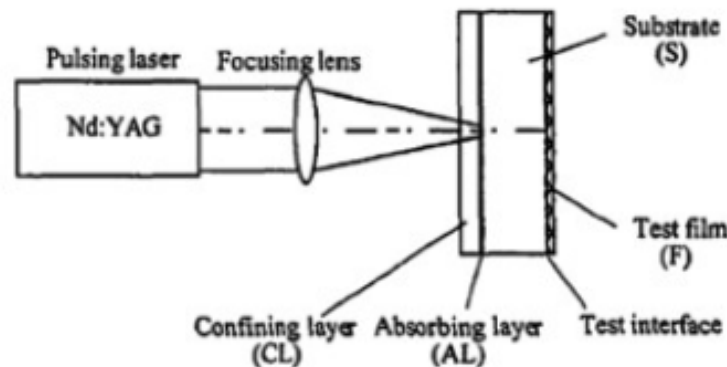
Claim Element	Plain and Ordinary Meaning
[1.d] “the glass element is configured to propagate and modify a stress wave to the coating/substrate interface to generate a tensile stress between the substrate and the coating”	"changing the profile of the laser generated compressive wave and <u><i>propagating the wave profile as modified to the free surface of the coating</i></u> , which upon reflection from the free surface as a tension
[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”	wave generates a tensile stress at the coating/substrate interface"

POR, 20; Ex.2011, ¶25

The Wang Dissertation

The Wang-Dissertation

- Wang-Dissertation Chapter 2: “theoretical analysis of the stress-wave”
- Wang-Dissertation Chapter 3: "experiments using laser-spallation to remove film Coatings"



POR, 21-22; Ex.1005, iii, 6

The Wang-Dissertation

- 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.”
 - Ex. 1005, 5, 7; POR 22
- Wang also theorized on "Future Work" (which the Board relied on)

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.

Ex. 1005, 124.

I.D., 24

Wang Admits That Her Theories Were Proved False

Wang Testified on Her Future Work:

12 Is there a shock depicted in this
13 figure?
14 A. So the shock was not expected
15 here.

Ex.2013, 62:5-15

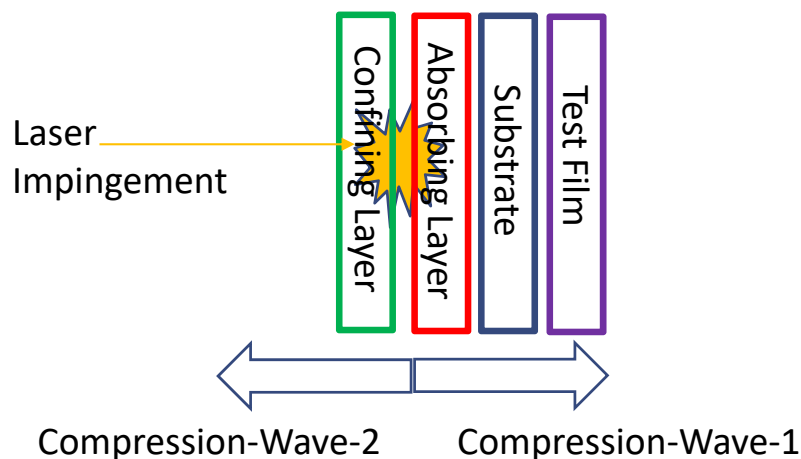
Wang Testified on Experiments Performed in her Dissertation:

17 Q Is it possible to tell, from your
18 experimental data, whether the tensile stress
19 shown in the interface is from the tensile wave,
20 itself, or the reflected compression waves?
21 A I don't think so. So either way, there
22 is a very high tensile stress reached.

Ex.2009, 152:17-22; POR 23

Wang-Dissertation Experiments

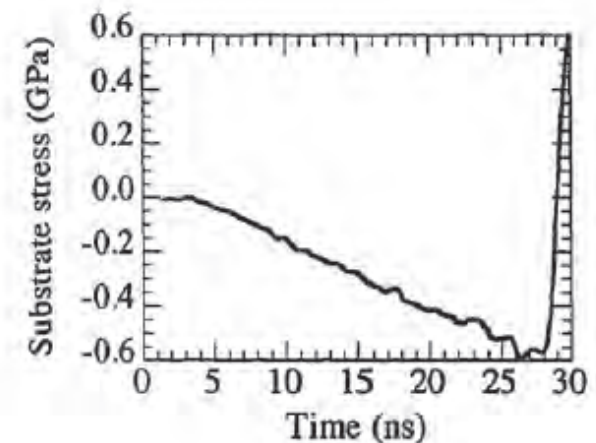
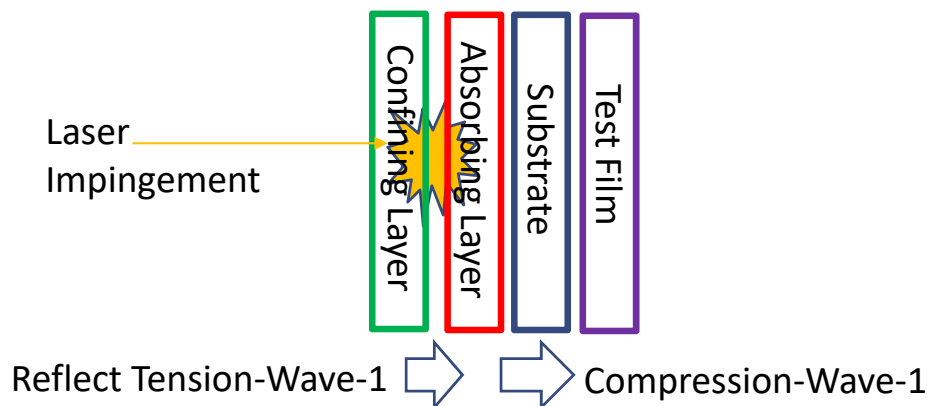
- 2 Compressive Waves Generated at Laser Impingement Point
 - **Compression-wave-1**: travels directly toward substrate in forward axial direction of laser.
 - **Compression wave-2**: (of same magnitude) travels in opposite direction into constraining layer.



EX-2011, ¶53; Ex-1005, 66; POR, 23

The Wang-Dissertation Experiments

- While Compression-Wave-1 Travels toward the substrate and interface, Compression-Wave-2 Reflects off of the free surface of the confining layer and returns as Tension-Wave-1 EX-2011, ¶53-55; POR, 23



(c)
Ex.1005, Fig. 3.15(c) (p. 81)

Wang-Dissertation Experiments

Wang Testimony Confirms presence of Two Waves

"Q. Okay. So we can consider that there [are] two waves, but the figure is measuring just stress in general. Would that be accurate?

A. Right. Right. Yeah"

Ex.2013, 20:2-6; POSR, 16

Wang Dissertation Confirms Reflected Tensile Wave

“The experimental picture is complicated somewhat by the presence of a tensile wave, reflected from the back of the constraining layer.”

- Ex.1005, 65; POR, 30

Wang-Dissertation Experiments

Wang Testimony Confirms Arrival of Tension-Wave-1

"Q. So you had testified that the tensile wave overtakes the compressive wave. So if the tensile wave overtakes the compressive wave, how do you explain that the compressive wave can reach the interface first?

