

1. **Candidate Name:** Dr. Anant Kumar Agarwal
2. **Peer Committee assignment:** Electronics, Communication and Information Systems Engineering
Second Peer Committee assignment:
3. **Type of nomination:** Member
4. **Candidate's primary work sector during accomplishments:** Other
5. **Proposed citation:**

Creating a manufacturing strategy for Wide Band Gap semiconductors and industrial adoption to reduce global warming through efficient power electronics.

6. Specific technical, professional engineering and/or engineering team leadership accomplishments/contributions:

Dr. Agarwal, while at Cree in NC (1999-2013), led a team of engineers and scientists to develop and manufacture SiC power devices for efficient electrical power conversion systems. He produced >60 patents and 300 research papers (https://u.osu.edu/sicpowerdevicesreliabilitylab/files/2020/04/Agarwal_CV.pdf) He realized these devices had the potential to make huge societal impact. Whereupon, he joined the DOE (2013-2017) under the Obama administration as a Senior Adviser/Program Manager to develop a strategy to manufacture WBG semiconductors (SiC and GaN) for the US industry, while educating a workforce for this industry. This was implemented with the formation of the PowerAmerica Institute with \$70M over 5 years - a paradigm change for the U.S. government in fossil-fuel independence. His approach had two parts:

(a) Convert existing 6" Si commercial manufacturing facilities to process 6" SiC substrates in the foundry's idle time. The substrates would be used to generate 1200-1700 V SiC power switches and diodes. With an existing Si infra-structure, SiC components could be manufactured at very low cost alongside Si components. This fabless approach has enabled many companies to enter the SiC market.

(b) Educate students to use SiC/GaN power switches and diodes to build high efficiency power electronics and accelerate industrial adoption for electric vehicles to reduce green-house global warming.

Dr. Agarwal's ultimate goal has been global manufacturing to supply WBG based power converters in applications to reduce the consumption of end-use electricity, dependency on fossil fuels, and lowering greenhouse gas emissions while making the integration of renewable energy with an electric grid possible. Significant job creation in the renewable energy sectors and health benefits through greenhouse gas reduction would have enormous economic ramifications worldwide. Dr. Agarwal has continued his dedication to expanding the workforce, after leaving Cree and the DOE, through his teaching career at The Ohio State University (August 2017-present). His career has spanned over 30 years in the industrial, government and academia sectors, taking SiC technology from basic R&D to prototype development and the manufacture of commercial products culminating into a national strategy to reduce costs/accelerate workforce development, fuel adoption of SiC technology, and decrease global warming through more efficient power electronics.

7. Impacts of work:

..(a) Cree, under the leadership of Dr. Agarwal, was the first to commercially release a 1200 V SiC power switch in January 2011. Since then, at least 10 companies have released commercial SiC parts and the offering has been expanded from 900 V to 3.3 kV switches.

..(b) PowerAmerica strategy has accelerated the U.S. movement towards higher energy efficiency, while lowering dependence on fossil fuels, but also in economic benefits to a worldwide community where outdated Si foundries were closing down. For example, XFAB in Lubbock, TX, the PowerAmerica funded Si foundry, also produced SiC devices and currently has more than 25 users, many of whom have already commercialized SiC components with revenue of about \$200 M for the US semiconductor industry in 2017-2019.

..(c) Estimated SiC device revenue for SiC will exceed \$1.5 Billion by 2023. Many of the products produced at XFAB are being used in power supplies, solar converters, and on-board battery chargers in electric vehicles with 3% efficiency advantage over Si per sub-system. The worldwide manufacturing of EV/HEVs is expected to rise to 18 million vehicles per year by 2023. Utilizing SiC for the traction drives, chargers and dc to dc converters in these applications alone will grow the industry exponentially.

..(d) The graduate students educated by funding programs initiated by Dr. Agarwal at DOE have been key to the adoption of SiC based power electronics by industry. The societal impact will be to reduce greenhouse gases and global warming by reducing the worldwide consumption of electricity through efficiency improvements and generation of cleaner forms of energy with renewables over the next 4-5 decades.

