

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

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

v.

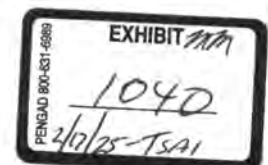
CHIEN-MIN SUNG,
Patent Owner

IPR2024-00535
U.S. Patent No. 9,724,802

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
P.O. Box 1450
Alexandria, VA 22313-1450
Submitted Electronically via PTAB E2E



IPR2024-00535
SUNG Exhibit 2011

I. INTRODUCTION

1. I am over the age of 18 years old and am competent to testify to the matters stated in this Declaration.

2. I am a Distinguished Professor in the Department of Mechanical Engineering, National Chin-Yi University of Technology, Taichung Dist., Taiping, Taiwan. A copy of my curriculum vitae is attached as Exhibit A.

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

4. 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.

II. RELEVANT LEGAL PRINCIPLES

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

A. Patent Claims

6. 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

7. 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.

8. 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

1. 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.

2. 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.

3. 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.

4. 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.

5. 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.

6. 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).

7. 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.

8. 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.

D. Priority Date

9. I understand that the earliest date of a patented invention is known as a priority date. I further understand that when a patent relies on an earlier application, it may claim the date of that application as its priority date. I further understand that a patent may claim priority from multiple previous applications. A group of patents and/or applications that share priority date is known as a family of patents.

10. Continuation applications may claim priority to an earlier application. I further understand that continuation-in-part applications may also claim priority to an earlier application.

11. In order for a continuation or continuation-in-part application to properly establish an earlier priority date, the earlier application or applications must disclose the subject matter which is claimed in the later application.

12. I understand that the subject matter claimed by a later application is sufficiently disclosed in an earlier application when one skilled in the art can reasonably conclude that the inventor had possession of the claimed invention.

III. LEVEL OF ORDINARY SKILL IN THE ART

13. I have 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.

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

A POSITA as of the earliest claimed filing date of the ’802 Patent (i.e., October 3, 2014) 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 ¶ 79.)

15. I have not assumed that a POSITA’s knowledge should be measured from the filing date of the ’802 patent for all claims. Instead, I have assumed the priority date for claims 1-7 and 13-21 of the ’802 patent is no later than Sept. 9, 2005 based on U.S. Patent Application No. 11/223,786 (“Sung ’786”) or Nov. 16, 2005 based on U.S. Patent Application No. 11/560,817 (“Sung ’817”). I have

assumed that the priority date for claims 8-12 is October 3, 2014, the filing date of the application that led to the '802 patent.

16. In addition, I note that Dr. Shanfield's definition of a POSITA lacks any specific reference to CMP technology, which is a specialized branch of semiconductor manufacturing. Some understanding of the context in which the microscopic structures on a CMP pad conditioner are manufactured and the factors that affect diamond tip height and distribution and pad conditioning is necessary to evaluate the teachings of the '802 patent and the references asserted by Samsung. Accordingly, I believe a POSITA for purposes of the '802 patent would have at least two years of experience in developing CMP technology including experience with the design and development of CMP pad dressers.

17. I have a keen understanding of this level of skill in the art as it existed at the time the '802 Patent was filed. I was directly involved in the design and development of chemical-mechanical planarization (CMP) technology and CMP pad conditioners, including publishing numerous research papers and scientific articles on the design and development of pad conditioners, as reflected in my curriculum vitae, and am qualified to provide an informed opinion on what the level of ordinary skill in the art was in the relevant time frame.

IV. THE TSAI REFERENCE

18. I am the lead author of an article titled Organic diamond disk versus brazed diamond disk for dressing a chemical–mechanical polishing pad, Diamond & Related Materials 23 (2012) 144–149 (Ex. 1004 or “Tsai”).

19. I understand that my article has been cited by Petitioners Samsung Electronics Co. Ltd., Samsung Electronics America, Inc., Samsung Semiconductor, Inc., and Samsung Austin Semiconductor, LLC (“Samsung”) in their Petition in this case in relation to U.S. Patent 9,724,802 (the “’802 patent”), which was issued to Mr. Chien-Min Sung.

A. Leveled Diamond Grits in Tsai

20. I understand that Samsung argues that the levelling of diamond grits described in the Tsai “designates a flat contour above the epoxy resin to which each of the tips of the diamond particles is intended to align.” (Pet. at 36.) I also understand that based on Samsung’s arguments, the Board has found that “Tsai intends for its diamond grit tips to be ‘leveled to the same height,’ that is, as contemplated by the ’802 patent, to form a flat or planar profile.” (Institution Decision at 58.)