A So, in this case, it's almost simultaneously."

Ex.2009, 50:16-22; POSR, 18.

Wang Dissertation That Tension-Wave-1 Overtakes Compression-Wave-1

"[B]ecause 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; POR, 30-31

Wang-Dissertation Experiments

Wang Dissertation That Tension-Wave-1 Overtakes Compression-Wave-1

The experimental picture is complicated somewhat by the presence of a tensile wave, reflected from the back of the confining layer. The surface properties of that confining layer are not well controlled. Assuming a plausible longitudinal wave speed in the confining layer, the original compressive pulse is followed, about 30 ns later, by a tensile pulse of comparable magnitude. Being tensile, it propagates faster than the peak compressive stress, and faster than the low stress tail of the main pulse. It eventually overtakes the compressive pulse

Ex.1005, 65; POSR, 18

The Wang-Dissertation Fails to Anticipate

- Undisputed that Tension-Wave-1 Is Not Modified
- No Evidence that Compression-Wave-1 is Modified, or if Modified, that Modified Wave Reaches Interface
- Wang concedes that there is no evidence that tensile Stress Spike Shown in Wang-Dissertation Experiments is from Modification of Compression-Wave-1
- Later-performed experiments by Wang Confirm that the "Future Work" Arrangement results in no modification

POR, 23; Ex.2011, ¶¶53-55

Wang-2009 Confirms Wang Dissertation "Future Work" Fails to Anticipate

- Later Experimental Work of Wang (Wang-2009) (Ex.1056) Confirms That the "Future Work" Arrangement Results in No Modification

Wang Testimony Confirms Wang-2009 Provides Experimental Results of "Future Work" in her Dissertation

"Q: Is it fair to say that the 2009 paper [describes] experimental results of the future work contemplated in your dissertation?

A. So, it's an experimental result using the configuration proposed in my future work. Yeah, similar to that proposed in my future work."

Ex. 2013, 64:20-65:5; POSR (Paper 33), 1

Wang-2009 Was Improperly Concealed

Gupta Testified That He First Identified Wang-2009

2 And then, as I mentioned earlier, I
3 stumbled upon this paper, which I then
4 read, which is the high strain-rate
5 spallation and fracture of tungsten by
6 laser-induced stress waves, so then I
7 spent some time analyzing that paper in
8 the context of the declaration submitted
9 by Dr. Wang, and basically it's
10 completely opposite to what Dr. Wang's
11 position is in her declaration. So I

Ex. 1039, 43:2-11

3 A That's right. So the paper was -- I
4 stumbled upon this paper while I was preparing
5 for this deposition, which was after I had
6 submitted my declaration, correct.

Ex. 1039, 45:3-6



Wang-2009 Was Improperly Concealed

iii) Unless previously served, **a party must serve relevant information that is inconsistent with a position advanced by the party during the proceeding concurrent with the filing of the documents or things that contains the inconsistency.**

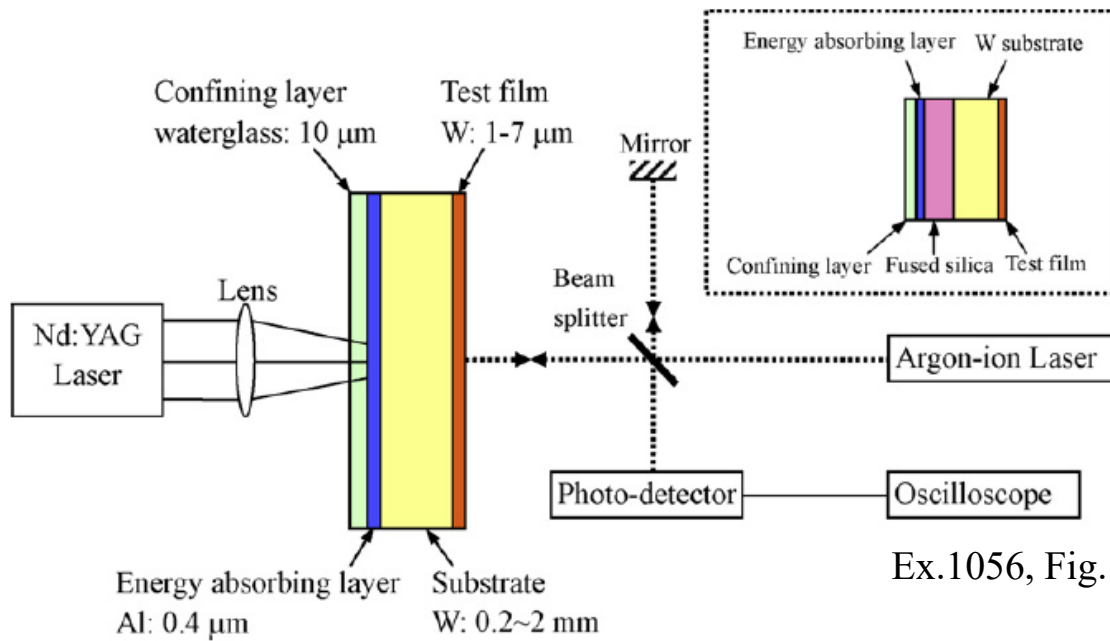
37 CFR §42.51(b)(1)(iii)

The Wang-Dissertation Fails to Anticipate

- Later Experimental Work of Wang Confirms That the "Future Work" Arrangement Results in No Modification
- “Enablement [(or lack thereof)] of an anticipatory reference may be demonstrated by a later reference.” POSR 23 (citing See *Bristol-Myers Squibb Co. v. Ben Venue Labs., Inc.*, 246 F.3d 1368, 1379 (Fed. Cir. 2001))

