

UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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SAMSUNG ELECTRONICS CO. LTD.,  
SAMSUNG ELECTRONICS AMERICA, INC.,  
SAMSUNG SEMICONDUCTOR, INC., and  
SAMSUNG AUSTIN SEMICONDUCTOR, LLC,  
Petitioner

v.

CHIEN-MIN SUNG,  
Patent Owner

IPR2024-00534  
U.S. Patent No. 9,138,862

**SECOND DECLARATION OF PROF. MING-YI TSAI**

Under 37 C.F.R. § 42.107

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Patent Trial and Appeal Board  
U.S. Patent and Trademark Office  
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Alexandria, VA 22313-1450  
*Submitted Electronically via PTAB E2E*

1. My name is Ming-Yi Tsai. I am over the age of 18 years old and I am competent to testify to the matters stated in this Declaration.

2. I provide this Declaration in support of Patent Owner Chien-Min Sung (“Dr. Sung”) in the above-captioned proceeding.

3. I am being compensated for the services I render in this proceeding at an hourly rate of \$150. My compensation is in no way dependent on the outcome of this proceeding.

4. To the extent missing from my testimony below, this Second Declaration incorporates by reference and re-adopts the substance of the testimony provided my first Declaration in this proceeding, dated June 28, 2024.

## **I. BACKGROUND**

5. I have extensive experience in the Chemical-Mechanical Processing (“CMP”) of semiconductor devices, with a focus on the design and characterization of CMP pad dressers (also known as CMP pad conditioners and CMP conditioning discs).

6. A copy of my curriculum vitae is attached as Exhibit A.

7. I received my Ph.D. in Mechanical Engineering from National Taiwan University in Taiwan.

8. I am a Distinguished Professor in the Department of Mechanical Engineering, National Chin-Yi University of Technology, Taichung City, Taiwan.

My research areas include difficult cut materials, chemical mechanical polishing and abrasive machining.

9. I have published articles through the IEEE and about 100 technical papers in journals and conferences (including international and Taiwanese).

10. Among these publications, I am the lead author of a publication titled Effect of CMP Conditioner Diamond Shape on Pad Topography and Oxide Wafer Performances, Int. J. Adv. Manuf. Technol. 55(1):253–262 (2011) (published online Dec. 4, 2010) (“CCDS article”).

11. I understand that my CCDS article has been cited by Petitioners Samsung Electronics Co. Ltd., Samsung Electronics America, Inc., Samsung Semiconductor, Inc., and Samsung Austin Semiconductor, LLC (“Samsung”) as Exhibit 1014 supporting in their Petition in this case in relation to U.S. Patent 9,138,862 (the “’862 patent), which was issued to Chien-Min Sung, a co-author of mine on other articles. I have received a copy of Samsung’s Petition and am familiar with its contents.

12. My publications also include other articles relating to CMP pad dressers, two of which are cited in the References Section of the CCDS article. Those two articles are Novel Diamond Conditioner Dressing Characteristics of CMP Polishing Pad, Int. J. Mach. Tool Mfg. 49:722–729 (2009), on which Dr.

Sung was one of my co-authors, and Dressing Characteristics of Oriented Single Diamond on CMP Polyurethane Pad, Mach. Sci. Technol. 13:92–105 (2009).

## **II. RELEVANT LEGAL PRINCIPLES**

13. I am not an attorney. The following legal principles have been provided to me by counsel.

### **A. Patent Claims**

14. I understand that independent claims are read separately, whereas dependent claims are based on the limitations of another independent and/or dependent claims. To determine the scope of a dependent claim, it must be read together with the claim or claims upon which it depends. In other words, each independent claim stands on its own, whereas each dependent claim includes the elements from that dependent claim plus any claim from which it depends, either directly or indirectly.

### **B. Anticipation**

15. A patent claim to a device is anticipated if the same device, system, or method, including all the claim limitations, is shown in a single prior art reference. The identical invention must be shown in as complete detail as is contained in the patent claim. Every element of the claimed invention must be literally present in the reference, arranged as in the claim.

16. For a prior art reference to anticipate a claim, the reference, as viewed by a person of ordinary skill in the art at the time of the invention, must disclose

each and every element of the claim with sufficient clarity to prove its existence in the prior art, and with sufficient clarity to enable one of ordinary skill in the art to make the invention without undue experimentation. Determination of whether the requisite amount of experimentation is undue may include consideration of (1) the quantity of experimentation necessary, (2) the amount of direction or guidance presented, (3) the presence or absence of working examples, (4) the nature of the invention, (5) the state of the prior art, (6) the relative skill of those in the art, (7) the predictability or unpredictability of the art, and (8) the breadth of the claims.

### **C. Obviousness**

17. To obtain a patent, a claimed invention must have, as of the priority date, been non-obvious in light of the prior art in the field.

18. To prove that prior art or a combination of prior art renders a patent obvious, it is necessary, by a preponderance of the evidence to: (1) identify the particular references that, singly or in combination, make the patent obvious; (2) prove that those references qualify as prior art to the patent; (3) specifically identify which elements of the patent claim appear in each of the asserted references; (4) explain how the prior art references could have been combined in order to create the inventions claimed in the asserted claim; and (5) identify a reason that would have prompted a person of ordinary skill in the relevant field to combine the elements in a way the claimed new invention does. It must be shown

that a person of ordinary skill would have had reason to attempt to make the device, or carry out the claimed method, and would have had reasonable expectation of success in doing so. Reasonable expectation of success is assessed as of the date of the invention described in the patent.

19. Obviousness can also be based on an “obvious-to-try” theory. In addition to the aforementioned requirements, a proper obvious-to-try conclusion also requires: (1) that at the relevant time, there had been a recognized problem or need in the art, which may include a design need or market pressure to solve the problem; and (2) that there had been a finite number of identified, potential solutions to that recognized need or problem known to persons of ordinary skill in the art. An obviousness inquiry based on an obvious-to-try rationale must always be undertaken in the context of the subject matter in question, including the characteristics of the technology, its state of advance, the nature of the known choices, the specificity or generality of the prior art, and the predictability of results in the area of interest.

20. The claimed invention must be considered as a whole in analyzing obviousness or non-obviousness. In determining the differences between the prior art and the claims, the question under the obviousness inquiry is not whether the differences themselves would have been obvious, but whether the claimed invention as a whole would have been obvious.

21. As part of the process of determining the scope and content of the prior art, it is appropriate to consider whether there is evidence of a “teaching, suggestion, or motivation” to combine the teachings in the prior art, the nature of the problem or the knowledge of a person having ordinary skill in the art.

22. In assessing obviousness, I have been instructed to consider the distortion caused by hindsight bias, to guard against slipping into the use of hindsight, and to be cautious of arguments that rely upon after-the-fact reasoning and avoid the temptation to read into the prior art the teaching of the invention in issue.

23. The following factors should be considered in analyzing obviousness: (1) the scope and content of the prior art; (2) the differences between the prior art and the claims; (3) the level of ordinary skill in the pertinent art, and (4) the objective evidence of non-obviousness (if present).

24. Certain objective indicia can be important evidence regarding whether a patent is obvious or non-obvious. Such indicia include:

- a. Commercial success;
- b. Long-felt, but unsolved needs in the art for the invention, particularly in the face of prior art later asserted to lead to a solution;
- c. Failure of others;
- d. Skepticism by experts

- e. Praise by others;
  - f. Unexpected results;
  - g. Recognition of a problem;
  - h. Copying of the invention by others in the field.
25. An objective indicium cannot be relevant to the obviousness discussion for a patent unless that objective indicium is connected, or has a “nexus,” with the invention claimed in the patent at issue.

