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LASER SPALLATION TECHNOLOGIES, LLC

**IN THE UNITED STATES DISTRICT COURT
FOR THE CENTRAL DISTRICT OF CALIFORNIA
WESTERN DIVISION**

LASER SPALLATION
TECHNOLOGIES, LLC,
a California company

Plaintiff,

v.

THE BOEING COMPANY, a
Delaware corporation,
Defendant.

Case No. 2:23-cv-02294-AB-SK

**DECLARATION OF VIJAY GUPTA
IN SUPPORT OF PLAINTIFF'S
RESPONSE TO DEFENDANT'S
MOTION TO DISMISS**

Judge: Hon. André Birotte Jr.

Date: September 1, 2023
Time: 10:00 a.m.
Courtroom: 7B

1 I, Vijay Gupta, Ph.D. declare as follows:

2 1. I submit this declaration in support of the Response of Laser Spallation
3 Technologies, LLC (“LST”) to the Motion to Dismiss of The Boeing Company
4 (“Boeing”) in the above-captioned action. The facts stated herein are true based on my
5 own personal knowledge or knowledge obtained through my employment at UCLA,
6 conversations with other persons, and my review of personal records and records kept
7 as part of my employment by UCLA. If called upon to testify, I could and would
8 competently testify thereto.

9 2. I am currently a Full Tenured Professor of Mechanical and Aerospace
10 Engineering at the University of California Los Angeles (“UCLA”). I also hold
11 appointments as a Full Professor in the Materials Science and Engineering Department
12 and Biomedical Engineering Department at UCLA. I have a Ph.D. in Mechanical
13 Engineering and an M.S. in Structural Engineering, both from the Massachusetts
14 Institute of Technology (“MIT”). After finishing my Ph.D. in 1990, I joined the
15 faculty at Dartmouth College as an Assistant Professor and was promoted to the rank
16 of Full Professor, with tenure, at UCLA in 1995, directly from the Assistant Professor
17 rank, without undergoing the usual Associate Professor step. At age 31, I became the
18 youngest Full Professor with tenure in the United States, only 5 years after receiving
19 my Ph.D. degree.

20 3. In April 2018, I was given the status of “Distinguished Professor” by the
21 Regents of the University of California, which is the highest rank bestowed on a Full
22 Professor in the University of California System.

23 4. My research has covered a wide range of areas, including interface
24 science and engineering, composite materials, aircraft structures, applied mechanics,
25 fracture mechanics, mechanical engineering design, manufacturing, and
26 biomechanics—both experimentally as well as through mechanistic computer modeling.
27 I am widely acknowledged as the leading experimentalist in the field of solid
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1 mechanics, notably in the areas of mechanical characterization of joints and interfaces,
2 and mechanical behavior and reliability of aerospace structures made using composite
3 materials, where I have made sustained and pioneering contributions. My research has
4 been widely disseminated in these areas, with over 150 papers published in leading
5 technical journals, conference proceedings and books. I have also given over 200
6 principal keynote lectures in governmental agencies, companies, and national and
7 international conferences and symposia in nearly all industrial countries. I also hold 4
8 United States Patents, with several others pending, with one widely used in the
9 semiconductor industry.

10 5. Measurement and control of the tensile strength of an interface or a joint
11 between two different materials is key to developing reliable components in a variety
12 of industries such as aircraft engines, paint, microelectronics, aerospace structures, and
13 civil construction. My group is best known for developing novel techniques to
14 measure the tensile strength of joints and interfaces. Notable among these is a laser
15 spallation experiment that uses a laser-generated stress wave to pry off an interface.
16 The work on this technique started as part of my Ph.D. thesis at MIT between 1985
17 and 1989, and a commercial version of this tool, with additional features, was
18 developed in 1992 during my tenure at Dartmouth College. This major development
19 in the field of adhesion science and technology was recognized by the U.S. Patent and
20 Trademark Office by granting a U.S. Patent No. 5,438,402 (“the ’402 Patent”). This
21 technique has been virtually used by all major semiconductor companies in the world
22 for characterization of adhesion in devices and packages. It has been transferred to or
23 used for product development in Intel Corporation, Texas Instruments, Hitachi,
24 Freescale Semiconductor, On Semiconductor, and Dow Corning Corporation. This
25 technology has also been widely used in other industrial sectors, such as, in automobile
26 (Ford, GM, Delco), television (LG Gould), biomedical (Baxter Corporation), aircraft
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1 engines (Pratt and Whitney, Westinghouse Corporation), paint (Du Pont, Boeing), and
2 Dentistry.

3 6. In the late 1990s, the aerospace industry had the need to test composite
4 joints which required higher stress wave amplitudes of the interrogating stress pulse in
5 the laser spallation tool. At the same time, the microelectronics industry was
6 manufacturing high density nanoscale chips and packages and needed to test the
7 adhesion properties in such nanoscale structures.

