

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

HANWHA SOLUTIONS CORPORATION,

Petitioner,

v.

MAXEON SOLAR PTE. LTD.,

Patent Owner.

Case No. IPR2024-01198

U.S. Patent No. 11,251,315

**DECLARATION OF GILBERT T. SMOLENSKI REGARDING
EXHIBITS 1016, 1018-1028, 1031, 1033-1034, 1040-1044, 1046-1049, 1051-
1054, 1057-1062, 1064, 1072-1075, 1077-1078, 1081-1084**

HANWHA v. MAXEON
IPR2024-01198
HANWHA 1140

I, Gilbert T. Smolenski, declare as follows:

1. I am an attorney at the law firm of Wilmer Cutler Pickering Hale and Dorr LLP in Washington, D.C., which represents the Petitioner Hanwha Solutions Corporation in this proceeding.

2. I was involved in the preparation of the Petition, and this declaration is based on my personal knowledge from being involved in the preparation of the Petition.

3. Exhibit 1016 is a copy of an article titled “A polysilicon emitter solar cell” and authored by N.G. Tarr. The article was published in a journal titled *IEEE Electron Device Letters* and is dated December 1985. Exhibit 1016 is a true and accurate copy of this article that was obtained from <https://ieeexplore.ieee.org/document/1485417> while preparing the Petition.

4. Exhibit 1018 is a copy on an article titled “Electron Transport in Amorphous Silicon” and authored by Zachary C. Holman. The article was presented to The Division of Mathematics and Natural Sciences at Reed College and is dated May 2005. Exhibit 1018 is a true and accurate copy of this article that was obtained from Dr. Zachary Holman while preparing the Petition.

5. Exhibit 1019 is a copy of an article titled “Backside-contact silicon solar cells with improved efficiency for the '96 world solar challenge” and authored by P.J. Verlinden, R.A. Sinton, K. Wickham, R.A. Crane, and R.M. Swanson. The

article was published in a journal titled *Proceedings of the 14th European Photovoltaic Solar Energy Conference, Barcelona, Spain* and has a copyright date of 1997. Exhibit 1019 is a true and accurate copy of this article that was obtained from https://web.archive.org/web/19990801000000*/http://www.sunpowercorp.com/technical_papers.htm while preparing the Petition.

6. Exhibit 1020 is a copy of an article titled “Simplified backside-contact solar cells” and authored by R.A. Sinton and R.M. Swanson. The article was published in a journal titled *IEEE Transactions on Electron Devices* and is dated 1990. Exhibit 1020 is a true and accurate copy of this article that was obtained from <https://ieeexplore.ieee.org/document/46364> while preparing the Petition.

7. Exhibit 1021 is a copy of an article titled “Studies of Diffused Phosphorous Emitters: Saturation Current, Surface Recombination Velocity, and Quantum Efficiency” and authored by R.R. King, R.A. Sinton, and R.M. Swanson. The article was published in a journal titled *IEEE Transactions On Electron Devices* and is dated February 1990. Exhibit 1021 is a true and accurate copy of this article that was obtained from <https://ieeexplore.ieee.org/document/46368> while preparing the Petition.

8. Exhibit 1022 is a copy of an article titled “Manufacture of solar cells with 21% efficiency” and authored by W.P. Mulligan, D.H. Rose, M.J. Cudzinovic, D.M. De Ceuster, K.R. McIntosh, D.D. Smith, and R.M. Swanson. The article was

published in a journal titled *Proceedings of the 19th European Photovoltaic Solar Energy Conference, Paris, France* and has a copyright date of June 2004. Exhibit 1022 is a true and accurate copy of this article that was obtained from <https://taylorandfrancis.com/reference/Electronics/Photonics/HighEfficiencySolarCells.pdf> while preparing the Petition.

9. Exhibit 1023 is a copy of excerpts from a book titled *The Physics of Solar Cells* and authored by J. Nelson. The book was published by Imperial College Press and has a copyright date of 2003. Exhibit 1023 is a true and accurate copy of excerpts from this book that was obtained while preparing the Petition.

10. Exhibit 1024 is a copy of excerpts from a book titled *Semiconductor Device Fundamentals* and authored by Robert F. Pierret. The book was published by Addison Wesley Longman and has a copyright date of 1996. Exhibit 1024 is a true and accurate copy of excerpts from this book that was obtained while preparing the Petition.

11. Exhibit 1025 is a copy of excerpts from a book titled *Solar Cell Device Physics* and authored by S.J. Fonash. The book was published by Elsevier and has a copyright date of 2010. Exhibit 1025 is a true and accurate copy of this book that was obtained while preparing the Petition.

