

A Materials Science Perspective of Quantum Materials

The experimental discovery of topological insulators, the emergence of graphene with exotic properties, and the exciting optoelectronic properties of van der Waals materials, all have energized researchers from physics, materials science and engineering and have brought them under the scientific canopy of quantum materials (QMs). QMs offer the exciting promise of new applications such as dissipationless electronics using topological currents and quantum spins, secure quantum computing and communication, and of different realms in energy harvesting using photovoltaics and thermoelectrics. Before harnessing some of these exciting applications, not only advances in the fundamental understanding of QMs are required, but also practical solutions to the myriad material challenges are imperative. This talk will cover a general introduction to QMs, their functions, synthesis & characterization, and an assessment of their realistic application potential in the near-to-mid-term.

Dr. Venkataraman (“Swami”) Swaminathan obtained his doctorate in Materials Science from the University of Southern California in 1975. He worked at Bell Laboratories for 24 years in many aspects of fiber optic communication systems and fiber-to-the-home technologies and held senior management positions. From 2004-2006, he was the Chief of the IR Materials and Devices Branch at the US Army Research Laboratory leading research in the area of infrared emitters and detectors. During 2008-2014, Dr. Swaminathan served as the Chief of the Acoustics and Networked Sensors Division at the US Army Combat Capabilities Development Command Armaments Center, (formerly known as ARDEC) Picatinny, NJ, and directed technology development in the areas of acoustic and other passive sensors for hostile fire defeat, IED and explosives detection. Between 2015-2017, he served as a Research Scientist at CCDC Armaments Center, and conducted research on two-dimensional nanomaterials, energy storage systems, neuromorphic processors, photonics, and electro-optics.



Dr. Swaminathan is a Fellow of IEEE and of the American Electrochemical Society. He has authored/co-authored 160 publications in peer-reviewed journals and has received 8 patents. He is the coauthor of a book on Materials Aspects of GaAs and InP Based Structures and has edited four books. Dr. Swaminathan retired from the US Army in Sept 2017. In recognition of his retirement, the flag of the United States of America was flown over the United States Capitol, at the request of Honorable Leonard Lance, Member of Congress.

Dr. Swaminathan is currently affiliated with Penn State University and Rice University as Adjunct Professor in the Department of Physics and Department of Materials Science and NanoEngineering, respectively.

Selected publications/patents include:

1. Yin-Ting Yeh, Yijing Zhou, Donghua Zou, He Liu, Haiyang Yu, Huaguang Lu, Venkataraman Swaminathan, Yingwei Mao, and Mauricio Terrones, “Rapid Size-Based Isolation of Extracellular Vesicles by Three-Dimensional Carbon Nanotube Arrays,” ACS Appl. Mater. Interfaces, 12, 13134-13139 (2020).
2. Yin-Ting Yeh, Kristen Gulino, YuHe Zhang, Aswathy Sabestien, Tsui-Wen Chou, Bin Zhou, Zhong Lin, Istvan Albert, Huaguang Lu, Venkataraman Swaminathan, Elodie Ghedin, and Mauricio Terrones, “A rapid and label-free platform for virus capture and identification from clinical samples,” Proc. National Academy of Sciences, 117, 895-901 (2020).
3. Marco Negri, Luca Francaviglia, Dumitru Dumcenco, Matteo Bosi, Daniel Kaplan, Venkataraman Swaminathan, Giancarlo Salviati, Andras Kis, Filippo Fabbri, and Anna Fontcuberta Morral, “Quantitative Nanoscale Absorption Mapping: A Novel Technique To Probe Optical Absorption of Two-Dimensional Materials,” Nano Lett., 20, 567-576 (2020).

Patent: Jin, F., Trivedi, S., Swaminathan, V., and Wang, C.C, “Apparatus and Method for Improving Detection Precision in Laser Vibrometric Studies,” US Patent 9829373, Nov 28, 2017.