8 7. I recognized these needs in the industry, and I worked to develop a
9 method and apparatus that modified the stress wave profiles of the '402 patent by
10 using a glass element that resulted in sharper stress wave profiles and much higher
11 interface stress amplitudes as needed to test nanoscale structures and composite joints,
12 especially those between thicker composite sections.

13 8. I collaborated with Vassilli Kireev on these subjects, and our work led to
14 the issuance of U.S. Patent No. 7,487,684 ("the '684 Patent"), which is directed to an
15 apparatus and method for propagating a stress wave to the coating/substrate interface
16 to generate a tensile stress between the substrate and the coating.

17 9. On March 16, 2010, Boeing presented its roadmap to certify adhesive
18 joints in its aircraft structures at The Center of Excellence for Advanced Materials in
19 Transport Aircraft Structures (AMTAS) at the University of Washington, Seattle, WA.
20 Boeing delivered a presentation entitled, "Boeing's Certifiable Primary Structural
21 Bonding Initiative." Slide No. 3 of the presentation indicates the view of Boeing's
22 engineers that a comprehensive certification approach for bonded structures requires
23 both "Advance Design and Analysis" and use of an "Advance NDE Techniques
24 LBID." The slide also displays the geometry of a stringer, results from a stress
25 analysis inside the stinger geometry, and the method of Laser Bond Inspection
26 ("LBI").
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1 10. Slide No. 4 from the same Boeing presentation shows the stringer
2 geometry and frame elements that run orthogonal to the stringers. The stress analysis is
3 performed by using the Finite Element Method, and it identifies significant weak bond
4 regions, such as at the joints between aircraft skin and the stringers and ribs. As noted
5 by the Boeing engineers, stress analysis is integral to the overall bond certification
6 process, as it tells them where to monitor and perform the bond inspection by using
7 LBI or the '684 Patent's method claims.

8 11. I understand that Boeing has a testing facility in Huntington Beach,
9 California, and that Boeing's engineers at that facility have conducted stress analysis
10 of the entire aircraft structure, including stringers and frame elements that are used to
11 stiffen the composite fuselage skin.

12 These testing activities by Boeing in Huntington Beach began as early as 2008
13 and has continued at least until 2021, as shown by publications by Boeing's engineers.
14 These publications include, "*Structural Response of a Stitched Composite Hybrid Wing*
15 *Body Center Section*," Jegley et al., Journal of Aircraft, Vol. 58, No. 3, May-June 2021;
16 and "*Analysis of a Hybrid Wing Body Center Section Test Article*," Wu et al., 54th
17 AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials
18 Conference, April 8-11, 2013. My review of these papers confirms that Boeing
19 engineers have identified areas that are most prone to adhesive failure and would
20 therefore require monitoring during servicing of the aircraft. Areas where highest out-
21 of-plane stress and strains occur are where the stringers join the aircraft skin and also
22 between the frame stacks or ribs and the skin or where they cross the stringers. Figure 2
23 from the Boeing papers shows the schematic of a stringer, fuselage skin, and a frame
24 stack, while Figure 3 from the same papers show an actual PRSEUS panel constructed
25 by using these basic elements. PRSEUS stands for Pultruded Rod Stitched Efficient
26 Unitized Structure and is a panel designed to minimize stresses that arise due to the non-
27 circular fuselage geometry of the wide body aircraft.

1 12. Figure 3 from Boeing's U.S. Patent No. 11,215,552 ("the '552 patent")
2 shows how the laser spallation method claimed in the '684 Patent is used by Boeing to
3 test the same areas of the stringers and frames that were identified by the Boeing
4 engineers at the Huntington Beach facility via their stress analysis as being critical for
5 joint failure, and would therefore require monitoring during servicing of the aircraft.

6 13. The papers published by the Boeing engineers from the Huntington Beach
7 facility show the material and other cross-sectional details of the stringer and frame
8 (panel). As described in the papers, all these elements are made using different types
9 of composites and joined together with different types of epoxies, including glass.
10 Figure 4 shows that the frame or the stinger can actually have a fiberglass core. The
11 glass element changes the profile of the stress wave to enhance the tensile stress at the
12 joint to be tested. In this way, the method steps of the '684 Patent cover Boeing's
13 testing of stringers by the LBI method. It is also noteworthy that the method steps of
14 the '684 Patent require the presence of composite panels through which the laser-
15 generated stress wave travels prior to arriving at the joint to be tested. These
16 composite panels can also act as the glass element depending upon their location and
17 composition. It is clear from the papers published by the Boeing engineers that the
18 Boeing's facilities in Southern California manufacture composite panels.