21. I believe that Samsung misunderstands Tsai and specifically, what is meant by the terms “leveling” and “leveled” in my article.

22. First, Tsai does not describe or show diamond grits “leveled to the same height.” (Institution Decision at 41.) On the contrary, Tsai says that “[a]lthough conventional diamond conditioners consist of regularly distributed diamond grits, the grit tips are *not* leveled to the same height.”¹ (Ex. 1004 at Abstract.)

23. Rather, the leveling described in Tsai refers to reducing overall tip variation between the tip heights of diamond grits across the face of a CMP disk. That is why the article states that in the case of the ODD, “the diamond tips can be *leveled* by compressing the disk with a flat plate *to reduce the variation in the heights of the diamond tips.*” (*Id.* at 6:8-10.) This passage shows that the object of levelling is to reduce the variation but not to eliminate it entirely such that all of the diamond tips have the same height. Similarly, the abstract refers to “[d]iamond levelling” as “height distribution of diamond grits” (*id.* at Abstract), which presumes that there are multiple heights of diamond grits across the face of the disk.

24. Tsai also describes why a reduction in variation between the tip heights of a diamond grits represents an improvement in CMP pad conditioning. While “[a] typical diamond disk contains over 10,000 grits; however, less than 10% of the diamond grits are engaged in cutting the polishing pad.” (*Id.* at 2:14-

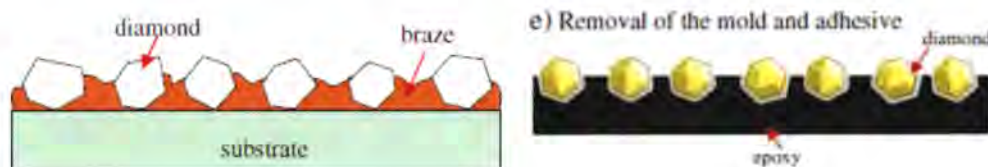
¹ Unless otherwise noted, all emphasis in this Declaration has been added.

16.) By contrast, “it can be inferred that the ODD can stabilize the wafer removal rate while consuming less pad material, thus resulting in a long pad lifespan.” (*Id.* at 10:1-3.)

25. Tsai does not assume, nor do I believe now, that reverse casting was intended to create disks with a single height for all diamond grits. Nor do I believe that reducing the variation in tip heights requires a designated profile or contour along which the tip heights of the diamond grits in an ODD are intended to align. That is because, as stated above, levelling refers to reducing the overall variation in tip heights.

26. Figure 2 of Tsai does not represent the actual distribution of tip heights across the face of an ODD. The purpose of Figure 2 is to illustrate the steps in the process of reverse casting. It was not intended to illustrate the alignment of diamond tips along a contour or the actual variation in diamond tip height across the disk. Moreover, Figure 2 is not drawn to scale.

27. That this is the case is shown by comparison with Fig. 1, which shows the conventional brazed diamond disk (“BDD”). For reference, I have placed the comparable sections of Figures 1 and 2 alongside one another below.



(Ex. 1004 at Fig. 1 and Fig. 2.)

28. It cannot be the case that **both** the BDD in Figure 1 and the ODD in Figure 2 have grits with the **same** heights across each respective disk. Yet Samsung's argument that Fig. 2 reflects the actual height variation of the diamond tips on the ODD only makes sense if Fig. 1 also represents the actual height variation of the diamond grits across the BDD. That would not be possible, because, as the article explains, "[t]he height variation in the diamond tips of the ODD is significantly smaller than that in the diamond tips of the BDD." (Ex. 1004 at 8:19-22.)

29. The actual variation in tip heights between a BDD and an ODD is shown in Figures 5 and 6 of Tsai. The text accompanying those images explains that "[t]he height variation in the diamond tips of the ODD is significantly smaller than that in the diamond tips of the BDD." (*Id.* at 8:19-22.) Specifically, "[i]n the case of the BDD, the diamond tips are leveled to more than 50 μm . However, as shown in Fig. 6, in the case of the ODD, the diamond tips of the ODD can be leveled to less than 15 μm because the diamond tips are already leveled." (*Id.* at 8:22-24.)