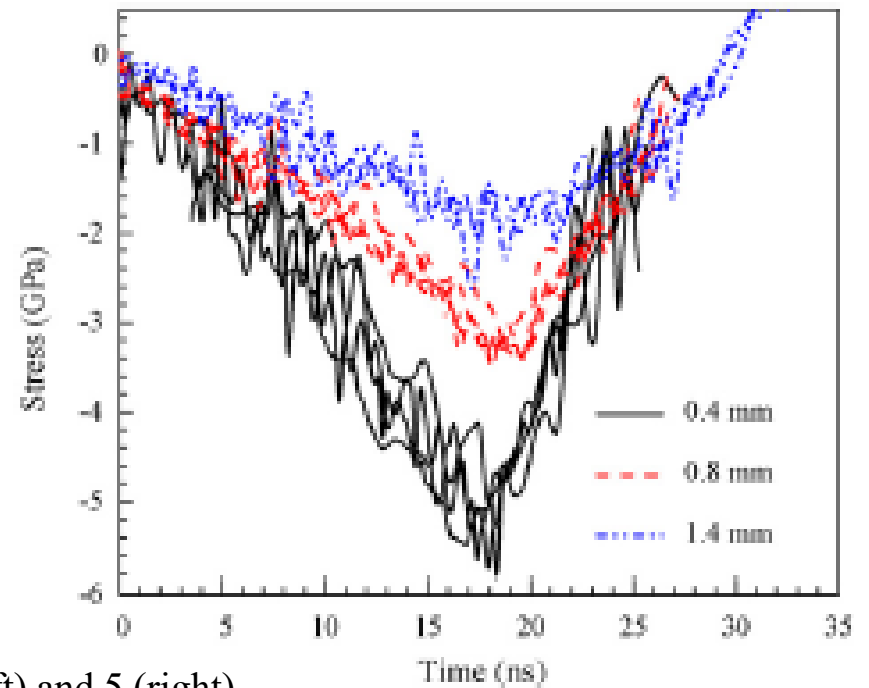
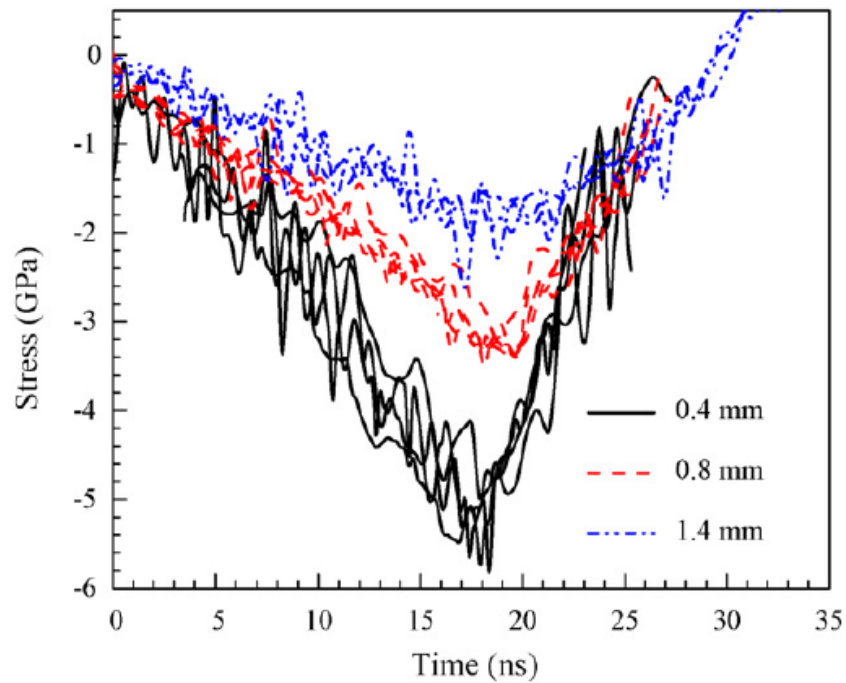
Ex. 2013, 64:20-65:5; POSR (Paper 33), 1

Wang-2009



Ex.1056, Fig. 1

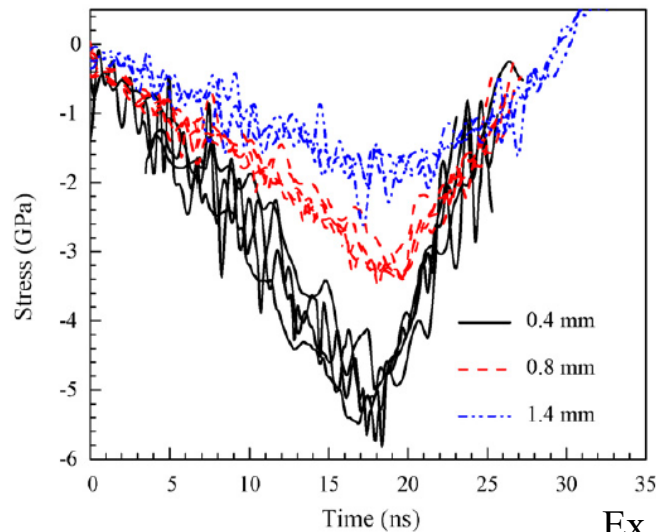
Wang-2009



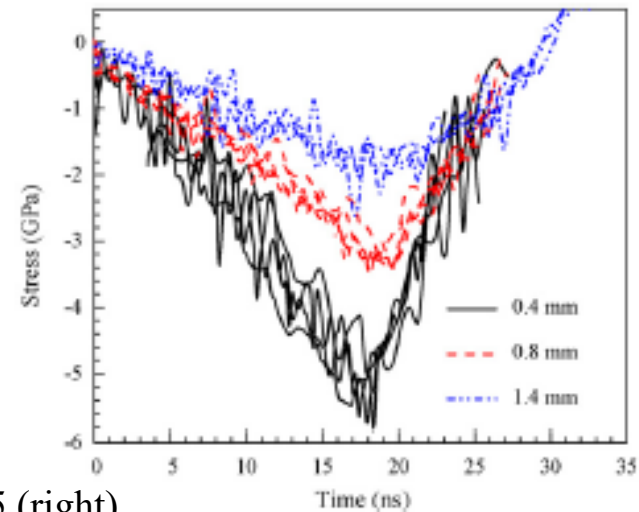
Ex.1056, Figs. 3 (left) and 5 (right)

Wang-2009

Wang: "Figure 3 (below) shows the substrate stress profile of a non-modified, or Gaussian, wave."
Ex.1038, ¶12



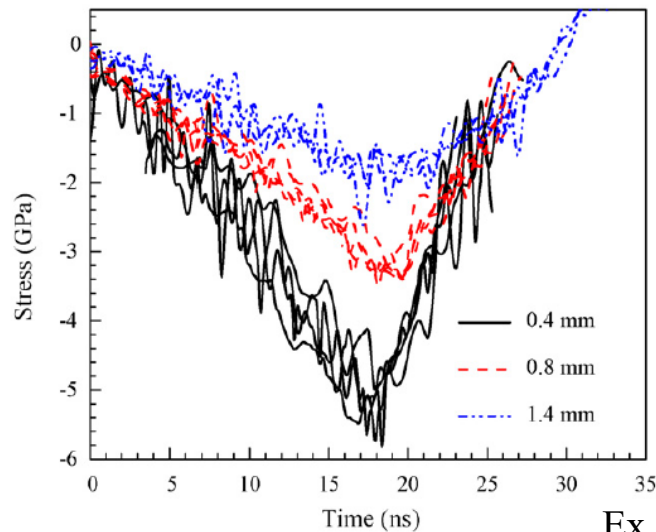
Wang: "In contrast, Figure 5 shows the stress profile of a stress wave that was modified by a fused silica layer" Ex.1038, ¶13



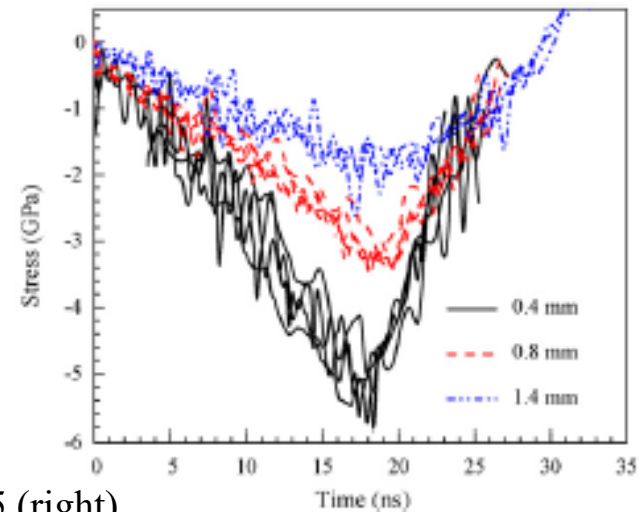
Ex.1056, Figs. 3 (left) and 5 (right)

