

Dr. Theodore Moustakas, Boston University

Fundamental Differences Between Traditional III-V Compounds and Nitride Semiconductors: The Formation and Role of Extended Defects

Abstract: In this talk Dr. Moustakas will address the fundamental question as to why the performance of optoelectronic devices based on nitride semiconductors is insensitive to high concentration of extended defects, which is not the case for traditional III-V compounds. He will discuss three important differences between these two families of materials, which contribute to this finding: (a) the chemical bonds in nitrides are strongly ionic while are mostly covalent in III-V compounds. This leads to the bunching of the intrinsic surface states as well as the states associated with dangling bonds in edge dislocations near the band edges where they act as traps rather than recombination centers; (b) the nitrides can exist in the wurtzite structure (equilibrium) and the cubic structure (metastable) and the enthalpy of formation of the two allotropic forms differs by only a few meV. Thus, conversion between the two phases occurs easily by creation of stacking faults along the close-packed (0001) and (111) planes, which due to the smaller energy gap of the cubic phase leads to strong band structure potential fluctuations in the wurtzite matrix; (c) additional band structure potential fluctuations exist in the InGaAlN alloys due to alloy disorder as well as phase separation and unique types of long range atomic ordering. Both types of potential fluctuations contribute to exciton localization and thus efficient radiative recombination even at room temperature.

Bio: Dr. Moustakas is the Distinguished Professor of Photonics and Optoelectronics at Boston University. He received his PhD from Columbia University in 1974. He held research positions at Harvard University and Exxon Corporate Research Laboratory prior to joining Boston University in 1987 as a Professor of Electrical and Computer Engineering. He is also a Professor of Physics and Associate Head of the Division of Materials Science and Engineering.

Dr. Moustakas' research contributions cover a broad spectrum of topics in opto-electronic materials and devices, including nitride semiconductors, amorphous semiconductors, III-V compounds, diamond thin films and metallic multi-layers. Intellectual property that resulted from his work has been licensed to a number of companies, including major manufacturers and users of blue LEDs and lasers (Cree, Nichia, Philips, OSRAM, Apple, Google, Amazon, Samsung, LG, Sony etc.).

Dr. Moustakas is a Fellow of the American Physical Society, the Electrochemical Society, the IEEE and a Charter Fellow of the National Academy of Inventors. He holds an honorary doctoral degree from the Aristotle University; he received the MBE Innovator Award in 2010; in 2011 he received the Distinguished Scholar Award from the BU College of Engineering and in 2013 he received the Boston University Innovator of the Year Award.