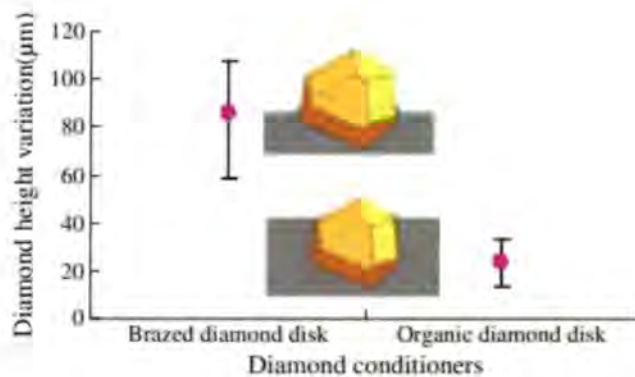


Fig. 6. Height variation in tips for diamond conditioners.

(Ex. 1004 at Fig. 6.)

30. Samsung describes the leveling of diamond grits disclosed in Tsai as equivalent to claim limitation 1[D] of the '802 patent, which recites a “a tip of each of the plurality of superabrasive particles aligns along a designated profile.” (Pet. at 36.)

31. However, Tsai makes no mention of a profile or contour of any kind, nor does it teach that its particles must align in any specific way. That is because, as I have described above, Tsai is concerned with reducing the overall variation in diamond tip height, not with causing the diamond tips to arrange along a specific profile or contour.

32. Dr. Shanfield takes the average of the tip heights of the ODD, which is purportedly represented in Fig. 6 by a purple square lying between the maximum and minimum values of diamond tip heights, to be a “designated profile.” (Ex. 1002 ¶ 133.) But the average tip height indicated in Fig. 6 does *not* represent a

target against which the levelled tips of the ODD were intended to align. That average was calculated *after* the reverse casting process was complete, based on measurements taken of the tip heights of the finished ODD. It was incidental to the reduction of overall tip heights. The average was not predetermined in advance as a level or contour at which the diamond tips would align.

33. In addition, I do not believe that diamond tips with a height variation of 15 μm across an ODD would align along a flat contour as Samsung contends. Even though the variation in tip protrusion heights of an ODD is lower than for a BDD, a variation of 15 μm still would not permit the tips to align along a flat profile, which requires that all the tips have the same height.

34. The inventor in the '802 patent disclosed his invention of the "designated profile" separately from the methods described in Tsai. The '802 patent refers to the reverse casting method in a different section of the specification from the one on the designated profile. The specification refers to reverse casting as used to "orient and attach" diamond particles:

Additionally, so-called "reverse casting" methods can be used to accurately orient and attach the dressing segments to the support substrate. Such methods can include initially securing the plurality of dressing segments to a substrate using a "mask" material. The portions of the dressing segments protruding from the mask material can then be attached to the rigid support using the methods discussed herein, after which (or during which), the masking material can be removed.

(Ex. 1001 at 25:14-22.)

35. In my opinion, the '802 patent's teaching of reverse casting to "accurately orient and attach the dressing segments" is further evidence that the reverse casting method does not involve the designation or predetermination of a profile as Samsung would have it. If reverse casting required designating a profile, Tsai would have drawn that connection and I would have considered it, but Tsai does not. Nor is the concept of a designated profile subject matter I thought about when conducting the BDD and ODD analyses underlying the Tsai article.

36. I understand that Samsung argues that Tsai anticipates or renders obvious claims 1-5, 13, 15, 19-21 of the '802 patent. (Pet. at 5-6.) However, as I have explained in the paragraphs above, Tsai does not teach or suggest a "designated profile," which is one of the limitations of claim 1. Accordingly, Tsai does not anticipate or render obvious claim 1. In addition, because each of dependent claims 2-5, 13, 15, and 19-21 depends from claim 1, Tsai does not anticipate or render obvious any of claims 2-5, 13, 15, or 19-21.

B. Spacing of Diamonds in Tsai

37. I understand that Samsung has made certain arguments in the Petition based on Fig. 3 of Tsai. The top two images in Fig. 3 of Tsai, reproduced below, show a segment of the ODD together with an image of the entire ODD and the place where the segment fits into the disk.