Wang-2009

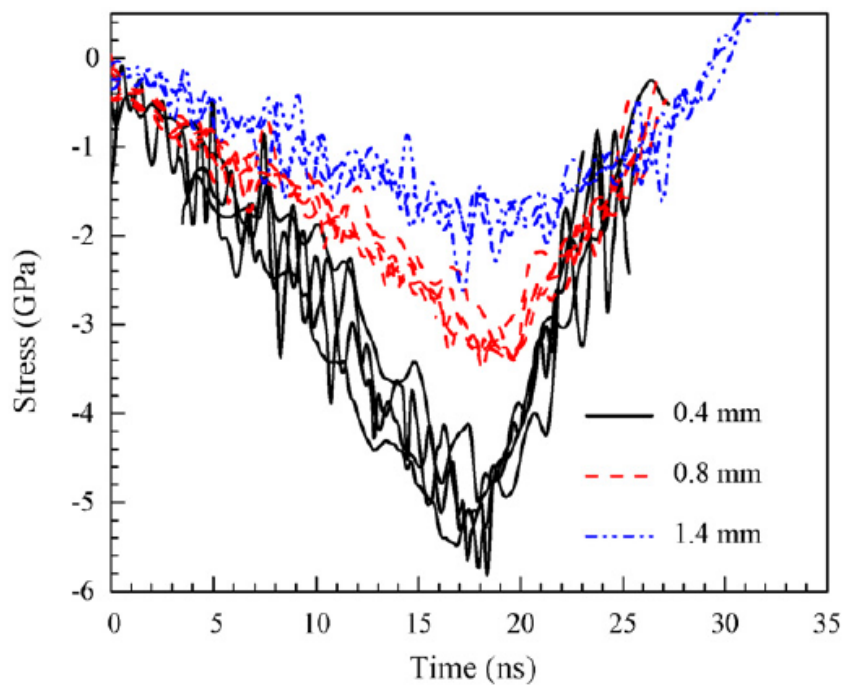
Wang: "The unmodified wave has a Gaussian loading with rise time less than 5 ns followed by a long unloading of 10-15 ns while the modified stress wave has a linear ramp load stretched to ~18 to 20 ns and shorter unloading portion of ~10 ns." Ex.1038, ¶14



Ex.1056, Figs. 3 (left) and 5 (right)



Wang-2009



Ex.1056, Fig. 3

Wang Testimony Confirms No Shock in Fig. 3:

2 Q. Okay. Do any of these waveforms
3 depict a shock?
4 A. No.

Ex.2013, 62:2-4

Wang-2009

Wang Testimony Confirms No Shock in Fig. 5:

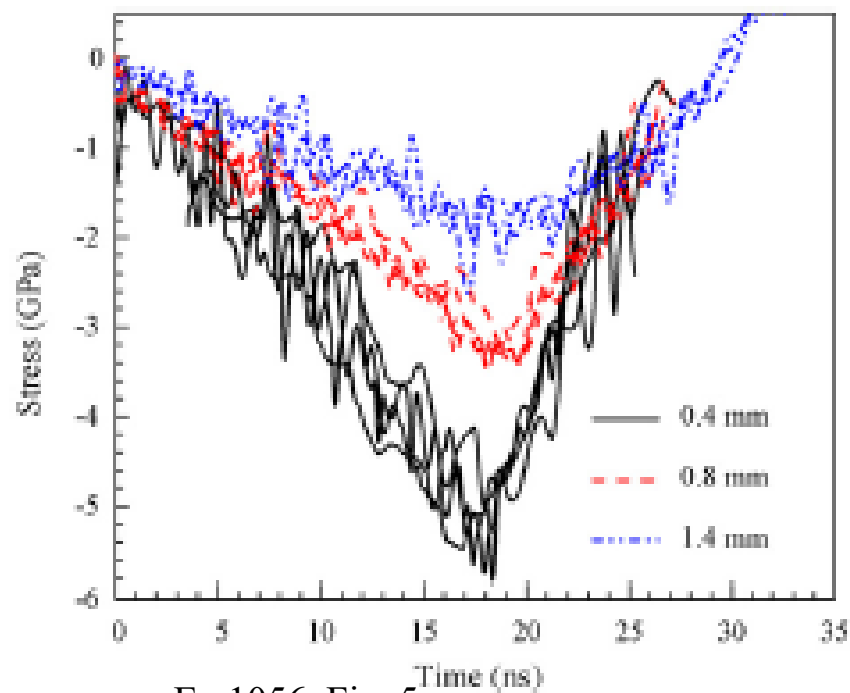
5 Q. Let's go to Figure 5, then.

6 A. Yes.

12 Is there a shock depicted in this
13 figure?

14 A. So the shock was not expected
15 here.

Ex.2013, 62:5-15



Ex.1056, Fig. 5

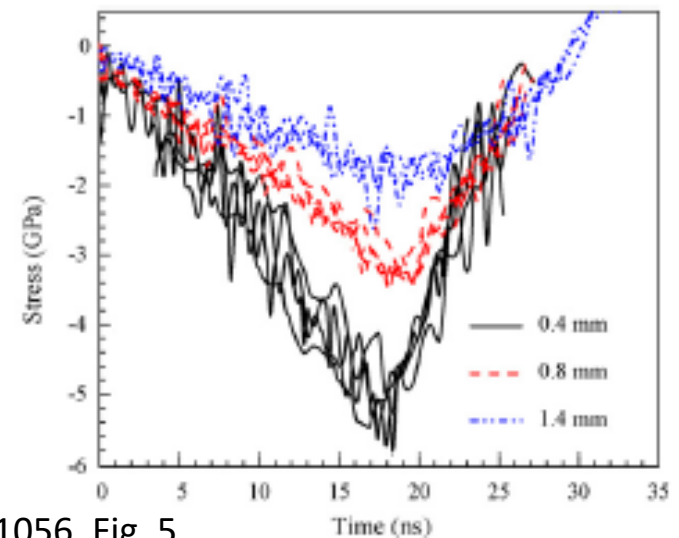
Wang-2009

On Cross, Wang Recanted Testimony on Longer Unloading Time in "Modified Wave":

Q. Can you show me how you calculated the 15 nanoseconds [in Fig. 5]?

A. Okay. It would go, for example, the .4 millimeter starts from 5. I think actually I will say around 10. Basically, the whole thing after the peak ends at 20 nanoseconds. But then you start from 5 or -- for example, *for the 1.8 millimeter*, the peak stress is around 10 nanoseconds. So if you start from there, ends at 20, *that's 10 nanoseconds*. So *the blue peak -- the blue peak is also around 10 or 11*. *The red peak is around 9 or 8. It ends at 20. So that's about 11*. And *the black peak* starts from 5 or 6. But because there is more noise in the last part, so it's hard to tell the exact ending time, but it's around -- it ends around 15 nanoseconds. *I would say around 10 nanoseconds*.

Ex. 2013, 61:7-62:1; see POSR, 16.