12. Exhibit 1026 is a copy of a chapter of a book titled *Solar Cells: From Basics to Advanced Systems* and authored by C. Hu and R.M. White. The book was

published by McGraw-Hill and has a copyright date of 1983. Exhibit 1026 is a true and accurate copy of this book that was obtained from https://nanohub.org/resources/14073/download/Solar_cells_by_Hu_and_White_1.pdf while preparing the Petition.

13. Exhibit 1027 is a copy of an article titled “The Front Surface Field Solar Cell, A New Concept” and authored by O. von Roos and B. Anspaugh. The article was published in a journal titled *Proceedings of the 13th IEEE Photovoltaic Specialists Conference* and has a copyright date of June 1978. Exhibit 1027 is a true and accurate copy of this article that was obtained from <https://search.library.wisc.edu/catalog/999584602102121/holdings?from=locations> while preparing the Petition.

14. Exhibit 1028 is a copy of an article titled “Back-contact Solar Cells: A Review” and authored by E. van Kerschaver and G. Beaucarne. The article states that it was first published online in December 2005 in a journal titled *Progress in Photovoltaics: Research and Applications* and has a publication date of 2006. Exhibit 1028 is a true and accurate copy of this article that was obtained from <https://onlinelibrary.wiley.com/doi/abs/10.1002/pip.657> while preparing the Petition.

15. Exhibit 1031 is a copy of an article titled “Methods of emitter formation for crystalline silicon solar cells” and authored by J. Bultman, I. Cesar, B. Geerligs,

Y. Komatsu, and W. Sinke. The article was published in a journal titled *Photovoltaics International*, and ResearchGate states that the article was published in January 2012. See https://www.researchgate.net/publication/48326742_Methods_of_Emitter_Formation_for_Crystalline_Silicon_Solar_Cells. Exhibit 1031 is a true and accurate copy of this article that was obtained from <https://publications.tno.nl/publication/34633408/5V24uG/w10011.pdf> while preparing the Petition.

16. Exhibit 1033 is a copy of an article titled “Gettering of impurities in solar silicon” and authored by I. Perichaud. The article was published in a journal titled *Solar Energy Materials & Solar Cells* and has a copyright date of 2002. Exhibit 1033 is a true and accurate copy of this article that was obtained from <https://www.sciencedirect.com/science/article/abs/pii/S0927024801001799> while preparing the Petition.

17. Exhibit 1034 is a copy of a thesis titled “Surface, Emitter and Bulk Recombination in Silicon and Development of Silicon Nitride Passivated Solar Cells” and authored by Mark John Kerr. The thesis was published by The Australian National University and is dated June 2002. Exhibit 1034 is a true and accurate copy of this thesis that was obtained from <https://openresearch-repository.anu.edu.au/server/api/core/bitstreams/e6ce96a2-01ca-4881-a54c-a94bd94163d0/content> while preparing the Petition.

18. Exhibit 1040 is a copy of an article titled “Analysis of the Impact of Rear Side Geometry on Performance of Back-Contact Back-Junction Solar Cells” and authored by P. Procel, V. Maccaronio, F. Crupi, G. Cocorullo, and M. Zanuccoli. The article was published in a journal titled *2014 Fotonica AEIT Italian Conference on Photonics Technologies, Naples, Italy* and is dated May 12-14, 2014. Exhibit 1040 is a true and accurate copy of this article that was obtained from <https://ieeexplore.ieee.org/document/6843919> while preparing the Petition.

19. Exhibit 1041 is a copy of an article titled “Analyzing the effects of front-surface fields on back-junction silicon solar cells using the charge-collection probability and the reciprocity theorem” and authored by M. Hermle, F. Granek, O. Schultz, and S. W. Glunz. The article was published in a journal titled *Journal of Applied Physics* and has a copyright date of 2008. Exhibit 1041 is a true and accurate copy of this article that was obtained from <https://pubs.aip.org/aip/jap/article-abstract/103/5/054507/370101/Analyzing-the-effects-of-front-surface-fields-on?redirectedFrom=fulltext> while preparing the Petition.

20. Exhibit 1042 is a copy of an article titled “P-Type Versus n-Type Silicon Wafers: Prospects for High-Efficiency Commercial Silicon Solar Cells” and authored by J. E. Cotter, J. H. Guo, P. J. Cousins, M. D. Abbott, F. W. Chen, and K. C. Fisher. The article was published in a journal titled *IEEE Transactions on Electron Devices* and has a copyright date of August 2006. Exhibit 1042 is a true

and accurate copy of this article that was obtained from <https://ieeexplore.ieee.org/document/1661892> while preparing the Petition.