### **III. THE LEVEL OF ORDINARY SKILL IN THE ART**

26. I have also been informed that there is a concept in patent law known as a person having ordinary skill in the art (“POSITA”). I have been informed that this concept refers to a person who is trained in the relevant technical field of a patent without possessing extraordinary or otherwise exceptional skill. Further, I have been informed that factors such as the education level of those working in the field, the sophistication of the technology, the types of problems encountered in the art, prior art solutions to those problems, and the speed at which innovations are made may help establish the level of skill in the art.

27. I understand that Samsung’s expert Dr. Stanley Shanfield has provided the following proposed definition of a POSITA for the ’862 patent:

[A] POSITA as of the earliest claimed filing date of the ’862 Patent (i.e., May 23, 2011) would have had a bachelor’s degree in material science, mechanical engineering, electrical engineering, or physics, and a minimum of two to three years of experience in the field of integrated

circuit processing and fabrication techniques. I note that a higher level of education or specific skills in the industry may make up for less experience, and vice versa.

(Ex. 1002 at ¶ 61.)

28. I have been made aware that Dr. Shanfield has failed to provide any explanation or analysis as to how or why he reached this conclusion.

29. It is my opinion that Dr. Shanfield's definition of a POSITA is deficient because lacks any specific reference to CMP technology, which is a specialized branch of semiconductor manufacturing. Accordingly, I believe a POSITA for purposes of the '862 patent would have at least two years of experience in developing CMP technology, including experience with the design and development of CMP pad dressers.

30. I have a keen understanding of this level of skill in the art as it existed at the time the '862 patent was filed. I was directly involved the development of chemical-mechanical planarization (CMP) technology and CMP pad conditioners specifically as reflected in my curriculum vitae and am capable of rendering an informed opinion on the level of ordinary skill in the art at the relevant time frame. Moreover, I am capable of rendering an opinion from the perspective of one of ordinary skill in the art at the relevant timeframe, as I have done below.

#### **IV. PRECISION IN ALIGNING SUPERABRASIVE PARTICLES IN CMP PAD DRESSERS**

31. Based on my experience, atomic-level precision in aligning the tip heights on a CMP pad dresser was not practically achievable circa 2011.

32. Based on my experience in CMP pad design and measurement, and my understanding of the development of CMP pad dressers at that time, circa 2005–2007, it was not practically achievable to consistently and predictably manufacture a CMP pad dresser having superabrasive particle tip height variation below 50 microns.

33. That level of variation causes a substantial variation in the cut depth of the pad dresser during actual usage and causes excessive wear and mechanical stress that aids in the removal of protruding superabrasive particles.

34. It was thought that this problem could be solved by controlling the variation in tip height distribution during pad dresser manufacturing. It was predicted that this reduction in height tip variation would result in the mechanical stresses being substantially evenly distributed over the bulk of the superabrasive particles during actual usage, rather than being disproportionately concentrated on the protruding particles. As a result, it was predicted that this reduction in variation in tip height would help retain the superabrasive particles when actually using the CMP pads.

35. By 2009, a number of different publications continued to recognize that the tips of superabrasive particles on CMP pad dressers would not be at the

same height or have the same shape or orientation. Nevertheless, it was still assumed that mechanical stresses would be substantially equally distributed among the bulk of the superabrasive particles during the use of the CMP pad dressers.

36. Despite the lack of empirical underpinnings, this assumption continued to underlie CMP pad dresser design and usage. Even a cutting-edge CMP conditioner simulation in 2010 still took this “bulk view” of the superabrasive particles, with its model applying a uniform distribution of particles that considered variations in their density and the radius of their distribution on the CMP pad. (This was justified by citing to another study titled Pad Conditioning Density Distribution in CMP Process with Diamond Dresser, IEEE Trans. Semicond. Manuf. 20(4):464–474, by Tyan that the distribution patterns of the superabrasive particles did not significantly influence the final dressing results.)

37. Because these variables were not considered to be significant contributors to variance in the performance of CMP pad dressers, as of 2009, it those of skill in the art still considered the dressing behavior of superabrasive particles, and of CMP pad dressers, in operation to be “unpredictable.” That unpredictability in actual usage remained the prevailing understanding, and remained a problem to be solved, notwithstanding the motivation to reduce tip height variation as much as possible.

## **V. THE DISCLOSURE OF SUNG '026 FROM THE PERSPECTIVE OF A PERSON OF ORDINARY SKILL IN THE ART CIRCA 2011**

38. I am aware that Petitioners cite extensively to US 2007/0060026 A1 (“Sung ’026”) as the primary reference in the above-captioned proceedings.

39. As its first page indicates, Sung ’026 is a patent application titled “Methods of bonding superabrasive particles in an organic matrix.” It was filed by Dr. Chien-Min Sung on September 9, 2005, and published on March 15, 2007. Ex. 1004.

40. As the Abstract of Sung ’026 confirms, its primary focus is on using an organic material layer to improve the retention of superabrasive particles in an abrading tool compared to the prior art metal matrices traditionally used to retain the abrasive particles in a CMP pad dresser. (See Ex. 1004 at Abst & [0006].)

41. To that end, Sung ’026 aims to minimize mechanical stress impinging on the protruding portion of any individual superabrasive particle when used in the pad dresser to condition a CMP pad by providing particular arrangements of the superabrasive particles that more uniformly distribute the frictional forces across the superabrasive particles. (See *id.* at [Abst.]).

**A. Sung ’026 Does Not Disclose Claim Limitation [1A] (“pressing a CMP pad dresser against a CMP pad”)**

42. It is my understanding that Claim Limitation [1A] of the ’862 patent requires only “pressing a CMP pad dresser against a CMP pad.”

43. From the perspective of a person of ordinary skill in the art, it is my opinion that Sung ’026 does not disclose this limitation.

44. To be sure, Sung '026 clearly describes the CMP pad dresser being used to condition the CMP pad, and this use necessarily requires physical contact between the CMP pad dresser and the CMP pad being groomed.

45. As a person of ordinary skill in the art would readily understand, superabrasive tools like CMP pad dressers could not be used to abrade a workpiece and would not experience frictional forces, nor would its protruding superabrasive particles experience the described impinging mechanical stresses, unless the tool and the CMP pad were in contact with each other.

46. But Sung '026 only indicates **that** the dresser and the pad are held in contact. It is silent about **how** they are held in contact.

47. As a matter of logic and physics, two objects (abrasive Object A and workpiece Object W) can be held in contact together in several different ways: (i) force can be applied to Object A to press it against Object W; (ii) force can be applied to Object W to press it against Object A; and (iii) both (i) and (ii) can occur such that force is applied to each of Object A and Object W to press them against each other. A simplified exemplary schematic of these three scenarios is presented below, in which Object A is a Pad Dresser and Object W:

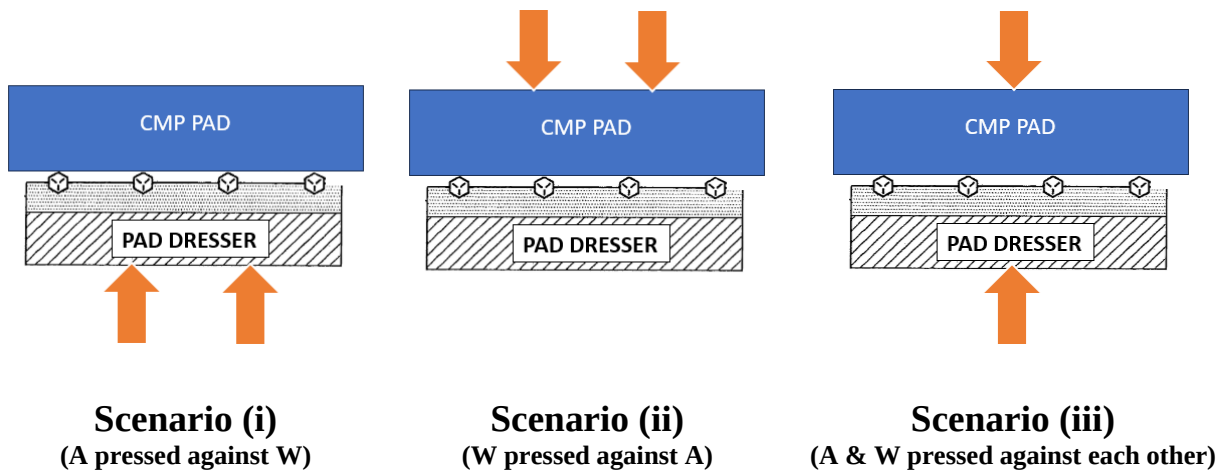


**Figure 1** (two objects can be held in contact by applying force in three ways)

48. If Object A has protruding portions and its surface is moving relative to that of Object W, those protrusions will experience frictional forces and mechanical stresses in each of scenarios (i), (ii), and (iii).

