

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

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

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

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.

Background

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

3. I am a Distinguished Professor in the Department of Mechanical Engineering, National Chin-Yi University of Technology, Taiping Central District, Taiwan. My research areas include difficult cut materials, chemical mechanical polishing and abrasive machining.

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

5. 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”).

6. 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.

7. 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).

8. I understand that Samsung (supported by its expert, Dr. Shanfield) has made certain arguments in its Petition that rely upon a particular understanding how CMP pad dressers function, what manufacturing tolerances were achievable for CMP pad dressers, and what a POSITA would have understood about the state of the art and how CMP pad dressers at the time of the invention of the '862 patent.

9. In particular, Samsung relies on the declaration of its expert Dr. Shanfield to support its arguments.

My Understanding of Dr. Shanfield's Prior Testimony

10. This section of my declaration provides my understanding of the contents of Dr. Shanfield's prior testimony as provided by counsel. I do not have independent knowledge of Dr. Shanfield or his testimony.

11. I have been made aware that Dr. Shanfield has testified that he has never actually designed any CMP equipment, and moreover, has never designed a CMP pad dresser.

12. I have also been made aware that Dr. Shanfield has testified that he has not done any research and development on CMP pad dressers.

13. I have further been informed that Dr. Shanfield has testified that he has not done atomic measurements on any CMP pad dresser, or the diamond cutting tips of any CMP pad dresser.

14. Likewise, I am informed that Dr. Shanfield has testified that he has not put a CMP pad conditioner in a scanning electron microscope (SEM), nor has looked at a CMP pad conditioner using a SEM.

15. I have also been informed that Dr. Shanfield has testified that diamond particles on a CMP disc can be made “exactly the same height” to the atom.

Precision in Aligning Superabrasive Particles in CMP Pad Dressers

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

17. 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.

18. 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.

19. 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.

20. 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.

21. 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 that the distribution patterns of the superabrasive particles did not significantly influence the final dressing results.)

22. 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.

23. 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 is 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.

24. 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.

25. Based on the difficulty in reducing variation in tip height variation, CMP pad dressers remained unpredictable in actual use circa 2011.

26. In particular, even one of skill in the art would not have been able to readily predict or otherwise determine, the expected cutting depth produced by a CMP pad in use based on a particular amount of variation in the tip height of its superabrasive particles as it was manufactured. Nor would one of skill in the art

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.

27. Rather, making such determinations would require substantial characterization of the usage conditions of the CMP pad dresser, including the characteristics of the CMP pad itself. It would require substantial and extensive 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, for one of skill in the art to understand the relationship between a particular variation in particle tip height and a particular cutting depth produced on a particular CMP pad.

28. 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 require characterization of the actual usage conditions, including operating parameters and consideration of the characteristics of the CMP being conditioned.

29. 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.

30. 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.

31. 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.

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: June 28, 2024

mingyi tsai

Ming-Yi Tsai