21. Exhibit 1043 is a copy of Chapter 1.16 of a book titled *Crystalline Silicon Solar Cells: State-of-the-Art and Future Developments* and authored by S.W. Glunz, R. Preu, and D. Biro. The book was published by Elsevier and has a copyright date of 2012. Exhibit 1043 is a true and accurate copy of this book that was obtained while preparing the Petition.

22. Exhibit 1044 is a copy of an article titled “7000 High-efficiency Cells for a Dream” and authored by P.J. Verlinden, R. M. Swanson, and R. A. Crane. The article was published in a journal titled *Progress In Photovoltaics: Research and Applications* and has a copyright date of 1994. Exhibit 1044 is a true and accurate copy of this article that was obtained from <https://onlinelibrary.wiley.com/doi/abs/10.1002/pip.4670020209> while preparing the Petition.

23. Exhibit 1046 is a copy of an article titled “Silicon solar cells: evolution, high-efficiency design and efficiency enhancements” and authored by M. Green. The article was published in a journal titled *Semiconductor Science & Technology* and has a copyright date of 1993. Exhibit 1046 is a true and accurate copy of this article that was obtained from https://www.researchgate.net/profile/Martin-Green-7/publication/231114788_Silicon_solar_cells_evolution_high-efficiency_design_and_efficiency_enhancements/links/55b4795508aec0e5f434e151/Silicon-solar-

cells-evolution-high-efficiency-design-and-efficiency-enhancements.pdf while preparing the Petition.

24. Exhibit 1047 is a copy of an article titled “Iron contamination in silicon technology” and authored by A.A. Istratov, H. Hieslmair, and E.R. Weber. The article was published in a journal titled *Applied Physics* and has a copyright date of 2000. Exhibit 1047 is a true and accurate copy of this article that was obtained from <https://link.springer.com/article/10.1007/s003390051074> while preparing the Petition.

25. Exhibit 1048 is a copy of an article titled “18.5% Efficient First-Generation MIS Inversion-Layer Silicon Solar Cells” and authored by A. Metz, R. Meyer, B. Kuhlmann, M. Grauvogl, and R. Hezel. The article was published in a journal titled *Conference Record of the Twenty Sixth IEEE Photovoltaic Specialists Conference* and has a copyright date of 1997. Exhibit 1048 is a true and accurate copy of this article that was obtained from <https://ieeexplore.ieee.org/document/653917> while preparing the Petition.

26. Exhibit 1049 is a copy of an article titled “Low Cost, High Volume Production of >22% efficiency silicon solar cells” and authored by D. De Ceuster, P. Cousins, D. Rose, D. Vicente, P. Tipones, and W. Mulligan. The article was published in a journal titled *22nd European Photovoltaic Solar Energy Conference*,

Milan, Italy and is dated September 2007. Exhibit 1049 is a true and accurate copy of this article that was obtained while preparing the Petition.

27. Exhibit 1051 is a copy of an article titled “The Interdigitated Back Contact Solar Cell: A Silicon Solar Cell for Use in Concentrated Sunlight” and authored by M.D. Lammert and R.J. Schwartz. The article was published in a journal titled *IEEE Transactions on Electron Devices* and is dated April 1977. Exhibit 1051 is a true and accurate copy of this article that was obtained from <https://ieeexplore.ieee.org/document/1478930> while preparing the Petition.

28. Exhibit 1052 is a copy of an article titled “Structure and Gettering Properties of Polycrystalline Silicon Layers” and authored by D. Lysáček, M. Lorenc, and L. Válek. The article was published in a journal titled *Proceedings of the 16th Joint Seminar Development of Materials Science in Research and Education* and is dated 2006. Exhibit 1052 is a true and accurate copy of this article that was obtained from https://www.onsemi.cn/site/pdf/Lysacek_Structure_and_gettering_properties_of_polycrystalline_silicon_layers.pdf while preparing the Petition.

29. Exhibit 1053 is a copy of an article titled “Gettering Properties of Silicon Wafer Covered by Polysilicon” and authored by K. Ishisaka, H. Tanaka, and T. Nakashizu. The article was published on the Nippon Steel website and is dated October 1993. Exhibit 1053 is a true and accurate copy of this article that was

obtained from <https://www.nipponsteel.com/en/tech/report/nsc/pdf/5903.pdf> while preparing the Petition.