49. In other words, the fact that Object A is experiencing frictional forces and mechanical stresses does not disclose whether Object A is being pressed against Object W, Object W is being pressed against Object A, or both are being pressed against each other. If the net same force is applied to hold Object A and Object W in contact, the same frictional forces will result regardless of how that net force is distributed between Object A and Object W.

50. As a person of ordinary skill in the art would readily understand, the phrasing of Claim Limitation [1A], requiring pressing the dresser against the pad, is meant to exclude scenario (ii) in which force is applied to the solely to CMP pad

to hold it in contact with the pad dresser so that it may be conditioned by the resulting friction.

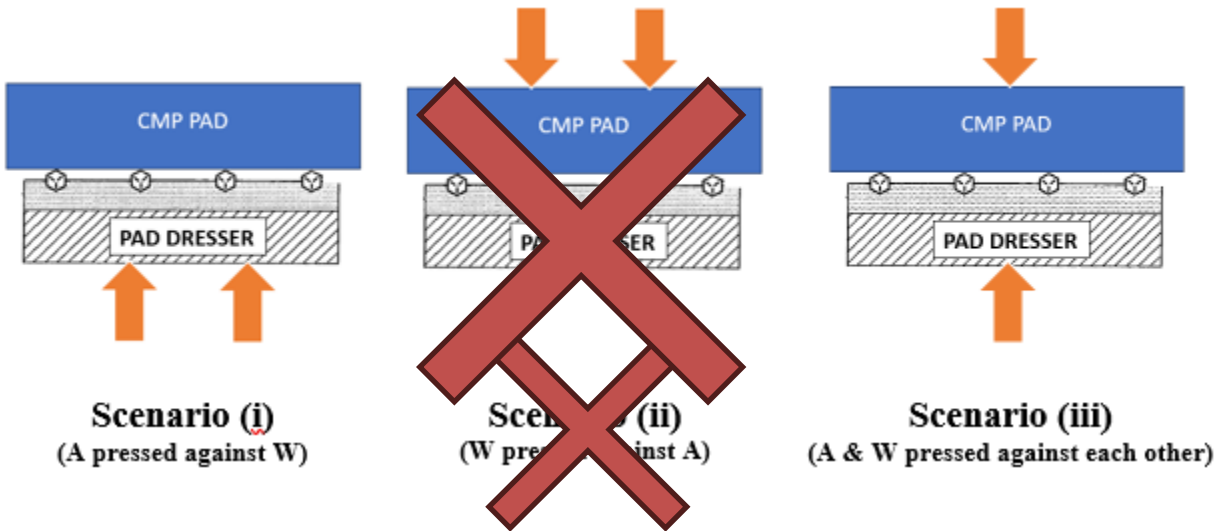


**Figure 2** (pad/dresser contact scenarios encompassed by Claim Limitation [1A])

51. To illustrate, consider the analogous example of cutting tools such as saws (Object A) being used to cut wood (Object W). Analogous to scenario (i), a stationary wooden workpiece like a log can be cut by applying force to a hand-held saw such as a hacksaw or a chainsaw. Analogous to scenario (ii), a movable wooden workpiece can be cut by applying force to press it against the moving surface of a stationary cutting tool, such as a table saw or bandsaw. And analogous to scenario (iii), force can be applied to both the wooden workpiece and the cutting tool at the same time, such as when a coping saw or a jigsaw and the wooden workpiece are being pressed together and maneuvered at the same time.



**Scenario (i)**  
**chainsaw analogue**  
(A pressed against W)

**Scenario (ii)**  
**table saw analogue**  
(W pressed against A)

**Scenario (iii)**  
**jigsaw analogue**  
(A & W pressed against each other)

**Figure 3** (depicting woodcutting analogues to scenarios (i)–(iii))

52. In each of these analogous examples, a wooden workpiece is cut by the frictional forces resulting from it being held against the working surface of a cutting tool—regardless of whether the workpiece is pressed against the cutting tool, the cutting tool is pressed against the workpiece, or both are pressed against each other.

53. When wood and a saw blade are held in contact such that their surfaces experience relative motion, the wood invariably will be cut. But the mere fact that friction results and cutting occurs does not provide sufficient information to identify the object(s) being pressed.

54. As one of ordinary skill in the art would readily understand, Sung '026 discloses only that the CMP pad dresser conditions the CMP pad as a result of

the two being held in contact. It is silent about whether that conditioning results from the CMP pad being pressed against the dresser (scenario i), the dresser being pressed against the pad (scenario ii), or both being pressed against each other (scenario iii).

55. While one of ordinary skill in the art would readily appreciate from the disclosure of Sung '026 that the described friction-induced conditioning **could** occur by pressing a CMP pad dresser against a CMP pad, that same conditioning **could also** result from pressing the pad against the dresser instead.

56. Thus, it is my opinion that notwithstanding the general disclosure that the CMP pad is groomed when it is held in contact with the moving surface of a dresser, Sung '026 **does not** describe the particular scenario in which that contact occurs and is maintained as a result of “pressing a CMP pad dresser against a CMP pad,” rather than vice versa.

57. In other words, the mere fact of the protruding superabrasive particles experiencing frictional forces and/or mechanical stresses does not **require** the specific scenario recited in Claim Limitation [1A] of “pressing a CMP pad dresser against a CMP pad.” The same result will occur in from the physically equivalent alternative scenario—which the phrasing of Claim Limitation [1A] **excludes**—of “pressing a CMP pad against a CMP pad dresser.”

58. I am also aware that to support their argument that Sung '026 discloses Claim Limitation [1A],<sup>1</sup> Petitioners have relied upon a description of “superabrasive tools and methods that are, without limitation, suitable to groom the CMP pads used for the delicate polishing applications” that are used to “abrade a work piece.” Pet. 26-27 (citing Ex. 1004 at [0009], [0051]).

59. I also understand that Petitioners have further relied on the declaration of Dr. Shanfield to further support their argument that Sung '026 discloses Claim Limitation [1A].

60. I have been informed that Dr. Shanfield has testified that “the CMP pad dresser is used to condition the CMP pad,” and has cited as support paragraph [0004] of Sung '026, which states “A CMP pad dresser can be used to revive the pad surface by ‘combing’ or ‘cutting’ it. This process is known as ‘dressing’ or ‘conditioning’ the CMP pad.” I further understand that Dr. Shanfield has testified that “[t]his conditioning process includes physical contact between the CMP pad dresser and the CMP pad.”

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<sup>1</sup> It is my understanding that Petitioners have neither argued that this Claim Limitation [1A] was inherently disclosed in Sung '026 nor that this Claim Limitation [1A] would have been obvious to a POSITA in view of the disclosure of Sung '026. Rather, I have been made aware that Petitioners only argued that Sung '026 “**discloses** limitation [1A].”