..(e) At Ohio State University, Dr. Agarwal has taught in-class courses, prepared video courses and written book chapters on the design and manufacturing aspects of SiC power components. He has put a major emphasis on dissemination of technology through his students, advising new upcoming companies and helping students at other universities. The technical vision of Dr. Agarwal has made it possible for Cree, a US based company, to lead the world in SiC device manufacturing. These devices reduce power losses by 70% during power conversion.

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8. Documentation for each impact:

- (a) <https://csmantech.org/OldSite/Digests/2006/2006%20Digests/14A.pdf>
<https://nanohub.org/resources/25890/download/2017.02.08-Agarwal-EE.pdf>
- (b) <https://u.osu.edu/sicpowerdevicesreliabilitylab/files/2020/04/1.pdf>
<https://u.osu.edu/sicpowerdevicesreliabilitylab/files/2020/04/2.pdf>
- (c) http://www.yole.fr/PowerElectronics_EV-HEV_MarketStructuration.aspx
http://www.yole.fr/iso_upload/News/2019/PR_SiC_IP_Landscape_YOLE_KNOWMADE_March2019.pdf
- (d) https://www.nist.gov/system/files/documents/pml/high_megawatt/Agarwal_wbg-for-Grid.pdf
- (e) Video Course: <https://cusp.umn.edu/power-electronics/wide-band-gap-wbg-devices>
<https://u.osu.edu/sicpowerdevicesreliabilitylab/files/2020/04/3.pdf>

9. Demonstrated record of service to the nation, the profession and the world:

After 14 years, in March 2013, Dr. Agarwal left his R&D Management position in WBG at Cree Inc. NC to joined the Department of Energy (DoE), Energy Efficiency and Renewable Energy Department as Senior Adviser to lead the Obama DoE initiative on WBG power devices, PowerAmerica, established at NC State University, NC <https://poweramericainstitute.org>. He created a manufacturing strategy to advance a foundry manufacturing model for SiC WBG power devices to provide efficient power electronics in electric vehicles to mitigate the rise in global warming. He moved to Ohio State University to educate students in the WBG age.

10. Professional recognition:

Dr. Agarwal became a Fellow at the Westinghouse - Northrop Grumman Technology Center in Pittsburgh, PA (1990-1999). He became an IEEE Fellow in the IEEE Electron Device Society "for contributions to silicon carbide power device technology" in January 2012. US DoE Special Act Group Award "For their exceptional work advancing U.S. competitiveness in developing efficient vehicle technologies".

11. Record of professional work experience:

- [1] 2017 - Present: The Ohio State University, Electrical and Computer Engineering, Professor, Teaching and Research
- [2] 2013 -2016: U.S. Department of Energy, Washington DC, Technical Advisor for the Wide Bandgap (WBG) Initiative, Establish and manage PowerAmerica Institute <https://poweramericainstitute.org>
- [3] 1999 - 2013: Cree Inc., Durham, NC, Technical R&D Manager for SiC Power Device development
- [4] 1990 - 1999: Northrop Grumman Science & Technology Center, Pittsburgh (formerly Westinghouse), Fellow Engineer, R&D in Solid State Devices

12. Current employment position and institution:

Title: Professor Anant K. Agarwal
Department: Electrical and Computer Engineering
Employer: The Ohio State University
Address: 205 Drees Laborstories
2015 Neil Avenue
Columbus, OH 43210

Phone/Email: 919-360-8215/agarwal.334@osu.edu

13. Citizenship (name of country or countries): United States

14. Education:

PhD Electrical Engineering 1984 Lehigh University; MS Electrical Engineering 1980 University of Tennessee Space Institute; BS Electrical Engineering 1978 M.N.R. Engg. Col., Univ. of Allahabad, India

15. Professional registrations or licenses: None

16. Nominator and References

Nominated by: Marvin H. White; The Ohio State University

Contact: (614) 688-4282 white.1829@osu.edu

Submitted date: 4/15/2020

Reference Name; Affiliation

1. B. Jayant Baliga; North Carolina State University
2. Umesh Mishra; University of California, Santa Barbara
3. Thomas Roland Kurfess; Oak Ridge National Laboratory

Supplemental References (optional, for international member candidate)

- 4.
- 5.