30. Exhibit 1054 is a copy of a document titled “BP MSX 120, 120-Watt Multicrystalline Photovoltaic Module” and authored by BP Solar Global Marketing. The document was published on the BP website and is dated 2002. Exhibit 1054 is a true and accurate copy of this article that was obtained from http://www.posharp.com/Businesses/daacacf6-2fa0-4fe2-b6f5-30211a36989a/Panel/msx_120.pdf while preparing the Petition.

31. Exhibit 1057 is a copy of an article titled “Passivated Tunneling Contacts to N-Type Wafer Silicon and Their Implementation into High Performance Solar Cells” and authored by P. Stradins, A. Dameron, S. Essig, V. Lasalvia, B. Lee, Y. Liu, J. Luo, W. Nemeth, A. Norman, and M. Page. The article states that it was presented at the 6th World Conference on Photovoltaic Energy Conversion in Kyoto, Japan and is dated November 23-27, 2014. Exhibit 1057 is a true and accurate copy of this article that was obtained from <https://www.nrel.gov/docs/fy15osti/63259.pdf> while preparing the Petition.

32. Exhibit 1058 is a copy of an article titled “A New Silicon P-N Junction Photocell for Converting Solar Radiation into Electrical Power” and authored by D. Chapin, C. S. Fuller, and G. L. Pearson. The article was published in a journal titled *Journal of Applied Physics* and is dated May 1954. Exhibit 1058 is a true and

accurate copy of this article that was obtained from a physical copy of the journal while preparing the Petition.

33. Exhibit 1059 is a copy of an article titled “Detailed Balance Limit of Efficiency of pn Junction Solar Cells” and authored by W. Shockley and H. J. Queisser. The article was published in a journal titled *Journal of Applied Physics* and is dated March 1961. Exhibit 1059 is a true and accurate copy of this article that was obtained from <https://pubs.aip.org/aip/jap/article-abstract/32/3/510/505950/Detailed-Balance-Limit-of-Efficiency-of-p-n?redirectedFromfulltext> while preparing the Petition.

34. Exhibit 1060 is a copy of an article titled “Metal Precipitates in Silicon p-n Junctions” and authored by A. Goetzberger and W. Shockley. The article was published in a journal titled *Journal of Applied Physics* and is dated October 1960. Exhibit 1060 is a true and accurate copy of this article that was obtained from <https://pubs.aip.org/aip/jap/article-abstract/31/10/1821/162357/Metal-Precipitates-in-Silicon-p-n-Junctions?redirectedFrom=fulltext> while preparing the Petition.

35. Exhibit 1061 is a copy of an article titled “Gettering of Metallic Impurities from Planar Silicon Diodes” and authored by S. W. Ing, Jr., R. E. Morrison, L. L. Alt, and R. W. Aldrich. The article was published in a journal titled *Journal of the Electrochemical Society* and is dated June 1963. Exhibit 1061 is a

true and accurate copy of this article that was obtained from <https://iopscience.iop.org/article/10.1149/1.2425808> while preparing the Petition.

36. Exhibit 1062 is a copy of an article titled “Poisoning and Gettering Effects in Silicon Junctions” and authored by E. J. Mets. The article was published in a journal titled *Journal of the Electrochemical Society* and is dated April 1965. Exhibit 1062 is a true and accurate copy of this article that was obtained from <https://iopscience.iop.org/article/10.1149/1.2423560> while preparing the Petition.

37. Exhibit 1064 is a copy of an article titled “Experimental Evidence for the Presence of Segregation and Relaxation Gettering of Iron in Polycrystalline Silicon Layers on Silicon” and authored by A. A. Istratov, W. Huber, and E. R. Weber. The article was published in a journal titled *Applied Physics Letters* and has a copyright date of November 8, 2004. Exhibit 1064 is a true and accurate copy of this article that was obtained from <https://pubs.aip.org/aip/apl/article-abstract/85/19/4472/896724/Experimental-evidence-for-the-presence-of?redirectedFrom=fulltext> while preparing the Petition.

38. Exhibit 1072 is a copy of excerpts from a book titled *Practical Photovoltaics Electricity From Solar Cells* and authored by R. J. Komp. The book has a copyright date of 2002. Exhibit 1072 is a true and accurate copy of excerpts of this book that was obtained while preparing the Petition.

39. Exhibit 1073 is a copy of an article titled “Simultaneous P and B Diffusion, In-Situ Surface Passivation, Impurity Filtering and Gettering for High-Frequency Silicon Solar Cells” and authored by T. Krygowski, A. Rohatgi, and D. Ruby. The article was published in a journal titled *Conference Record of the Twenty Sixth IEEE Photovoltaic Specialists Conference* and is dated 1997. Exhibit 1073 is a true and accurate copy of this article that was obtained from <https://ieeexplore.ieee.org/document/653915> while preparing the Petition.