61. I am informed that Dr. Shanfield has opined that because “frictional forces on the CMP pad dresser described by Sung ’026 can **only** be the result of the CMP pad being pressed against another object (e.g., a CMP pad dresser), Sung ’026 discloses pressing a CMP pad dresser against a CMP pad.” (emphasis added). I disagree.

62. Specifically, I disagree with Dr. Shanfield’s reasoning, and I also disagree with his conclusion. It is my opinion that Dr. Shanfield is incorrect, both logically and as a matter of physics.

63. While Dr. Shanfield correctly recognizes that the described frictional forces **can** result from the dresser being pressed against the CMP pad, it does not follow that pressing the dresser against the CMP pad is the **only** way that such forces can result.

64. As I have explained above, the same frictional forces on the CMP pad dresser described by Sung ’026 will result irrespective of whether a given amount of net force is used to press (i) the pad against the dresser, (ii) the dresser against the pad, or (iii) both against each other. The description of resulting frictional force does not suffice to identify the object that is being pressed to maintain contact between the objects that produce the friction.

65. And as a person of ordinary skill in the art would readily understand from the phrasing of Claim Limitation [1A], it does not encompass every scenario

in which two objects are held in contact, but only those in which that contact occurs as a result of pressing the abrasive tool against the workpiece.

66. Dr. Shanfield's inference that friction cannot result without pressing the abrasive tool against the workpiece lacks logical and scientific bases.

**B. Sung '026 Does Not Disclose Claim Limitation [1C] (“wherein the difference in protrusion distance between the highest protruding tip and the second highest protruding tip of the monolayer of superabrasive particles is less than or equal to about 10 microns and the difference in protrusion distance between the highest 10 protruding tips of the monolayer of superabrasive particles are [sic] within about 20 microns or less”)**

67. It is my understanding that Petitioners rely on paragraphs [0006], [0053], [0056], and [0073] of Sung '026, along with Dr. Shanfield's Declaration, to support their argument that Sung '026 discloses Claim Limitation [1C].

68. In my opinion, viewed from the perspective of a person of ordinary skill in the art, these various portions of Sung '026 are separate and distinct “aspects” or embodiments of the invention that individually do not disclose what Claim Limitation [1C] recites, as I will elaborate below.

69. It is also my opinion that it would not have been obvious to a person of ordinary skill in the art circa 2011 to combine these distinct “aspects” or embodiments involving the separate parameters of predetermined tip profile, permitted variation from the tip profile, and particle protrusion height range.

70. Rather, only through hindsight would a person of ordinary skill in the art have been able to have selected from the among the potentially infinite combinations of these parameters relating to the distinct embodiments described in Sung '026 (including the 13 specific permitted variations from the tip profile and 4 specific particle protrusion height ranges) to form the one particular combination that is purported to satisfy Claim Limitation [1C].

71. To the extent that there was any motivation to try to combine these distinct embodiments of Sung '026 to level the particle tips as recited in Claim Limitation [1C], that motivation would have been further minimizing the mechanical stress on individual superabrasive particles when used to abrade a work piece and thus improving their retention relative to the prior art abrading tools.

This is most clear in paragraph [0052]:

A superabrasive particle that protrudes to a significantly greater height than other superabrasive particles will experience a greater proportion of the impinging mechanical forces and thus is more prone to pull out of the solidified organic material layer. Thus an even height distribution of superabrasive particles may function to more effectively preserve the integrity of the abrading tool as compared to abrading tools lacking such an even height distribution.

But Sung '026 consistently explains its motivation throughout.<sup>2</sup> The leveling it discloses is desirable because it improves the internal structural integrity of the dresser—specifically its retention of the superabrasive particles.

72. A person of ordinary skill in the art would have understood Sung '026 to provide motivation to combine or modify its elements or embodiments in

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<sup>2</sup> Just considering those other paragraphs of Sung '026 cited by Petitioner and Dr. Shanfield, these include: [0006] (recognizing that prior art dressers' traditional metal matrices were unsuitable for holding and retaining appropriately-sized superabrasive particles), [0009] (discussing “arrangements” “minimiz[ing] mechanical stress” and “uniformly distribut[ing] drag forces across substantially each superabrasive particle”), [0010] (“Various methods are contemplated for minimizing the mechanical stress impinging on the superabrasive particles held in the abrading tool. One example may include superabrasive particle arrangement according to protrusion height.”), [0051] (discussing an “arrangement that minimizes mechanical stress,” and “various methods of minimizing mechanical stress,” including “one aspect” in which the arrangement of the plurality of superabrasive particles may be configured to uniformly distribute frictional forces across substantially each superabrasive particle. Such a uniform distribution of frictional force prevents any individual superabrasive particle from being overstressed and pulling out of the solidified organic material layer.), [0073] (“Superabrasive particles can be-arranged in various configurations that may help to distribute the frictional forces impinging on the too[l]. For example, in one aspect each of the plurality of superabrasive particles may protrude to a predetermined height above the solidified organic material layer. By minimizing the variance in the protrusion of the plurality of superabrasive particles above the solidified organic material layer, mechanical forces impinging on individual superabrasive particles can be minimized.”), [0075] (“Embodiments of the present invention also provide CMP pad dressers with improved superabrasive particle retention as recited herein. . . . Such an arrangement may increase the retention of the superabrasive particles **12** in the organic material layer **14** due to a substantially even distribution of frictional forces across all the superabrasive particles in the tool. This distribution of forces improves retention by minimizing mechanical stress impinging on any individual particle”).

whatever ways preserve the integrity of the abrading tool by enhancing its ability to retain the superabrasive particles.

73. The portions of Sung '026 relied upon by Petitioners do not identify uniformity of dressing the pad or precision in cutting performance as a motivation to combine various different embodiments of *the invention of Sung '026* with the particular parameters that result in the most precisely leveled tips. Rather, “*any predetermined height that would be useful in an abrading tool* [is] considered to be within the presently claimed scope.

**1. Sung '026 Does Not Disclose A Single Embodiment That Satisfies the Recitation of Claim Limitation [1C]**

74. It is my understanding that Petitioners rely on paragraphs [0053], [0056], and [0073], and corresponding claim language—along with Dr. Shanfield’s declaration explaining these portions of Sung '026—to support that Sung '026 discloses what Claim Limitation[1C] requires.

75. However, Sung '026 makes very clear that those cited portions of Sung '026 each discuss particular “aspects” of Sung '026, which from the perspective of a person of ordinary skill in the art, disclose those features as being distinct embodiments that provide a number of different various “aspects” of the invention that may help to reduce frictional force and mechanical stress on individual superabrasive particles.

76. I do not disagree that Sung '026 contains, in its extensive disclosure describing arranging the superabrasive particle tip heights according to a predetermined height profile, a particular embodiment in which the superabrasive particle tips are intended to be arranged in a planar profile such that their tips are intended to be substantially level. However, this embodiment does not specify what, if any, variance from the predetermined profile is permitted.

77. Paragraph [0053] teaches that the superabrasive particles of the pad dresser “may protrude from the solidified organic material layer to a predetermined height or series of heights that is/are along a designated profile,”<sup>3</sup> with “numerous configurations for designated profiles [being] possible” (“profile aspects”). Among these profile aspects, paragraph [0053] continues to describe “one aspect” or category of embodiment in which “the designated profile may be a plane,” such that “the highest protruding points of the superabrasive particles are intended to be substantially level.”<sup>4</sup> Paragraph [0053] explains that while “it is preferred that these points align with the designated profile . . . there may be some height deviation between superabrasive particles that occur due to limitations inherent in the manufacturing process.”

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<sup>3</sup> Verbiage echoing this portion of [0053] is recited in Sung'026 claim 31.

<sup>4</sup> Verbiage echoing these portions of [0053] is recited in Sung'026 claims 36–37.