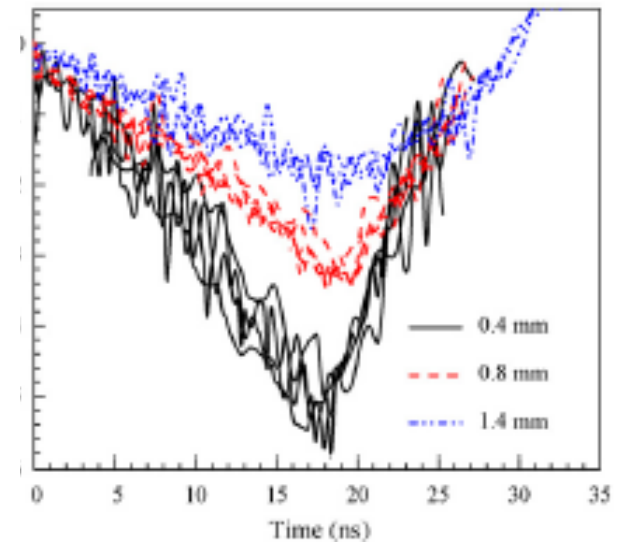


Ex.1056, Fig. 5

Wang-2009

Wang-2009 Confirms Identical Unloading Times in Figs. 3 and 5

Fig. 5 shows the substrate stress profiles measured after the stress wave traveling through the tungsten thicknesses of 0.4, 0.8 and 1.4 mm, respectively. All the data collected were from experiments conducted under the same conditions. Similar to what was observed under Gaussian stress wave, the stress wave maintained the same shape at several traveling distances with attenuating amplitude due to the wave absorption in tungsten. The stress profile has a stretched linear loading ramp of about 18 ns, and an unloading ramp of about 10 ns, which is not as sharp (~ 1 ns) as reported in the previous work by Wang et al. [29].



Ex.1056, 76; POSR 16

Ex.1056, Fig. 5

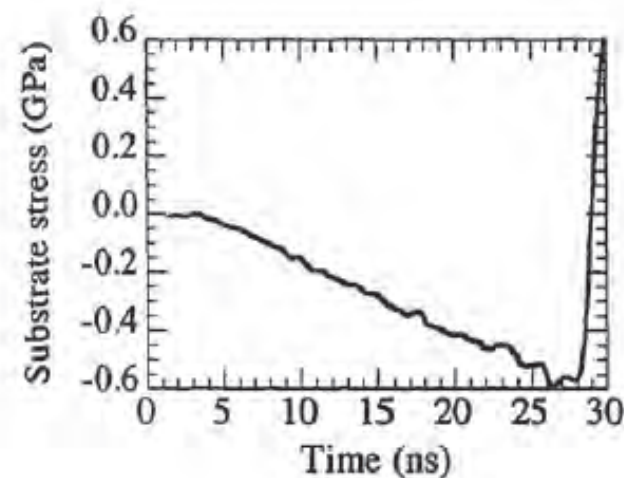
The Wang-Dissertation Fails to Anticipate

Wang Testified No Evidentiary Support for Modified Compression Wave-1 in Wang Dissertation Experiments:

17 Q Is it possible to tell, from your
18 experimental data, whether the tensile stress
19 shown in the interface is from the tensile wave,
20 itself, or the reflected compression waves?

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

Ex.2009, 152:17-22; POR 23



(c)

Ex.2005, Fig. 3.15(c)

The Wang-Dissertation Fails to Anticipate

- No Evidence of Modification of Compression-Wave-1
- Even if Compression-Wave-1 Were to Be Modified, It Would Not Propagate to the Interface
 - Reflected **Tension-Wave-1** would catch-up and overtake compression-wave-1, neutralizing it before it reached the interface.
 - POR, 24 (citing EX-2011, ¶¶ 62, 64, 115, 123).

The Wang-Dissertation Fails to Anticipate Claims 1 and 13

- Wang-Dissertation Experiments Fail to Disclose:
 - [1.c] "a glass element disposed on the second side of the substrate and axially spaced along the first axis"
 - [13.a]: "positioning a glass element along the first axis on the second side of the substrate"

Wang admits that experiments described in Chapter 3 of Her Dissertation Fail to Depict the Arrangement of the Glass Element:

"Q: In the experiments performed in your dissertation, was there a separate glass element and substrate?

A. There is no second"

Ex.2013, 53:22-54:2

The Wang-Dissertation Fails to Anticipate Claims 1 and 13

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”
- [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”

Wang's Fused Silica Is Not Equivalent To The Claimed "Glass Element"

- '684 Patent does not disclose “fused silica” as suitable for the “glass element” (POR, 25 (citing Ex-1001, 3:18-20)).
- "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." (POR, 25, citing 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." (POR, 25, citing 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." (POR, 25, citing EX-2011., ¶¶94, 138-139).

Wang's Fused Silica Is Not Equivalent To The Claimed "Glass Element"

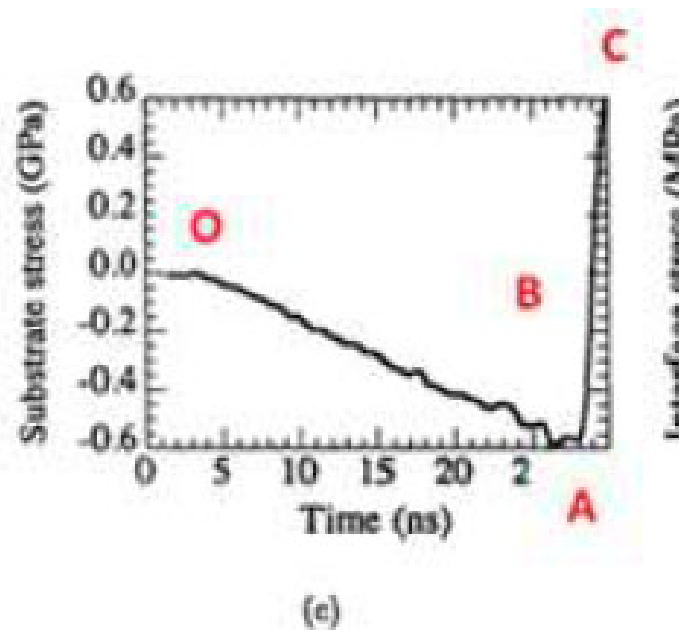
Wang Testified:

Q. Based on your experience, and in light of your dissertation, do you expect stress/strain propagation characteristics to be different in a crystalline versus in an amorphous solid?

A. So it really depends. So every material is different. So some material between the amorphous and crystalline might be similar, might be different. So it's all intrinsic property of the material.