40. Exhibit 1074 is a copy of an article titled “PECVD PSG as a Dopant Source for Industrial Solar Cells” and authored by J. Benick, J. Rentsch, Ch. Schetter, C. Voyer, D. Biro, and R. Preu. The article was published in a journal titled *21st European Photovoltaic Solar Energy Conference* and is dated September 4-8, 2006. Exhibit 1074 is a true and accurate copy of this article that was obtained from https://www.researchgate.net/publication/216564244_PECVD_PSG_as_a_dopant_source_for_industrial_solar_cells while preparing the Petition.

41. Exhibit 1075 is a copy of excerpts from a book titled *Silicon Solar Cells Advanced Principles & Practice* and authored by M. A. Green. The book was published by the Centre for Photovoltaic Devices and Systems and has a copyright date of 1995. Exhibit 1075 is a true and accurate copy of excerpts of this book that was obtained while preparing the Petition.

42. Exhibit 1077 is a copy of an article titled “Identification of Metal Impurities in Crystalline Silicon Wafers” and authored by B. Paudyal, Y. H. Yoon, D. Cornwell, P. Shaw, and F. Machuca. The article was published in a book titled *Conference Record of the IEEE Photovoltaic Specialists Conference* and has a copyright date of June 3-8, 2012. Exhibit 1077 is a true and accurate copy of this article that was obtained from <https://ieeexplore.ieee.org/document/6317652> while preparing the Petition.

43. Exhibit 1078 is a copy of an article titled “From Electronic Grade to Solar Grade Silicon: Chances and Challenges in Photovoltaics” and authored by S. Pizzini, M. Acciarri, and S. Binetti. The article was published in a journal titled *Physica Status Solidi* and has a copyright date of 2005. Exhibit 1078 is a true and accurate copy of this article that was obtained from <https://online.library.wiley.com/doi/abs/10.1002/pssa.200521104> while preparing the Petition.

44. Exhibit 1081 is a copy of a press release titled “Cypress Announces Investment In Designer and Manufacturer Of Ultra-High-Efficiency Silicon Solar Cells.” Exhibit 1081 is a true and accurate copy of this press release that was obtained from <https://investors.sunpower.com/static-files/103bae51-d5a4-46f3-ae4c-efc7d65b968a> while preparing the Petition.

45. Exhibit 1082 is a copy of a press release titled “SunPower Announces World’s Most Efficient, Low-Cost Silicon Solar Cell.” Exhibit 1082 is a true and

accurate copy of this press release that was obtained from <https://investors.sunpower.com/static-files/4e352cd3-71ed-45ca-a441-165e996c8222> while preparing the Petition.

46. Exhibit 1083 is a copy of an article titled “Improved Iron Gettering of Contaminated Multicrystalline Silicon By High-Temperature Phosphorus Diffusion” and authored by D.P. Fenning, A.S. Zuschlag, M.I. Bertoni, B. Lai, G. Hahn, and T. Buonassisi. The article was published in a journal titled *Journal of Applied Physics* and has a copyright date of 2013. Exhibit 1083 is a true and accurate copy of this article that was obtained from <https://pubs.aip.org/aip/jap/article-abstract/113/21/214504/371397/Improved-iron-gettering-of-contaminated?redirectedFrom=fulltext> while preparing the Petition.

47. Exhibit 1084 is a copy of an article titled “Industrial Silicon Wafer Solar Cells” and authored by D.H. Neuhaus and A. Munzer. The article was published in a book series titled *Advances in OptoElectronics* and has a copyright date of 2007. Exhibit 1084 is a true and accurate copy of this article that was obtained from <https://onlinelibrary.wiley.com/doi/abs/10.1155/2007/24521> while preparing the Petition.

48. In signing this declaration, I recognize that the declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I also recognize that I may be subject

to cross-examination in the case and that cross-examination will take place within the United States. If cross-examination is required of me, I will appear for cross-examination within the United States during the time allotted for cross-examination.

49. I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief 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 Section 1001 of Title 18 of the United States Code.

Dated: March 25, 2025

/Gilbert T. Smolenski/

GILBERT T. SMOLENSKI
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CERTIFICATE OF SERVICE

I hereby certify that, on March 25, 2025, I caused a true and correct copy of the following materials:

- Declaration of Gilbert T. Smolenski Regarding Exhibits 1016, 1018-1028, 1031, 1033-1034, 1040-1044, 1046-1049, 1051-1054, 1057-1062, 1064, 1072-1075, 1077-1078, 1081-1084

to be served via electronic service on the counsel of record for Patent Owner:

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