78. A person of ordinary skill in the art would understand paragraph [0053] of Sung '026 to describe a set of “profile aspect” embodiments in which the protrusion depth of the superabrasive tips from the solidified organic material layer is intended to align to the designated profile to the degree permitted by the manufacturing process. One particular subset of these described “profile aspect” embodiments comprises planar profile aspect embodiments having substantially level superabrasive particle tips.

79. I do not disagree that Sung '026 contains, in its extensive disclosure regarding the extent to which particle tip height may be permitted to vary from a predetermined height profile, a particular embodiment in which the superabrasive particle tips vary from a designated tip height profile by less than about 1 micron out of a number of such ranges. However, this embodiment describes nothing about the particular tip height profile from which the less than about 1 micron variance occurs.

80. Paragraph [0056] discusses a number of distinct “aspects” or embodiments in which the superabrasive particle tips are permitted to vary by differing amounts from the designated profiles (“deviation aspects”). It specifically identifies 13 different deviation aspects that specify permitted variances for the highest protruding points of the superabrasive particle tips, from which it selected the twelfth (less than about one micron):

- 1) 1–150  $\mu\text{m}$
- 2) 5–100  $\mu\text{m}$
- 3) 10–75  $\mu\text{m}$
- 4) 10–50  $\mu\text{m}$
- 5) 50–150  $\mu\text{m}$
- 6) 20–100  $\mu\text{m}$
- 7) 20–50  $\mu\text{m}$
- 8) 20–40  $\mu\text{m}$
- 9) less than about 20  $\mu\text{m}$
- 10) less than about 10  $\mu\text{m}$
- 11) less than about 5  $\mu\text{m}$

**12) *less than about 1  $\mu\text{m}$***

- 13) less than about 10% of the average superabrasive particle size

81. Paragraph [0056] discloses that “[t]hese deviations may be the result of the design or manufacturing process of the tool” and “may be highly dependent on a particular application.” It does not describe any of its “deviation aspects” as being specific to or used in conjunction with any of the previously-described “profile aspects” described in paragraph [0053], including the “planar profile aspects”.

82. I do not disagree that Sung ’026 contains, in its extensive disclosure regarding the height(s) to which particles height may protrude from the solidified organic material layer from a predetermined height profile, a particular embodiment in which the superabrasive particles protrude, with a height range

variance of about 10 microns to about 20 microns, out of a number of such potential heights and variance ranges. However, this embodiment describes nothing about any predetermined tip height profile or the permitted extent of any variance therefrom.

83. Paragraph [0073] addresses “various configurations” of the arrangements of superabrasive particles “that may help to distribute the frictional forces impinging on the tool[1].” It identifies as one such parameter the extent to which the superabrasive particle tips may protrude from the organic matrix layer profiles (“protrusion aspects”), including specifically identifying a protrusion height of “greater than about 20  $\mu\text{m}$ .”

84. This paragraph [0073] also specifically identifies a number of different specific variances for the protrusion aspects that bound to different degrees the amount that the superabrasive particle tips are permitted to protrude from the solidified organic material layer, including specifically identifying the following variance ranges permitted from the predetermined height protrusion:

- 1) about 1  $\mu\text{m}$  to about 20  $\mu\text{m}$
- 2) about 5  $\mu\text{m}$  to about 20  $\mu\text{m}$
- 3) ***about 10  $\mu\text{m}$  to about 20  $\mu\text{m}$***

85. Paragraph [0073] explains that these protrusion aspects “may vary between tool applications.” It does not describe any of its “protrusion aspects” as

being specific to or used in conjunction with any of the previously-described “profile aspects” described in paragraph [0053], including the “planar profile aspects.” Nor does it describe any of its “protrusion aspects” as being specific to or used in conjunction with any of the previously-described “deviation aspects” described in paragraph [0056], including the “about 10 mm to about 20 mm” aspect.

86. Sung ’026 explains that the purpose of “minimizing the variance in the protrusion of the plurality of superabrasive particles above the solidified organic material layer” is so that “mechanical forces impinging on individual superabrasive particles can be minimized.”

87. Sung ’026 does not describe in paragraph [0073] any effect on asperity cutting depth that results from “minimizing the variance in the protrusion of the plurality of superabrasive particles above the solidified organic material layer.” Nor does it describe any other effect on the conditioning performance of such a dresser<sup>5</sup> based on “minimizing the variance in the protrusion of the plurality of superabrasive particles above the solidified organic material layer.”

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<sup>5</sup> While paragraph [0006] posits that the superabrasive particle tip height variation of more 50  $\mu\text{m}$  in *prior art* “traditional” pad dressers would make such a dresser “useless if it were required to dress a CMP pad and achieve a uniform asperity depth of 20  $\mu\text{m}$  or less,” the described superabrasive particles do not protrude from any

88. The foregoing portions of Sung '026 do not describe any embodiment in which both a “profile aspect” and a “deviation aspect” are both specified.

89. The foregoing portions of Sung '026 do not describe any embodiment in which both a “profile aspect” and a “protrusion aspect” are both specified.

90. The foregoing portions of Sung '026 do not describe any embodiment in which both a “deviation aspect” and a “protrusion aspect” are both specified.

91. Accordingly, the foregoing portions of Sung '026 do not describe any embodiment in which all of a “profile aspect,” a “deviation aspect,” and a “protrusion aspect” are all identified.

92. Nor do the foregoing portions of Sung '026 describe any one embodiment having all of: (a) a planar designated profile for the predetermined series of heights for the superabrasive particles; (b) tip height variance from the planar designated profile of less than about 1 micron; and (c) protrusion above the solidified organic material layer of about 10 to about 20 microns.

93. Rather, Sung '026 describes each of these varied parameters as a particular one of a set of different “aspects” of its invention, which a person of ordinary skill in the art would understand to describe separate embodiments that

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“solidified organic material layer” utilized by Sung '026. Rather, they are described as being retained by and protruding from “a traditional metal matrix.”

each individually have the effect of reducing impinging mechanical stresses on individual superabrasive particles.

94. That Sung '026 lacks a description of each of these specific parameters, let alone one existing with each of the specific values identified by Petitioners is confirmed by Dr. Shanfield's need to have created a mock-up schematic drawing of what he claims that Sung '026 discloses.

**2. The Ranges Recited in Claim Limitation [1C] Were Chosen by Dr. Shanfield's Application of Hindsight and Need Not Occur by Following the Teachings of Sung '026**

95. But this only reflects Dr. Shanfield's picking and choosing of 3 particular embodiments having 3 specific values from the entirety of the extensive disclosure of Sung '026. Specifically, Dr. Shanfield reveals, through the citations to Sung '026 in paragraphs 101 and 102 of his declaration, that he has, at most created a particular embodiment based on the teachings of Sung '026 that satisfies the recitation of Claim Limitation [1C] and identified the specific portions of Sung '026 on which he relied.

96. I am not aware of any explanation from Dr. Shanfield as to why he chose these particular values (as opposed to others) for each of these parameters.

97. I am aware that Dr. Shanfield opines that the claimed ranges recited by Claim Limitation [1C] are what "would" result from a mere "effort" to provide

more precisely leveled tips as set forth by Sung '026 because it was well-known that unleveled tips have numerous disadvantages.

98. Based on express statements in Sung '026, I disagree with Dr. Shanfield.

99. In particular, the claimed ranges would not necessarily result from following the teachings of Sung '026; in fact, Sung '026 discloses in paragraph [0056] no fewer than thirteen different ranges of permissible tip-height variation. Likewise, Sung '026 discloses in paragraph [0073] no fewer than three different tip height variance ranges from a large protrusion height range. And only certain combinations of these within the teachings of Sung '026 would result in the overall tip height variance ranges recited by Claim Limitation [1C].

100. Moreover, Sung '026 explains repeatedly that there may be height deviations (of an unspecified amount) due to limitations in the manufacturing process, and that deviations may also be the result of the result of a design, because they “may be highly dependent on a particular application.” (Ex. 1004 at [0053], [0056].)