19 14. The method claims of the '684 Patent are also infringed when Boeing
20 tests its stringers and frame elements in a manner disclosed in Boeing's '552 patent.
21 Since the stringers and frame elements are used to stiffen the fuselage section all-
22 round, there are ceiling areas in which a continuous flow of water to constrain the
23 ablative film to generate the interrogating stress wave is not feasible. To solve this
24 problem, the '552 patent proposes the arrangement shown in Figure 2, where a
25 transparent adhesive tape 24 is directly placed on top of the ablative layer 4. A thin
26 layer of water is encapsulated under the transparent tape. The tape in this configuration
27 is the "glass element" that is protected under the method claims of the '684 Patent, and
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1 as such is used by Boeing to shape the stress wave to enhance the tensile stress wave
2 amplitude to test the complex stringer/frame element/skin joints that otherwise
3 disperse the wave energy. The presence of both water and transparent tape is evidence
4 that one of the layers is used for shaping the stress wave to enhance the tensile stress at
5 the adhesive joint to be tested.

6 15. I understand that Richard Bossi, who was the lead engineer for bond
7 inspection at Boeing, had outlined a similar plan for bond certification in Boeing
8 aircrafts as early as June of 2008 at the 4th FAA JAMS technology review meeting
9 held in Everett, WA. Slide 3 from his presentation, entitled, "*Aviation Industry*
10 *Perspective on the Presented Research*," displays the wide body aircraft structures and
11 results from a stress analysis. As noted above, engineers at Boeing's Huntington
12 Beach Facility have analyzed these wide body aircraft structures and have identified
13 areas where adhesion loss is expected and thus would require monitoring using the
14 method claims of the '684 Patent.

15 16. In conjunction with the filing and securing of the '552 patent, Boeing has
16 advertised job openings in May 2023, seeking structural stress analysts and test
17 engineers in the Central District of California for analyzing and validating (testing) the
18 bonded adhesive joints.

19 17. Boeing appears committed to using the '684 Patent's method claims for
20 manufacturing and inspecting of adhesive bonds in their entire fleet of aircraft,
21 including sections comprising of stringers and frames. They have even planned to
22 change the configuration of their entire airframe structural system so that the system
23 would be amenable to inspection by the laser bond inspection method that is based on
24 the '684 Patent's method claims. This is evident from Figure 2 of Boeing's recently
25 published patent application No. US 2023/0104854, where the upwardly and
26 downwardly pointing arrows 142 in Figure 2 are meant to indicate the travel path of
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1 the interrogating laser-generated stress wave, which is disclosed in the method claims
2 of the '684 Patent.

3 18. I called Richard Bossi of Boeing via telephone on August 2, 2004, after
4 discovering his 2004 SAMPE paper in which several of my trade secrets that were
5 protected under a Proprietary Agreement with Boeing were disclosed. Specifically, the
6 paper disclosed the use of a transparent tape and a black tape alongside the use of a
7 water stream to enhance and shape the laser-generated stress wave profile to test
8 adhesion between two layers. The Proprietary Agreement was signed with Boeing's
9 coating group (Doug Berry and Seana Kobak) in the year 2000 when Boeing samples
10 were tested by using laser-generated stress waves in my lab. I approached Mr. Bossi
11 directly after receiving no response from either Mr. Berry or Ms. Kobak after several
12 phone calls and email messages. Copies of two emails between Mr. Bossi and myself
13 memorialize the fact that a phone call took place between Mr. Bossi and me on or
14 around August 2, 2004 (Exhibit 7A and Exhibit 7B).

15 19. Mr. Bossi told me on his own that he was aware of my U.S. Patent No.
16 5,438,402 ("the '402 Patent"). The '684 patent builds upon the '402 patent in that it
17 uses a glass element to enhance the amplitude of the interrogating stress wave. Such an
18 enhancement is necessary as the amplitude of the interrogating stress wave dissipates
19 very quickly as the wave travels through multiple fiber layers of the composite
20 laminate.

21 20. Mr. Bossi had firsthand knowledge of my work with Boeing that was
22 done back in 2000 with the Kobak/Doug Berry's group.

23 21. Our discussion then centered around how to enhance the stress wave
24 amplitude, and I told him about the glass related work I was doing to enhance the
25 stress wave amplitudes. He mentioned that he actively interacts with the engineers at
26 the Boeing facilities in Southern California as he was a part of the Boeing Phantom
27 Works which had a substantial presence in Southern California.

22. Subsequent to that phone conversation, Mr. Bossi sent me a copy of his 2004 Society for the Advancement of Material and Process Engineering (SAMPE) paper, even though I had already read it prior to our phone discussion. I sent him a follow up email indicating that several of the steps involved in his 2004 SAMPE paper were directly taken from my prior work.

I declare under penalty of perjury under the laws of the United States of America that the foregoing facts are true and correct, based on my knowledge, understanding, information, and belief.

Dated: August 11, 2023

By: 
Vijay Gupta