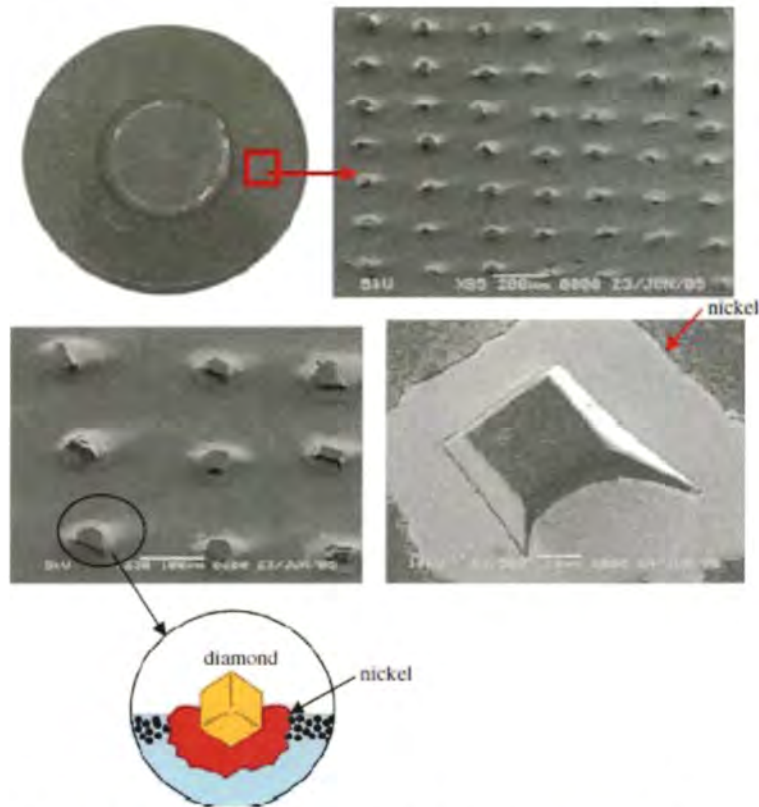


Fig. 3. Outer appearance of the organic diamond disk. Note that each diamond is covered with nickel.

38. The image in the upper right-hand corner of Fig. 3 only represents a segment of the ODD. I understand that Samsung argues in its Petition that it is able to calculate the total number of diamond grits on the ODD based on the assumption that the spacing between diamonds shown in this segment reflects the spacing between diamonds across the entire surface of the ODD. (Pet. at 46-52.) Samsung makes similar arguments based on other figures in Tsai.

39. But Tsai is a study on the impact of leveling tips on the cut rate of pads and wafer quality. And the reverse casting method discussed in the article was

not concerned with spacing between diamond tips. Rather, as stated above, Tsai is concerned with leveling diamond tip heights, or reducing the overall variation in tip heights. The reverse casting method was not intended to produce a specific distribution, spacing or pattern of diamonds.

40. As to spacing, I did not verify whether the spacing between all of the tips on the ODD disclosed in Tsai was exactly the same across the entire disk. This is because spacing was never the focus of my article. In my opinion, it is not appropriate to assume that the spacing on any one segment of the ODD reflects the spacing across the entire ODD, particularly because the diamonds are distributed randomly (which lead to randomized spacing between the diamond particles) across the ODD. In my experience, it is typical, if not common, for the spacing or distribution of diamonds across a disk to differ significantly.

41. Tsai's reference to "regular distribution" (Ex. 1004 at 5:24) does not mean perfect distribution across the disk such that all spacing is identical. The distribution of the diamonds on the ODD is not perfectly regular. I believe that Samsung and Dr. Shanfield assume a degree of precision in distribution which was never contemplated by me or my co-authors. Just as "levelling" does not mean "flat," "regular" does not mean "absolutely uniform distribution."

42. Just as it would not be possible to extrapolate the tip spacing of the entire ODD from the single segment disclosed in Fig. 3 of Tsai, it would also not

be possible to extrapolate the total number of diamonds on the ODD from that segment, or any other partial segment of the disk. The reason is the same: even with “regular” tip spacing, the number of particles will vary from one section of the ODD to another. The total number of particles can only be determined by counting all of the grits on a disk.

C. “Working Superabrasive Particles”

43. Samsung argues that Tsai discloses certain numbers of “working superabrasive particles” (Pet. at 60-66.) For example, Samsung argues that “Tsai’s monolayer of diamond grits in the ODD “includes a plurality of working superabrasive particles.” (Pet. at 60.) Dr. Shanfield goes so far as to say that “Tsai discloses that *all the diamond particles on the CMP pad dressers are cutters* and share an equal dressing load when conditioning CMP pads.” (Ex. 1002 at ¶ 189.)

44. As an initial matter, I note that there is no explicit disclosure of any specific numbers of “cutters” on an ODD anywhere in Tsai, or of a plurality of cutters. For that reason alone, Tsai does not teach or suggest the “plurality of working superabrasive particles” of claim 6, the “at least 100 working superabrasive particles” of claim 8, the “at least 1000 working superabrasive particles” of claim 9, the “about 1000 to about 6000 working superabrasive particles” of claim 10, the “about 2000 to about 5000 working superabrasive particles” of claim 11, or the “at least about 1000 working superabrasive particles”

of claim 12. Nor is the number of working diamonds even contemplated in the research underlying Tsai since my study was to analyze how tip variation between diamond tips, as opposed to the number of diamonds, would impact cut rate on a CMP pad and quality of the wafer polished by that pad and reduce manufacturing costs of the conditioners as I have discussed above.