101. These deviations in height resulting from intentional design, limitations in the manufacturing process, and/or the needs of a particular CMP pad dressing application as taught by Sung '026 confirm that the 10  $\mu\text{m}$  maximum variation between the two-highest-protruding tips and the 20  $\mu\text{m}$  maximum

variation among the ten-highest-protruding tips need not occur merely by trying to follow the teachings of Sung '026.

102. Rather, Sung contains a substantial number of embodiments or “aspects” that permit much more than the  $\pm 1$   $\mu\text{m}$  height variance that Dr. Shanfield claims “would” necessarily result merely from “trying” to follow the teachings of Sung '026.

**C. Sung '026 Does Not Provide an Enabling Disclosure of Claim Limitation [1D] (rotating the dresser against the CMP pad such that asperities are cut into the CMP pad having a maximum cutting depth of about 60 $\mu\text{m}$ )**

103. It is my understanding that Claim Limitation [1D] of the '862 patent requires the particular pad dresser recited (which Claim Limitation [1C] requires having has its two-highest-protruding tips both within 10  $\mu\text{m}$  of each other and its ten-highest-protruding tips all within 20  $\mu\text{m}$ ) to be actually rotated against the CMP pad such that it cuts asperities into the CMP pad to a depth of no more than about 60 microns.

104. Thus, it is my understanding that Sung '026 does not disclose Claim Limitation [1D] unless its contents describe a single embodiment with sufficient specificity to have enabled a person of ordinary skill in the art to have used a CMP pad dresser satisfying the structural requirements of Claim Limitations [1B] and [1C] to produce—without undue experimentation, circa 2011—an asperity depth of no more than about 60 microns in a CMP pad when rotated against it.

105. I am also aware that to support their argument that Sung '026 discloses Claim Limitation [1D],<sup>6</sup> Petitioners have only cited a single line that appears in two different places of Sung '026. Pet. at 36 (citing Ex. 1004 [0010], [0052]). The cited language states (without further explanation) only that “the predetermined height” (of each of the plurality of protruding superabrasive particles) “may produce a cutting depth of from about 10 micron[s] to about 20 microns when used to abrade a work piece.” *Id.*

106. I was unable to find any language in the cited paragraphs [0010] and [0052] of Sung '026 that identifies or otherwise discloses “the predetermined height” that “may produce” such a cutting depth of “about 10 micron[s] to about 20 microns when used to abrade a work piece.”

107. I disagree that these paragraphs [0010] and [0052] of Sung '026 disclose Claim Limitation [1D]; it is my opinion that they do not disclose Claim Limitation [1D].

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<sup>6</sup> It is my understanding that Petitioners have neither argued that this Claim Limitation [1D] was inherently disclosed in Sung'026 nor that this Claim Limitation [1D] would have been obvious to a POSITA in view of the disclosure of Sung'026. Rather, I have been made aware that Petitioners only argued that Sung'026 “**discloses** limitation [1D].”

108. Based on my review of the disclosure of Sung '026 from the perspective of a person of ordinary skill in the art, paragraphs [0010] and [0052] of Sung '026 fail to disclose Claim Limitation [1D] for several reasons.

**1. Sung '026 Does Not Disclose the Recited Cutting Depth Resulting from Using a CMP Pad Dresser Satisfying Claim Limitations [1B] and [1C]**

109. As I explain in further detail below, these portions of Sung '026 do not disclose Claim Limitation [1D] because they fail to describe *a pad dresser that satisfies the structural requirements of Claim Limitation [1B] and Claim Limitation [1C]* as being used to produce the recited cutting depth of less than about 60 microns.

**a. Sung '026 Does Not Identify the Height Profile that May Produce the Described 10–20um Asperity Cutting Depth**

110. First, the cited language from Sung '026 states only that “the predetermined height [of the protruding superabrasive particles] may produce a cutting depth of from about 10 micron[s] to about 20 microns when used to abrade a work piece,” (Ex. 1004 at [0010], [0052]).

111. That same paragraph [0052] expressly recognizes that “[v]arious configurations or arrangements are contemplated for minimizing the mechanical stress impinging on the superabrasive particles held in the abrading tool.” (Ex. 1004 at [0052].)

112. But Sung '026 never identifies *that particular* predetermined height profile (nor any set of or range for such profiles) from which the described cutting depth of about 10 microns to about 20 microns results.

113. Nor does Sung '026 identify the predetermined height profiles (or any sets of or ranges for such profiles) that would produce the other cutting depth ranges it describes: “less than about 20 microns” and “from about 1 micron to about 20 microns” “when used to abrade a work piece.” (Ex. 1004 at [0052]; *see also* Ex. 1004 at [0010].)

114. Each of these three ranges is described identically in Sung '026—as what “may [be] produce[d]” by “*the* predetermined height . . . when used to abrade a work piece.” (Ex. 1004 at [0010], [0052].) But no such predetermined height is identified for these ranges, or for any others, in the cited portions of Sung '026.

115. Rather, Sung '026 rejects any such differentiation in resulting cutting depths or specificity regarding the corresponding appropriate tip height profiles, stating instead that “*any predetermined height that that would be useful in an abrading tool* would be considered to be within the presently claimed scope.” (Ex. 1004 at [0052].)

116. Sung '026 is otherwise silent regarding any relationship between cutting depth and the appropriate tip height profiles that can produce the same; it teaches only that each such height is “predetermined,” and nothing more.

117. Sung '026 fails to describe any relationship at all between the desired asperity cutting depths it discusses and the appropriate height profile(s) of the CMP pad dresser's superabrasive particle tips that will or can produce those cutting depths.

118. Instead of any effect on the resultant asperity cutting depth on the work piece, Sung '026 states that "an even height distribution of superabrasive particles may function to more effectively preserve the integrity of the abrading tool as compared to abrading tools lacking such an even height distribution." (Ex. 1004 at [0052].) Sung '026 explains that "the height that the superabrasive particles protrude" is just "[o]ne potentially useful parameter," but even that utility applies to the stated purpose of "minimizing the mechanical stress impinging on the superabrasive particles." (*Id.*)

119. As one of ordinary skill in the art would have understood, these portions of Sung '026 describe the height distribution of the superabrasive particles as a parameter that affects the integrity and durability of the pad dresser itself by reducing the mechanical stress on the superabrasive particles.

120. Conversely, one of ordinary skill in the art would not have understood these portions of Sung '026 to describe "the height that the superabrasive particles protrude" as a parameter affecting the work piece being conditioned by the CMP pad dresser, let alone the asperity cutting depth that may result.

121. As I discussed in my first Declaration, and as I discuss further below, a particular asperity cutting depth or depth range alone provides insufficient information to infer the height tip profile of the CMP pad dresser that produced that depth. Circa 2011, it was not possible to characterize the relationship between asperity cutting depth and the tip height profile in general fashion. Rather, the actual performance of the CMP pad dresser (including the resulting cutting depth) when used to abrade a work piece is highly dependent on a substantial number of other variables, parameters, and usage conditions that were not well-characterized circa 2011.

122. It is my opinion, based on my experience in designing CMP pad conditioners, that Sung '026 certainly would not have taught a person of ordinary skill in the art, circa 2011, how to select a particular height profile that would produce any particular cutting depth when used to abrade a work piece.

123. It is also my opinion that Sung '026 would not have taught a person of ordinary skill in the art, circa 2011, how to select a height profile for a CMP pad dresser, that when used to abrade a work piece, would produce either the claimed range of less than about 60 microns or the range described in Sung '026 of about 10 microns to about 20 microns.

