

GaN Devices in Power Electronics, Space Missions, and Quantum Photonics

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ABSTRACT:

Gallium nitride (GaN) based wide bandgap (WBG) materials are revolutionizing an increasing number of applications ranging from applied electronics such as LEDs and lasers, power electronics, RF and power ICs, to quantum information such as quantum photonics and quantum sensing. For example, GaN WBG devices are presently making a significant impact on power electronic devices technologies, which are vital for electric vehicles, data centers, and smart grids. The new power devices based on GaN are expected to outperform the current Si power devices, with promises to trim the losses in power conversion circuits, trip the size, weight and cost of power systems, and overall, drive a 10 percent reduction in global power consumption. At the heart of all these exciting applications is the WBG materials, the unique electronic and optical properties of which have enabled and will continue to enable new paradigms in electronic and photonic technologies. In this talk, I will review our progress on GaN materials research, and discuss their device applications in kV-class power transistors, high temperature memory and ICs for space missions, and integrated photonics for quantum information and biomedical sensing applications. Additionally, I will also discuss the research challenges and opportunities of emerging ultra-wide bandgap (UWBG) materials, including Ga₂O₃, diamond, and AlN, which represent the next frontier in electronic and optical materials.

BIOGRAPHY:

Yuji Zhao is an Associate Professor of Electrical and Computer Engineering at Rice University. He received the Ph.D. degree from University of California Santa Barbara (UCSB) in 2012 under the supervision of Nobel Laureate Professor Shuji Nakamura. Dr. Zhao's research interests are in the field of wide bandgap materials and devices (e.g., GaN, Ga₂O₃, diamond) for applications in power electronics, RF and power ICs, and quantum photonics. He has authored/co-authored more than 180 journal and conference publications, 4 book chapters, and over 20 patents. Dr. Zhao is the receipt of 2019 Presidential Early Career Award for Scientists and Engineers, 2019 MIT-TR 35 China Award, 2017 ASU Fulton Outstanding Assistant Professor Award, 2016 DTRA Young Investigator Award, 2015 NASA Early Career Faculty Award, 2015 SFAz Bisgrove Scholar Faculty Award, and 2010–2013 UCSB SSLEC Outstanding Research Award.