Ex. 2013, 45:23-46:8; POSR, 22

The Wang-Dissertation Fails to Anticipate Claims 1 and 13

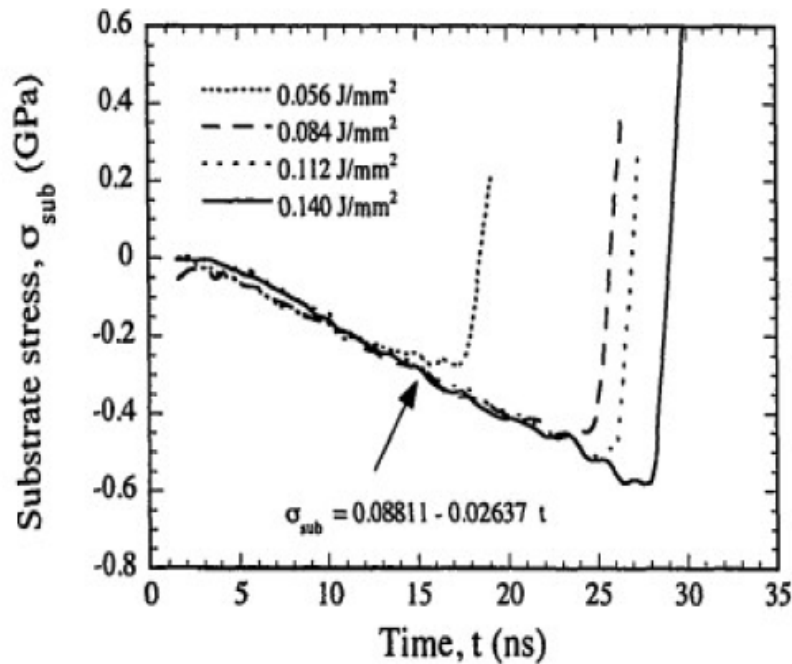


Gupta Testified:

- "Portions AB and BC are part of the same continuous curve."
- "the initial delay between the tension wave and the compression wave is controlled by the thickness and properties of the waterglass layer which, in turn, are not very well controlled or characterized and hence would vary from test to test."
- "[P]ortions AB and BC are none other than part of the sharp rise-time of the direct tension wave."

Ex.1005, 64 (Fig. 3.15(c); Ex. 2011, ¶¶57-59; POR, 31

The Wang-Dissertation Fails to Anticipate Claims 1 and 13

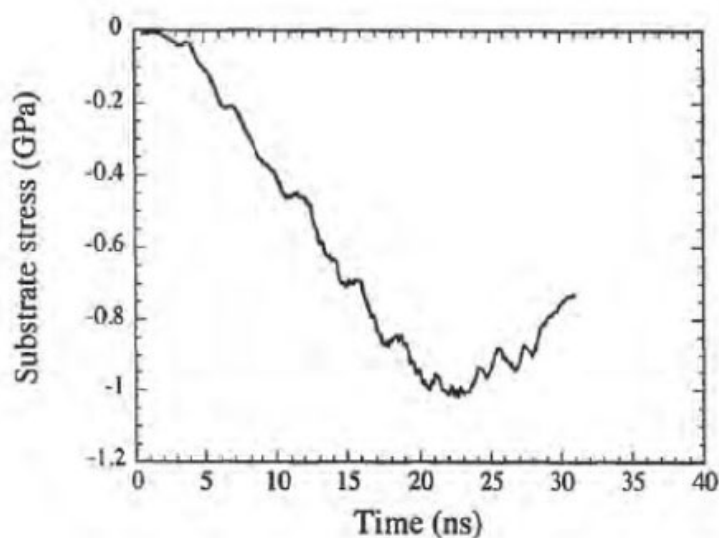


Gupta Testified:

"A POSITA would understand that as the laser fluence is increased, as per Dr. Wang's experiments in her Dissertation, all higher amplitude stress waves would have rise-time slopes that would be parallel to each other."

Ex.1005, Fig. 3.16; Ex. 2011, ¶68

The Wang-Dissertation Fails to Anticipate Claims 1 and 13



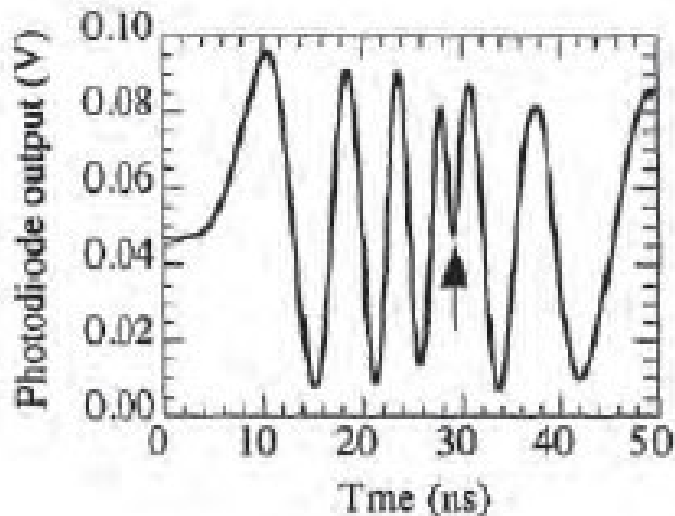
(b)

Gupta Testified:

"Fig. 3.19 clearly shows there is no sharp decay in the postpeak stress in the recorded wave. Notably, this is the only data in the entire Wang Dissertation where there is no influence of the direct tension wave."

Ex.1005, Fig. 3.19(b); POR, 38; Ex. 2011, ¶88

The Wang-Dissertation Fails to Anticipate Claims 1 and 13



(a)
Ex.1005, Fig. 3.15(a); POR, 35

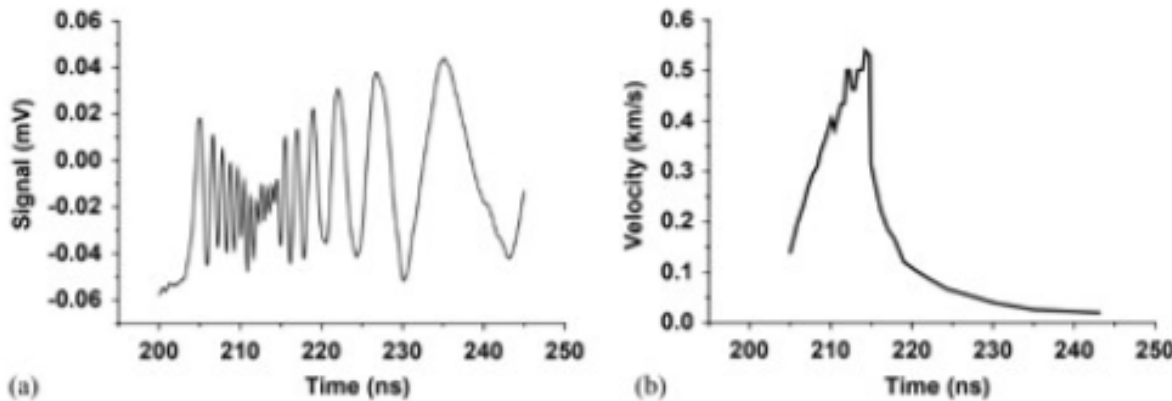
"[F]ringes before [] turning point are caused by the arrival of the ramp of the un-modified compression-wave-1 [] at the interface, which 'pull[s] in the free surface of thin film gradually as compression builds up [] slowly.' 'As soon as the tension wave[-1] arrives . . . it instantly will push the surface of the film outward . . . thus reversing the direction of the surface movement" and causing the appearance of the 'turning point[.]'" POST, 20-21 (Citing Ex.2011, ¶¶ 106-119).