**b. Sung '026 Does Not Disclose Any Asperity Cutting Depth Resulting from Using a CMP Pad Dresser Satisfying Claim Limitations [1B] and [1C]**

124. Second (and conversely), Sung '026 does not describe in paragraphs [0010] and [0052] the use of a CMP pad dresser *that satisfies Claim Limitation [1B] and Claim Limitation [1C]*<sup>7</sup> to cut any asperities of any depth in the CMP pad.

125. These paragraphs simply describe certain “example[s]” and “aspect[s],” “various configurations or arrangements,” that “are contemplated for minimizing the mechanical stress impinging on the superabrasive particles held in the abrading tool.” Paragraph [0010] states that “[o]ne example may include superabrasive particle arrangement according to protrusion height.” Paragraph [0052] elaborates that “[o]ne potentially useful parameter may include the height that the superabrasive particles protrude above the organic material layer.”

126. As I just discussed, the cited paragraphs of Sung '026 are completely silent on the height tip profile(s) of the CMP pad dresser(s) that “may produce” the three asperity cutting depths that it describes beyond their being “predetermined.” Sung '026 likewise teaches nothing about any general relationship between tip

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<sup>7</sup> This assumes for the sake of argument that Sung '026 does disclose the use of a pad dresser satisfying Claim Limitation [1B] and Claim Limitation [1C] elsewhere, but as I discussed above, Sung '026 does not disclose such a dresser.

height profile and the resulting cutting depth that it “may produce” when used to abrade a particular work piece.

127. Because the structural “aspects” that produce these disclosed cutting depths are not described in any way in paragraphs [0010] and [0052] of Sung ’026, it is my opinion that these portions of Sung ’026 do not disclose these cutting depths resulting from the use of a CMP pad dresser having the structure recited by Claim Limitation [1B] and Claim Limitation [1C].

128. Rather, as one of ordinary skill in the art would have understood, those structural features are described elsewhere in Sung ’026 as different “aspects” of the invention of Sung ’026 distinct from the “aspects” concerning the recited cutting depth produced described in paragraphs [0010] and [0052].

129. It is my understanding that Petitioners rely on paragraphs [0053], [0073] and [0076], along with portions of Dr. Shanfield’s declaration, to establish that Sung ’026 discloses Claim Limitation [1C].

130. As discussed above in Section V.B.1 of this Declaration, those cited portions of Sung ’026 each discuss particular “aspects” of Sung ’026, which from the perspective of a person of ordinary skill in the art, disclose those features in distinct embodiments.

131. Moreover, those “aspects” regarding the structural arrangement of the superabrasive tips, are both individual and collectively, from the perspective of a

person of ordinary skill in the art, distinct from the “aspects” in which an unspecified “predetermined height” produces one of three different cutting depth ranges when used to abrade a work piece.

132. In other words, even assuming that Sung '026 disclosed a single embodiment that satisfied all of the structural requirements of Claim Limitation [1C]—which in my opinion, it did not, as I discuss above—Sung '026 never identifies *that* embodiment having no more than 2-micron variation as being “the predetermined height [that] may produce” any of the various cutting depth aspects described in paragraphs [0010] and [0052].

133. Recognizing in paragraph [0053] that “numerous configurations for designated profiles are possible,” Sung '026 is silent about the depth to which superabrasive particles configured along a planar profile (or any other predetermined height profile) will cut asperities when used to abrade a work piece. This is true no matter how much or how little height deviation there is between the superabrasive particles in this aspect.

134. Discussing in paragraph [0056] a number of distinct aspects each having superabrasive tips permitted to vary by differing amounts from the designated profile, Sung '026 is silent about the depth to which a CMP pad dresser configured accordingly will cut asperities when used to abrade a work piece. This

is true no matter how much or how little variance is permitted in the tip heights of each of these aspects.

135. Identifying in paragraph [0073] a number of distinct aspects in which the superabrasive tips protrude to various predetermined heights above the organic material layer, Sung '026 is silent about the depth to which a CMP pad dresser with tips configured accordingly will cut asperities when used to abrade a work piece. This is true no matter how large or how small the predetermined height.

136. In fact, Sung '026 says nothing about depths to which CMP pad dressers having any or all of those tip height configurations will cut asperities when used to abrade a work piece.

137. At most, Sung '026 identifies an exemplary limit on the asperity cutting depth that could be achieved **by prior art pad dressers** having substantial variation in the height of the abrasive particles arranged in a “traditional metal matrix.” (Ex. 1004 at [0006].) Specifically, in paragraph [0006], Sung '026 posits that because “[t]raditional CMP pad dressers can have particle tip height variations of more than 50  $\mu\text{m}$  without compromising dressing performance. . . . such a variation would render a dresser useless if it were required to dress a CMP pad and achieve a uniform asperity depth of 20  $\mu\text{m}$  or less.”

138. But as one of ordinary skill in the art would appreciate, that language addressing limits on the cutting depth uniformity based on the use of prior art pad

dressers involving traditional metal matrices does not describe the cutting performance of the various aspects *of the invention*, which as Claim Limitation [1B] recites, requires that the superabrasive particles protrude instead from an organic material layer.

139. Likewise, one of ordinary skill in the art would appreciate that language addressing the expected cutting depth uniformity from using of prior art pad dressers having a particular range of tip height variation does not describe the cutting performance of the various aspects of the invention cited and relied upon by Petitioners in paragraphs [0053], [0056], and [0073], either separately or in combination.

140. In other words, Sung '026 does not describe any CMP pad dresser that satisfies the tip height variation requirements of Claim Limitation [1C] (or any other particular configuration) as cutting asperities to a depth of no more than 60 microns, no more than about 10 microns to about 20 microns, or to any other depth.

141. Thus, it is my opinion, based on my review of the disclosure of Sung '026 from the perspective of a person of ordinary skill in the art, that Claim Limitation [1D] is absent from the disclosure of Sung '026 because it does not describe *any cutting depth resulting from the use of a CMP pad dresser that*

*satisfies Claim Limitations [1B] and [1C]*, let alone the cutting depth of less than about 60 microns.

**2. Circa 2011, a POSITA would not have been able to Determine the Predetermined Tip Height(s) that would reliably produce an asperity cutting depth of less than 60 microns without substantial experimentation**

142. Third, based on my experience in the field of CMP pad dressers, a person of ordinary skill in the art would not have been able to ascertain circa 2011—without extensive study and empirical testing of a particular well-characterized CMP pad dresser, a particular workpiece, and a narrow range of usage conditions—the “predetermined” height profile or range of height profiles that would produce cutting depths of the ranges described in the cited paragraphs [0010] and [0052] of Sung ’026. I explained this in my first Declaration, and I will elaborate further below.

143. Rather, at that time, extensive empirical testing of particular CMP pad dressers was required to even begin to understand how they would perform under even a narrow set of usage conditions.

144. As I stated in my previous Declaration, in April 2009, I published a paper titled “Dressing Characteristics of Oriented Single Diamond on CMP Polyurethane Pad” in a publication called *Machining Science and Technology*. (This was attached to the Preliminary Response as Exhibit 2002.) As far as I know, this was the first time that anyone had characterized how even one superabrasive

particle would perform in practice when used to condition a CMP pad dresser.

Recognizing the unpredictable performance of CMP pad dressers, I sought to study how a single superabrasive particle on such a dresser actually functioned in order to gain greater insight into the operation of such particles in bulk. Among other conclusions, I realized that orienting the diamond such that the point (rather than a line or a face) was used for cutting removed less of the CMP pad and produced a pad that polished at a higher and more consistent rate during the CMP process.

145. In 2012, I was the lead author (with Dr. Sung as one of my co-authors) of article titled Organic Diamond Disk Versus Brazed Diamond Disk for Dressing a Chemical-Mechanical Polishing Pad. Diamond & Related Materials 23 (2012) 144–149. This article describes my work using a stylus-type 2D surface to measure the variation in tip-height for two different types of pad dressers, one of which was a novel type of pad dresser that we created and studied (“ODD”). We tried to level the tips of our ODD as much as possible, but we were only able to achieve leveling of the superabrasive tips to within 15um variation via reverse casting methods.