45. To be clear, I did not predict or otherwise determine the number or location of the diamonds or diamond tips that would actually cut asperities into the CMP pad dresser during use because they were not the focus of my research. Had they been relevant to my search, I would have analyzed how they would impact the cut rate, wafer quality, and cost reduction in the same way that I did with respect to tip variation.

46. Also, making such determinations would require substantial characterization of the usage conditions of the CMP pad dresser, including operating parameters and the characteristics of the CMP pad itself. It would require substantial and extensive research and experimentation, which would 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.

47. 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.

48. 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 provides great insight into the expected and actual behavior of a CMP pad dresser in operation.

49. Moreover, as I explained in my Dressing Characteristics of Oriented Single Diamond on CMP Polyurethane Pad published in *Machining Science and Technology* in 2009 (Ex. 2010), the extent to which cutting occurs also depends on other facts, such as the orientation and size 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 absent extensive experimentation, such as that performed by the inventor in the '802 patent, and the use of a designated profile, such as that described in the '802 patent, a POSITA cannot use height variation among particles and particle location alone to identify those tips that are cutting the pad.

50. Samsung also argues that Sung '026, filed in 2005, discloses the “at least 100 working superabrasive particles” of claim 8 and the “at least 1000

working superabrasive particles” of claim 9 of the ’802 patent. Samsung argues, relying on Dr. Shanfield, that “because each of the superabrasive particles experiences frictional forces against the CMP pad, *all of Sung ’026 superabrasive particles are contributing to cutting asperities.*” (Pet. at 65 (citing Ex. 1002 at ¶ 191).)

51. I note that there is no explicit disclosure of “working superabrasive particles” in Sung ’026. Moreover, it does not follow automatically that because a superabrasive particle experiences frictional forces, that particle is cutting a pad. I believe that a POSITA as of the priority date of claims 8-12 of the ’802 patent, which for purposes of this declaration I assume was October 3, 2012, would have understood that particles that experience frictional forces do not all cut a CMP pad.

52. Dr. Shanfield’s view that diamond particles that experience frictional forces are by definition working particles that cut a CMP pad reflects an understanding of how a pad conditioner works that had been superseded by 2012. Prior to 2012, it was widely assumed that mechanical stresses would be substantially equally distributed among the bulk of superabrasive particles during use of CMP pad dressers.

53. As mentioned above, that view has now given way to empirical data showing that it is the outlying superabrasive particles that provide the greatest

contribution to the behavior of the CMP pad dresser in operation. And likewise, the orientation of superabrasive particles also impacts which particles cut the pad.

54. For these reasons, I do not believe that Sung '026's disclosure of "substantially even distribution of frictional forces across all the superabrasive particles in the tool" (Ex. 1005 at [0075]) teaches or suggests any specific number of working superabrasive particles, including those recited in claims 8, 9 and 12 of the '802 patent. This is also because even distribution of frictional forces across the conditioner could also be achieved by diamond particles that are randomly distributed on a conditioner as such frictional forces can be tightly controlled by tip leveling.

55. Similarly, I do not believe that "a POSITA would have found it obvious to try different pad conditioners that meet the claimed number of particles [in claims 10 and 11] based on the range of fabrication values disclosed in Tsai and Sung '026." (Pet. at 66.) This argument is flawed due to its assumption that it is possible to accurately calculate the number of particles on Tsai's ODD, as discussed in Section IV.B above. I did not calculate what this number was at the time of publication, nor was there a need to perform such a calculation. Without any means of calculating the number of particles on Tsai's ODD, there would have been no way for a POSITA to experiment with the diamond spacings disclosed by Sung '026. This is particularly true since there are tens of thousands of diamonds

on the ODD. To determine the spacing between each such diamond would be extremely labor intensive, and no imaging technology at the relevant time would have allowed such determination to be performed accurately because doing so would require perfect image alignment among thousands of images, which must first be taken. And even then, a POSITA at that time would not be able to determine which of those particles were “working superabrasive particles.”