The Wang-Dissertation Fails to Anticipate Claims 1 and 13

Gupta Testified:

"There are almost 7 to 8 fringes in a short span of just 5 ns as shown []. That is, a rapid deceleration and rapid acceleration of the free surface that is indeed the hallmark of a shockwave arrival signature. Now contrast this fringe record with the fringe record in Dr. Wang's Dissertation."

Ex. 2011, para 113.



Ex. 1001, Figs. (3(a)-3(b)); POR, 37

The Wang-Dissertation Fails to Anticipate Claims 1 and 13

Wang Testified:

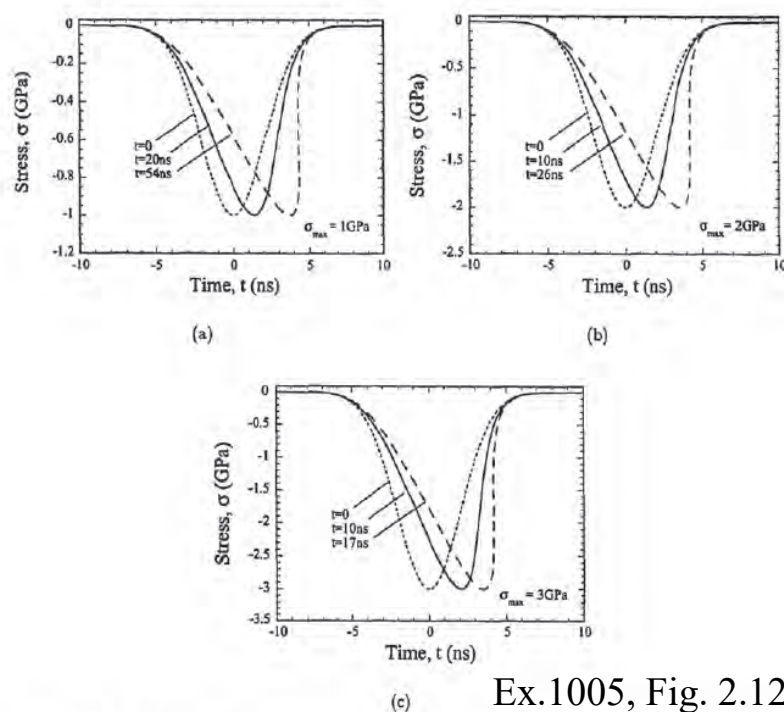
Q: Is it possible to tell, from your experimental data, whether the tensile stress shown in the interface is from the tensile wave, itself [*i.e.*, tension-wave-1], or the reflected compression waves [*i.e.*, compression-wave-1]?

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.

POR, 45

The Wang-Dissertation Fails to Anticipate Claims 1 and 13



Ex.1005, Fig. 2.12

Gupta Testified:

"As the Wang-Dissertation also explains, a dramatic reduction in its amplitude then occurs soon after its formation and as Fig. 2.12 in her dissertation shows, the wave can lose almost 80% to 90% of its amplitude at wave amplitudes (1 GPa and higher) that are of interest to the laser spallation technique."

Ex. 2011, para 146.

Wang Testified:

"If the waterglass is too thin, no shock is detected either 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."

Ex.-1005, pp. 69-70.

The Wang-Dissertation Fails to Anticipate Claims 1 and 13

Table 3.4: Effect of substrate thickness on $\sigma_{\text{sub}}^{\text{max}}$ and $\sigma_{\text{int}}^{\text{max}}$ on fused silica samples with a 1.1 μm thick aluminum film at maximum YAG power (0.140 J/mm²).

Substrate thickness	1500 μm	3000 μm	6000 μm
$\sigma_{\text{sub}}^{\text{max}}$	-1.2	-0.5	-0.3
$\sigma_{\text{int}}^{\text{max}}$	370	350	50

Ex.1005, Table 3.3 (p. 86); POR, 41-42

Gupta Testified:

"Here, the shock profile cannot be maintained at such low stress amplitudes in fused silica and hence could be another reason that Dr. Wang was unable to record them."

Ex. 2011, para 97.

Dr. Gupta's Testimony is Unchallenged

Petitioner Does Not Challenge Dr. Gupta's Analysis:

- Compression-Wave-1 is not shown to be modified in Wang Dissertation experimental data (Ex.2011, ¶¶50-84; POSR, 16).
- Wang did not measure the non-linear stress-strain curves for fused silica in her experiments (Ex.2011, ¶92; POSR, 19).
- Wang Incorrectly analyzed her Dissertation fringe data (Ex.2011, ¶¶106-119; POSR, 20-21).
- Wave attenuation in fused silica would prevent propagation of any modified wave (if it even formed (it didn't)) (Ex.2011, ¶¶94, 138-139; POSR, 21).
- Difficulty and unfeasibility of optimizing stress waves in Wang Dissertation (Ex. 2011, ¶238; POSR, 22).

Dr. Gupta's Technical Analysis is Unchallenged

Wang Testified:

Given the few

academics in the niche field of laser spallation techniques for measuring thin-films

in the 1990s and early 2000s, a POSITA looking to develop tensile laser spallation

techniques for thin films at the time of the invention would know to look to the

research of key players such as Dr. Gupta and myself.

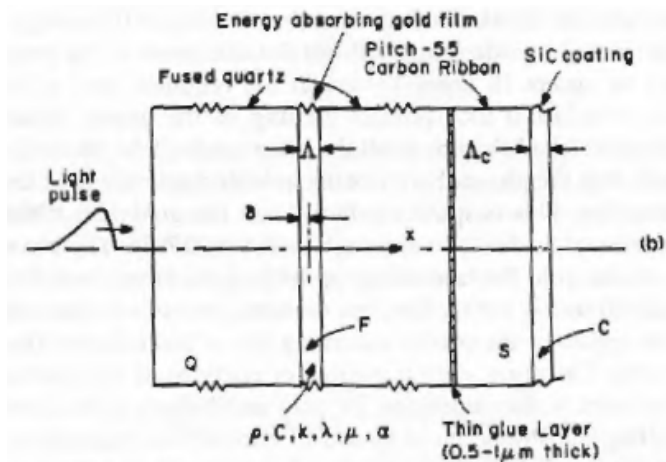
Ex. 1038(2), ¶10

“Buckley is biased because he receives a material percentage of revenues associated with enforcement of the ’199 patent[]; however, *Petitioner identifies no evidence to contradict any of his testimony*. As a result . . . we give weight to testimony regarding specific unrebutted facts.” *Google LLC v. DDC Tech., LLC*, IPR2023-00709, Paper 76 at 38, n. 17 (PTAB Nov. 4, 2024) (cited by Petitioner, at Pet.R., 2); POSR, 24

Ground 4

Ground 4: Gupta-1992 Fails to Anticipate Claims 1-8, 10-19, and 21-22

Gupta-1992 is Cumulative of the Wang Dissertation



Ex. 2011, 5 (Fig. 2(b))

Wang Testified:

Q How is the configuration shown in Figure 2B different than the future work portion you discuss in your dissertation?

A That's same idea.

Q Are there any differences?

A This is the same idea. [] fused silica or fused quartz, yes. I think you can consider them as equivalent, or the same.