146. Based on the difficulty on controlling tip height variation, the cutting performance of CMP pad dressers remained unpredictable in actual use circa 2011 even to those at the cutting edge of the field, like me.

147. In particular, even one of extraordinary skill in the art circa 2011 would not have been able to readily predict or otherwise determine, without substantial experimentation involving the intended usage conditions, the expected cutting depth produced by a CMP pad dresser in actual use based on a particular amount of variation between the tip heights of its superabrasive particles as it was manufactured. Nor would one of even extraordinary skill in the art circa 2011 have been able to readily predict or otherwise determine a maximum cutting depth from the use of such a CMP pad dresser with any particular level of variation in superabrasive particle tip height. This was demonstrated, among other places, by my 2009 article (Ex. 2002), which considered the effect of only a single working superabrasive particle.

148. Based on the challenges to even one of extraordinary skill in the art circa 2011, it is my opinion that one of merely ordinary skill in the art would not have been able to readily predict or otherwise determine, without substantial experimentation, the expected asperity cutting depth produced by a CMP pad dresser in actual use based on the dresser's superabrasive particles being arranged according to a particular designated profile. It is likewise my opinion that one of ordinary skill in the art would not have been able to readily predict or otherwise determine, without substantial experimentation, a maximum asperity cutting depth

from the use of a CMP pad dresser with its superabrasive particles arranged to any particular designated profile.

149. Rather, making such determinations about the actual cutting depth that would result from any pattern of variation in the tip height of the superabrasive particles would require substantial characterization of the usage conditions of the CMP pad dresser, including the characteristics of the CMP pad itself.

150. It would have required substantial and extensive experimentation, which would have involved involve detailed surface measurements of CMP pad dressers post-manufacture and post-use, along with examination of various types of CMP pads on which they were used, for one of even extraordinary skill in the art to begin to understand a general relationship between a particular variation in particle tip height and a particular cutting depth produced on a particular CMP pad.

151. Similarly, as a result of the unpredictability of CMP pad dressers in actual use, one of skill in the art would not have been able to determine, without substantial and extensive experimentation, the number or location of the superabrasive tips that would actually cut asperities into the CMP pad dresser during use. As with the cutting depth, this determination would also have required characterization of the actual usage conditions, including operating parameters and consideration of the characteristics of the CMP being conditioned.

152. This difficulty in determining which superabrasive particles actually performed cutting only increases as the variation in tip height became more tightly controlled. That is because extreme outlying superabrasive particles would be most likely to actually cut asperities, and so such particles are more likely to perform the cutting, and so reducing the variance in outlying parties correspondingly reduces the ability to predict which particles will cut.

153. As we now understand, it is the outlying superabrasive particles that provide the greatest contribution to the behavior of the CMP pad dresser in operation. Characterization of these outliers is what thus provides the most insight into the expected and actual behavior of a CMP pad dresser in operation.

154. Moreover, as I explained in my Dressing Characteristics of Oriented Single Diamond on CMP Polyurethane Pad article in 2009, the extent to which cutting occurs also depends on the orientation of the superabrasive particles, with point orientation being most likely to cut, and a face-orientation unlikely to cut and instead producing wear dominated by plowing action. So height variation among particles and particle location cannot alone identify those that are cutting the pad.

155. As a result, based on my experience and research in CMP pad dresser design, the disclosure of Sung '026 would not have enabled a person of ordinary skill in the art to bound to under 60 microns the asperities cut by a CMP pad dresser having a planar tip profile with its two highest protruding tips within 10

microns of each other and its ten highest-protruding tips all within 20 microns of each other.

156. Such a resultant bounded cutting depth simply could not be ensured based solely on the variance in the tip heights of the two highest-protruding and ten highest-protruding tips, even in a planar profile.

157. Rather, based on my extensive experience with characterizing CMP pad dressers, including as of the priority date of the '862 patent, it is my opinion that one of ordinary skill in the art would not have been able, without extensive empirical testing of the intended usage parameters, to bound the asperity depth cut by actually using such a CMP pad dresser based solely on the tip height variation between its two-highest and ten-highest protruding superabrasive particles without extensive empirical testing on all of the usage parameters of that CMP pad dresser. Such parameters include (but are not limited to) its material composition, the amount of force applied to the pad dresser, the angle of the force, the angular velocity of the pad dresser, the size of the pad dresser, the structural and material characteristics of the work piece.

I hereby declare that all statements made herein of my own knowledge are true and that all statements are made on information and are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. § 1001.

Dated: December 11, 2024

*mingyi tsai*

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Ming-Yi Tsai

# EXHIBIT A

# MING-YI TSAI

## University Chair Professor

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### EDUCATION

#### National Taiwan University of Science and Technology

Aug, 1992- Jul, 1993

B.A. in Department of Mechanical Engineering

#### National Chung-Hsing University

Aug, 1997- Jul, 1999

M.A. in Department of Mechanical Engineering

#### National Taiwan University

Aug, 2002- Jul, 2007

PhD. in Department of Mechanical Engineering

### AWARDS & CERTIFICATIONS

- 2014-2023 NSTC/MOST Special Outstanding Talent Award
- 2016 CSME Annual meeting Paper Award
- 2016-2017 TAMI Industrial Collaboration Contribution Award
- 2017 ICSS Best Paper Award
- 2017 the 3rd ICI Best Paper Award

### PROFILE

I am currently the Dean of the College of Engineering at the National Chin-Yi University of Technology and a distinguished professor. My research interests include machining, semiconductor processing technology, abrasive processing, and chemical mechanical polishing. I have published about 100 papers in journals and conferences (both international and Taiwanese) and obtained about 5 patents. At the same time, I have also assisted more than 50 industry-university projects and served as the host of many integrated projects, including the National Science and Technology Council's next-generation smart manufacturing key technology research and development project and the Difficult to Cut Materials Processing Technology Alliance. These research contents not only cover the improvement indicators of advanced grinding and polishing technology but also consider specific practical applications and industrial economic benefits. Therefore, its research results are oriented towards industrial application potential and value. In the past five years, it has also been awarded to the special outstanding talents funded by the Ministry of Science and Technology for 6 consecutive years, the 2017 ICSS Best Paper Award, the 3rd ICI Best Paper Award in 2017, and the 2016 CSME Annual Meeting Best Paper Award. These results have given me research skills and conference management and preparation skills.

### WORK EXPERIENCE

UNIVERSITY CHAIR PROFESSOR

#### National Chin-Yi University of Technology

August 2007 - Present

- Teaching professional subjects: including planning course content, setting up progress, and testing methods.
- Guiding MA, and PhD students : guiding students to conduct research in related fields and increase relevant professional knowledge
- Administrative work: Assisting with university, college, or department-related work.
- Conduct planning and research: apply for and implement relevant academic research projects, such as industry-university cooperation and government projects.

### OTHER EXPERIENCE

- Director of Chemical Mechanical Planarization User Group Taiwan (Jan 2014 - Dec 2016)
- Director of Taiwan Society of Abrasive Technology (TSAT) (Jan 2013 - Dec 2021)
- Vice Director of Taiwan Society of Abrasive Technology (TSAT) (Jan 2021 - Dec 2022)
- Chairman of Taiwan Society of Abrasive Technology (TSAT) (Jan 2024 - Dec 2026)

## PUBLISH PAPER LIST

- Y. T. Lin, K. J. Chen, C. Y. Chen, Y. X. Lin and M. Y. Tsai\*, The Study of the Performance of the Diamond Wheel's Steel and CFRP Hubs in Tungsten Carbide (WC) Grinding, Applied Science (SCI), 13(22) , 2023/11. Corresponding author: M. Y. Tsai
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