V. WHETHER CLAIM LIMITATIONS 1[E] AND 1[F] OF THE '802 PATENT ARE DISCLOSED BY DR. SUNG'S PATENT APPLICATIONS IN THE SAME FAMILY

56. I understand the issues in this proceeding include whether two of Dr. Sung's patent applications U.S. Patent Application 11/560,817 (“Sung '817”) and U.S. Patent Application 11/223,786 (“Sung '786”) and would have sufficiently informed a POSITA of the subject matter of limitations [1E] and [1F] of claim 1 of the '802 patent. (Institution Decision at 36-47.) Based on the legal principles in Section II of this declaration, I understand that the priority date of certain claims of the '802 patent depends on whether a POSITA would reasonably understand that the subject matter of those claims were disclosed in Dr. Sung's earlier applications.

A. Sung '817

57. In my opinion, a POSITA would conclude that the applicant had possession of the subject matter of claim limitations [1E] and [1F] of the '802 patent based on the disclosures of Sung '817.

1. **Claim Limitation [1E]: “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 50 microns”**

58. Sung '817 includes the following disclosures:

As such, in one aspect a majority of the plurality of cutting elements is arranged such that the tips vary from the designated profile by from about 1 micron to about 150 microns . . . [or] from about 5 microns to about 100 microns.

(Sung '817 at 14:14–16.)

In yet another aspect, the plurality of cutting elements are arranged such that their tips vary from the designated profile by from about 10 microns to about 75 microns . . . from about 10 microns to about 50 microns . . . from about 50 microns to about 150 microns . . . from about 20 microns to about 100 microns . . . from about 20 microns to about 50 microns . . . from about 20 microns to about 40 microns . . . by less than about 20 microns . . . by less than about 10 microns . . . by less than about 5 microns . . . [or] by less than about 1 micron . . . [or] less than about 10% of the average size of the superabrasive particles.

(*Id.* at 14:16-15:4.)

59. While these disclosures relate to variation from a designated profile, rather than variation between protrusion heights, a POSITA would know that the claimed difference in protrusion distance of “less than or equal to about 50 microns” between the highest and second highest tips are supported by the foregoing portions of the Sung '817.

60. This is because any two tips that vary from a reference point (whether it is the designated profile or another vantage point) would necessarily yield a

height difference between those two tips.

61. For example, any two tips that vary “from about 20 microns to about 50 microns” from a designated profile (e.g., a “planar designated profile” as alluded to by Dr. Shanfield; *see* Ex. 2008 at ¶ 115) would mean that their height difference would at least be between about 0 microns (e.g., where they both have the same height of about 20 microns) and about 50 microns (e.g., where one tip perfectly aligns with the designated profile and the other is above/below the designated profile by about 50 microns, which is prescribed in this range of “about 20 microns to about 50 microns”).

62. As another example, any two tips that vary “by less than about 20 microns” from a designated profile would mean that their height difference would at least be between about 0 micron (e.g., where they both have the same height of about 20 microns) and about 40 microns (e.g., where one tip is below/above the designated profile by about 20 microns and the other tip is above/below the designated profile by about 20 microns). Hence, a POSITA would know that protrusion distances of from about 1 micron to about 150 microns, about 5 microns to about 100 microns, less than about 20 microns, less than about 10 microns, or from about 20 microns to about 50 microns all provide sufficient written support for claim limitation 1[E] of “less than or equal to about 50 microns” as of the filing date of Sung ’817. (Ex. 2001 at 13:5-8 (“It may also be beneficial for the cutting

elements to protrude from the solidified organic material layer to a predetermined height or series of heights that is/are along a designated profile.”.)

63. As to the disclosure of the height relationship between the highest and the second highest tips, Sung '817 is also clear that “the term ‘tip’ is intended to *include the highest protruding point* of a superabrasive particle” (Sung '817 at 14:10-13.) In other words, those disclosed ranges (and their differences) cited above are measured with respect to the highest protruding tip (i.e., at least one of the two tips as discussed in the above examples necessarily is the highest protruding tip). Because the disclosed ranges are in reference to the highest protruding tip, a POSITA would know that such ranges would necessarily encompass and apply to all tips on the conditioner, including the second highest tip.

64. Also, in the portions cited above, I note that Sung '817 describes that the cutting elements “are arranged such that their tips vary from a designated profile,” affirming that the disclosed ranges are in relation to all tips, which necessarily include the second highest tip. Based on this disclosure, a POSITA would readily conclude that a disclosed difference in protrusion distance of about 0 to 50 microns (as illustrated in the above examples) between all tips would provide sufficient written support for a difference in protrusion distance between the two highest tips of “less than or equal to about 50 microns” because a POSITA would

know that the ranges of tip variation as taught in Sung '817 would encompass all of the asperities, including those with the highest and second highest tips. In sum, I have reviewed all the relevant ranges disclosed in Sung '817, and based on my review, they cover all the ranges disclosed in claim limitation 1[E].