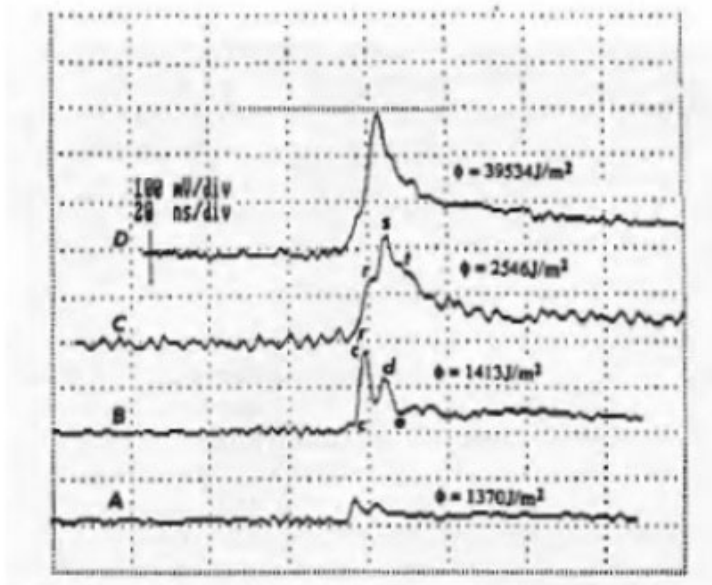
Ex. 2009, 186:2-9; POR, 50-51

Gupta-1992 Fails to Anticipate

Gupta Testified:

"The wave profile, confirmed by both theory and experiments, do not show the formation of any shock profile."

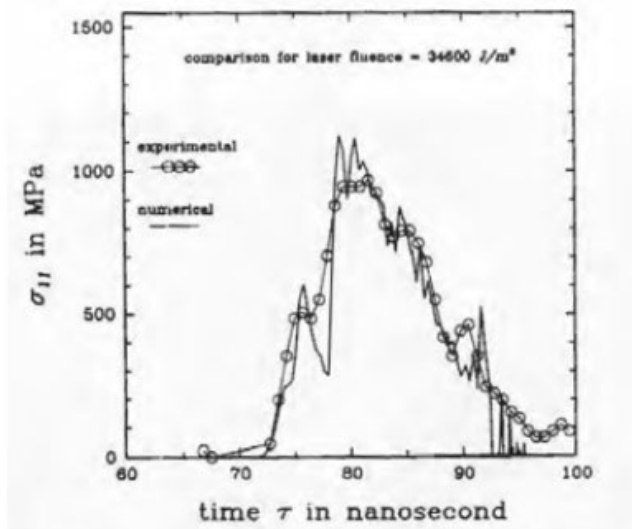
Ex. 2011, para. 210



Ex-1011, 157 (Fig. 11)

POR, 54

Gupta-1992 Fails to Anticipate



Ex-1011, 157

POR, 54

Wang Testified:

Q: Is a shock shown in any of the waveforms depicted in Figure 15?

A: Doesn't look like [it].

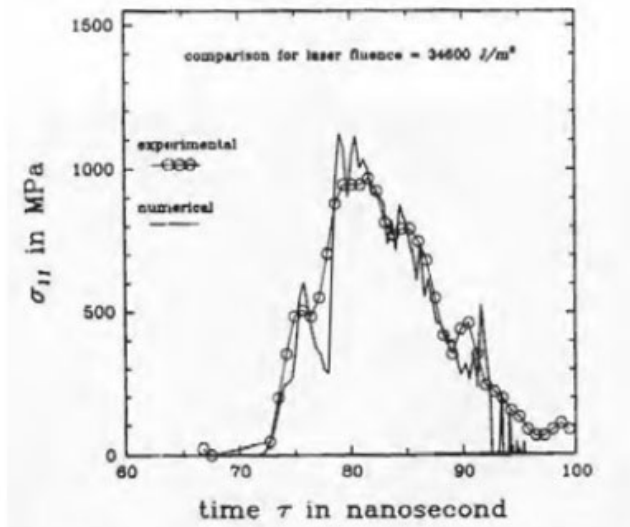
Ex.2009, 188:22-189:2; POR, 54

Q: Is a shock depicted in these waveforms?

A: I can't tell

Ex. 2009; 188:13-17; POR, 56

Gupta-1992 Fails to Anticipate

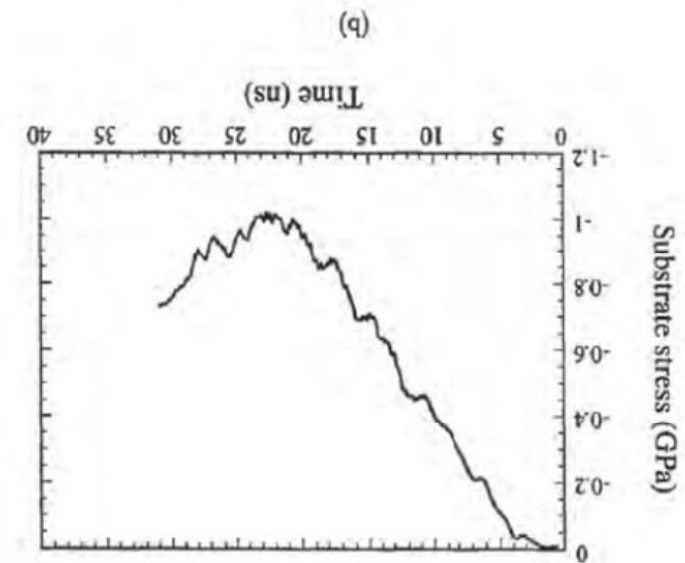


Ex-1011, 157

POR, 54

"[T]he shock wave profiles depicted in Fig. 15 of Gupta-1992, closely match the shock wave profile in Fig. 3.19 of the Wang-Dissertation[]. In both experiments, there is no reflected tension-wave-1 effect, and no shock profile for the compression wave."

POR, 55-56.



Ex. 1005, 74 (Fig. 3.19(b); POR, 56

Ground 7

Ground 7: Wang-2002 and Gupta-1992 Together Fail to Render Obvious Claims 1-24

Wang-2002 is Cumulative of the Wang Dissertation

Wang Testified:

Q Does this paper discuss experiments with the same setup that you used in your dissertation?

A Yes.

Ex-2009, 190:16-19; POR, 71

Wang Testified:

Q [W]hat, if any, differences are described in this paper compared

to what's disclosed in the dissertation?

A It's one section o the dissertation.

It's -- yeah, it's part of the dissertation work.

Q Okay. So the dissertation is a more comprehensive analysis than what's included in here?

A Right.

Q But everything in this paper is included in the dissertation?

A Think so. Most part, yes. Ex-2009, 190:20-191:9; POR, 71



Remaining Grounds

- **Ground 2**: The Wang-Dissertation (Ex.1005) Fails to Render Obvious Claims 4, 6, 9, 15, 17, 20, and 23-24
- **Ground 3**: The Wang-Dissertation (Ex.1005) And Gupta-1992 Together Fail to Render Obvious Claims 1-24
- **Ground 5**: Gupta-1992 And Gupta-1993 Together Fail to Render Obvious Claims 9 and 20
- **Ground 6**: Gupta-1992 Fails to Render Obvious Claims 4, 6, 10, 15, 17, and 23-24