Mechanical Engineering Department Seminar

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1130 Mechanical Engineering
111 Church Street SE, Minneapolis, MN 55455

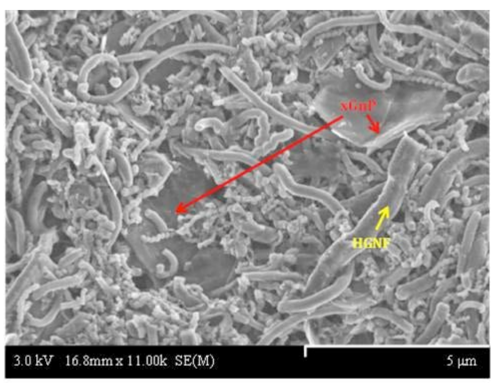
Manipulating Nano-sized Constrictions at Few Layer Graphene Interfaces to Tune Thermal Transport and Energy Storage in Amorphous Phase Change Materials

Amy S. Fleischer

Professor; Department of Mechanical Engineering, Villanova University

It is well known that carbon-based nanoparticles exhibit exceptionally high thermal conductivities. As such, various configurations of carbon-based nanoparticles have been embedded or suspended in a wide variety of thermal materials including heat transfer fluids, thermal interface materials and energy storage materials. Despite nearly two decades of intense research in this area, however, nanoparticle-based materials have not yet been able to achieve the high levels of thermal transport originally predicted. This is due in part to an evolving understanding of the physics governing the heat flow both within and between nanoparticles. In this study, the contact interfaces between graphene nanoparticles are controlled to better understand the high degree of phonon boundary scattering that occurs across nanoparticle interfaces. Of particular interest here is the transition from ballistic to diffusive transport due to differently sized constrictions that are formed at contacting junctions as the magnitude of this effect on thermal transport in bulk materials is not well known.

In this study, the effect of atomic layer thickness, diameter and concentration of few-layer graphene (FLG) on both the microscopic and macroscopic thermal transport properties and performance of an organic paraffin is examined. Results suggest that: (1) the interfacial thermal resistance has a strong dependence on the size of the micro/nano-constrictions formed at each type of interface and (2) at comparable concentrations, optimal geometries of randomly oriented FLG are more effective at increasing thermal transport of amorphous phase change materials than aligned carbon nanotubes.



Bio: Professor Amy Fleischer received her Ph.D. in Mechanical Engineering from the University of Minnesota in 2000. She is currently a Professor of Mechanical Engineering at Villanova University. She also serves as Associate Department Chair and Director of Graduate Studies. Her research interests include the broad topics of thermal transport in nanoenhanced materials, sustainable energy system design and thermal management of electronic systems. She is Director of the NovaTherm Research Laboratory where ongoing funded projects include the development of nanostructured energy storage materials and the recovery of waste heat from data centers through organic Rankine and absorption refrigeration cycles. Dr. Fleischer is a fellow of ASME, and served as Chair of the ASME Heat Transfer Division K-16 Technical Committee on Electronics Thermal Management from 2009-2011. Dr. Fleischer also served on the Executive Committee of the ASME Electronics and Photonics Packaging Division (2009-2011). Dr. Fleischer was recognized as the ASME Electronics and Photonics Packaging Division (EPPD) 2010 Women Engineer of the Year and was awarded the 2011 ASME K-16/EPPD Clock Award in recognition of her outstanding and continuing contributions to the science and engineering of heat transfer in electronics. She is an Associate Editor of the Journal of Electronic Packaging. In her 14 years at Villanova, Dr. Fleischer has supported 15 graduate students to degree completion and worked with 38 undergraduate researchers. She is the author of more than 70 technical peer reviewed papers, and has edited one book, Thermes 2007: Thermal Challenges in Next Generation Systems.