2. Claim Limitation [1F]: “and the difference in protrusion distance between the highest 1% of the protruding tips of the monolayer of superabrasive particles are within about 80 microns or less

65. Sung '817 includes the following disclosure:

In another aspect, the plurality of cutting elements are arranged such that their tips vary from the designated profile by from about 5 microns to about 100 microns . . . from about 10 microns to about 75 microns . . . [or] from about 10 microns to about 50 microns. . . .

(*Id.* at 14:16-21.)

66. A POSITA would know that the foregoing disclosure provides sufficient written support for the subject matter of claim limitation [1F] because the above disclosure references “the plurality of cutting elements,” which covers all of the tips, including the highest 1%. In addition, for the same reasons discussed above with respect to claim limitation 1[E], information about two tips vary from the designated profile would provide information on a height difference between those two tips. For example, any two tips that “vary from the designated profile by from about 5 microns . . . to about 75 microns” would mean that their height difference would at least be between about 0 micron (e.g., where they both have the same height of about 5 microns) and about 80 microns (e.g., where one tip

is below/above the designated profile by about 5 microns and the other is above//below the designated profile by about 75 microns).

67. A POSITA would also know that these ranges as taught in Sung '817 would necessarily encompass all tips, including the highest 1%, which Dr. Shanfield agrees and adopts in his declaration. Ex. 1002 at ¶ 142 (“With respect to limitation [1F], since Tsai’s tip-to-tip variation for all superabrasive particles on the CMP pad dresser is about 19.8 microns in the example shown in Figure 6, and can be less than about 15 microns, the difference in protrusion distance between the highest 1% of protruding tips must also be about 19.8 microns (or less than 15 microns), which is within the claimed range in [1F] of about 80 microns or less”). In sum, I have reviewed all the relevant ranges disclosed in Sung '817, and based on my review, they cover all the ranges disclosed in claim limitation 1[F].

B. Sung '786

68. In my opinion, a POSITA would reasonably conclude that the applicant had possession of the subject matter recited in claim limitations [1E] and [1F] of the '802 patent based on the disclosures of Sung '786.

1. **Claim Limitation [1E]: “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 50 microns”**

69. In my opinion, a POSITA would conclude based on the disclosures of Sung '786 that Dr. Sung had possession of the subject matter of '802 claim limitation 1[E] as of the filing date of Sung '786.

70. First, similar to Sung '817, Sung '786 discloses:

As such, in one aspect a majority of the plurality of superabrasive particles are arranged such that their tips vary from the designated profile by from about 1 micron to about 150 microns. In another aspect, the plurality of superabrasive particles are arranged such that their tips vary from the designated profile by from about 5 microns to about 100 microns . . .
 from about 10 microns to about 75 microns . . . from about 10 microns to about 50 microns . . . from about 50 microns to about 150 microns . . .
 from about 20 microns to about 100 microns . . . from about 20 microns to about 50 microns . . . from about 20 microns to about 40 microns . . .
 by less than about 20 microns . . . by less than about 10 microns . . . by less than about 5 microns . . . by less than about 1 micron . . . [or] less than about 10% of the average size of the superabrasive particles.

(Ex. 2009 at 22:16-13:14.)

71. Based on the foregoing disclosures, a POSITA would know that Sung '786 provides written support for the subject matter recited in claim limitation 1[E] for the same reason that Sung '817 provides written support for the subject matter recited in claim limitation 1[E]. This is because, as illustrated in the examples discussed with respect to Sung '817, the protrusion distance of two tips relative to the designated profile would necessarily yield information about the difference in their protrusion distances. Since Sung '786 discloses the same ranges as those in Sung '817, the examples discussed with respect to Sung '817 apply

equally to Sung '786.

72. In addition, Sung '786 provides written support for claim limitation 1[E] in the form of particle size. (Ex. 2009 at 13:34-14:4 (“[I]n one aspect the plurality of superabrasive particle may be from about 30 microns to about 500 microns in size . . . from about 100 microns to about 200 microns in size . . . [or] substantially the same size.”).) When combined with Sung '786's disclosure that the tips can also “vary from the designated profile to less than about 10% of the average size of the superabrasive particles” (*id.* at 13:12-14), a POSITA would understand that the tips could vary from about 0 micron (e.g., where the tips have the same size) to about 50 microns (e.g., 10% of 500 microns) with respect to the designated profile. A POSITA would understand that this range would necessarily cover the difference in protrusion distance between the two highest tips (e.g., where the highest tip is 50 microns above the designated profile and the second highest tip is of the same height as the designated profile (i.e., about 0 micron), which would yield “less than or equal to about 50 microns” in their difference in protrusion distance as recited in claim limitation 1[E]).

73. This conclusion is consistent with Sung '786's disclosure that “[t]raditional CMP pad dressers can have particle tip height variations of more than 50 μ m without compromising dressing performance. However, 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 μm or less, for example.” (Ex. 2009 at 2:21-24.) A POSITA would understand that Sung ’786 provides disclosure that CMP pad dresser with tip height variations of more than 50 microns would not achieve a uniform asperity depth of 20 μm or less.

74. For example, Sung ’786 teaches that “the predetermined height may produce a cutting depth of less than about 20 microns . . . [or] from about 1 micron to about 20 microns when used to abrade a work piece.” (Ex. 1009 at 11:6-10.)

75. Hence, a POSITA would understand that in order to achieve these cutting depths, the variation in particle heights across the pad dresser could not exceed 50 microns. Since the total variation in particle heights cannot not exceed 50 microns, it follows that the variation in particle heights between the highest and second highest tip also cannot exceed 50 microns. In sum, I have reviewed all the relevant ranges disclosed in Sung ’786, and based on my review, they cover all the ranges disclosed in claim limitation 1[E].

2. 1[F] “and the difference in protrusion distance between the highest 1% of the protruding tips of the monolayer of superabrasive particles are within about 80 microns or less”

76. First, similar to Sung ’817, Sung ’786 discloses:

In another aspect, the plurality of cutting elements are arranged such that their tips vary from the designated profile by from about 5 microns to about 100 microns . . . from about 10 microns to about 75 microns . . . [or] from about 10 microns to about 50 microns. . . .

(Sung '786 at 14:16-21; *see also id.* at 12:22-24 (disclosing a range of “from about 1 micron to about 150 microns”).)

77. Based on the foregoing disclosures, a POSITA would know that Sung '786 provides written support for the subject matter recited in claim limitation 1[F] for the same reason that Sung '817 provides written support for the subject matter recited in claim limitation 1[F]. This is because, as illustrated in the examples discussed with respect to Sung '817, the protrusion distance of two tips relative to the designated profile would necessarily yield information about the difference in their protrusion distances. Since Sung '786 discloses the same ranges as those in Sung '817, the examples discussed with respect to Sung '817 apply equally to Sung '786.

78. For example, any two tips that “vary from the designated profile by from about 5 microns . . . to about 75 microns” would mean that their height difference would at least be between about 0 micron (e.g., where they both have the same height of about 5 microns) and about 80 microns (e.g., where one tip is below the designated profile by about 5 microns and the other is above the designated profile by about 75 microns).

79. A POSITA would also know that these ranges as taught in Sung '786 would necessarily encompass *all* tips (e.g., as supported by Sung '786's language of “the *plurality* of superabrasive particles”), including the highest 1%, which Dr.

Shanfield agrees and adopts in his declaration. Ex. 1002 at ¶ 142 (“With respect to limitation [1F], since Tsai’s tip-to-tip variation for all superabrasive particles on the CMP pad dresser is about 19.8 microns in the example shown in Figure 6, and can be less than about 15 microns, the difference in protrusion distance between the highest 1% of protruding tips must also be about 19.8 microns (or less than 15 microns), which is within the claimed range in [1F] of about 80 microns or less”). In sum, I have reviewed all the relevant ranges disclosed in Sung ’786, and based on my review, they cover all the ranges disclosed in claim limitation 1[F].

80. In addition, Sung ’786 provides written support for claim limitation [1F] in the form of cutting depth. As discussed above, a POSITA would understand from the Sung ’786 disclosure that in order to achieve “a cutting depth of less than about 20 microns . . . [or] from about 1 micron to about 20 microns when used to abrade a work piece,” the variation in particle heights across the pad dresser could not exceed about 50 microns.

81. Because Sung ’786 discloses a maximum cutting depth of about 20 microns, coupled with a maximum tip height of about 50 microns, a POSITA would know that the highest 1% of protruding tips are within 80 microns or less (e.g., 20 microns + 50 microns = 70 microns). In sum, I have reviewed all the relevant ranges disclosed in Sung ’786, and based on my review, they cover all the ranges disclosed in claim limitation 1[F].

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

Ming-Yi Tsai

EXHIBIT A

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EDUCATION

**National Taiwan University of
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B.A. in Department of Mechanical
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National Chung-Hsing University

Aug, 1997- Jul, 1999

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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

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- 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)
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PUBLISH PAPER LIST

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