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DEPARTMENT OF MATERIALS SCIENCE & ENGINEERING

VIRTUAL SEMINAR

Wednesday, February 3, 2021
11:00 am – 12:00 Noon

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Development and commercialization of graphene-oxide based hybrid nano-fillers – a university lab to market story

Ranji Vaidyanathan
Materials Science and Engineering Department
Oklahoma State University, Tulsa

Abstract Due to their high specific strength, carbon and glass fiber reinforced composites find wide applications as lightweight and high strength materials, for aerospace and automotive applications. However, these composite materials are extremely sensitive to relatively low velocity, and localized impact loads leading to damage in the through thickness direction. The mechanical damage induces delamination (separation cracks) at the boundary between plies. Delamination due to crack growth is one of the most prevalent life-limiting factors of a composite. To overcome this problem, graphene oxide (GO), polyhedral oligomeric silsesquioxanes (POSS) and hybridized GO-POSS nanoparticles were introduced in the interlaminar region of carbon fiber–epoxy composites. Nano-additive compositions ranged from 0-0.7% by weight of the composite to study the degree of enhancement these additives have on fracture toughness. A range of improvement in mode I interlaminar fracture toughness (G_{IC}) of specimens ranged from 70% to over 100% depending on the level of addition. Two patents issued to our lab were subsequently licensed to an Oklahoma State student start-up MITO Material Solutions for commercialization. Our research group worked with the start-up who subsequently received ~$1.5 million in research funding and $1.6 million in investment dollars. The start-up has developed a graphene functionalization technique allowing them to make hybrid polymer modifiers for use in industries such as aerospace and automotive. Their initial offering of hybridized Graphene Oxide and an Epoxide POSS (named “E-GO”) allows fiber reinforced thermoset and thermoplastic consumers to boost product performance anywhere between 20-135% beyond normal performance, allowing increased part durability and weight to be shed.
**Biosketch:** Dr. Ranji Vaidyanathan is Varnadow chaired professor of materials science and engineering in the school of materials science and engineering at Oklahoma State University, with several years of entrepreneurial and product development in the composites and additive manufacturing areas. Ranji received his B.Tech. in Metallurgical Engineering from the Indian Institute of Technology, Varanasi, an MS in Mechanical Engineering from North Carolina A&T State University and a Ph.D. in Materials Science and Engineering from North Carolina State University. Ranji has published over 60 peer-reviewed articles, two book chapters, over 90 conference proceedings and holds 23 patents, four of which have been licensed. His awards include an R&D 100 Award, Induction into the National Academy of Inventors, and was a member of a team winning Oklahoma State University President’s Cup for Creative Interdisciplinarity.
Identification, understanding, and manipulation of novel electronic and magnetic states is essential for the discovery of new quantum materials for future spin-based electronic devices. In particular, materials that manifest a large response to external stimuli such as a magnetic and electric field are subject to intense investigation. Hall effect measurement is sensitive to both electronic topological states and chiral spin textures, giving rise to large anomalous, and topological Hall effects, respectively. In this talk I will present our recent results on two materials, one which shows an anomalous Hall effect (AHE), and the other which manifests a topological Hall effect (THE), both with unconventional origin. In the first part I will talk about the AHE we discovered in a collinear antiferromagnet CoNb3S6, that is not allowed in the conventional theory. In the second part, I will present a THE in the kagome-net magnet YMn6Sn6, for which we have recently formulated a new fluctuation based mechanism.

Biography:

Nirmal J. Ghimire received his PhD from The University of Tennessee at Knoxville in 2013 working as a graduate research assistant at the nearby Oak Ridge National Laboratory. He was a postdoctoral research associate in Los Alamos National Laboratory from 2013 – 2015, and a Director's Postdoctoral Fellow at Argonne National Laboratory from 2015-2018. He joined GMU in 2018, where he is currently an Assistant Professor. He co-leads the materials group of the Quantum Science and Engineering Center at GMU. His research focuses in discovering and understanding emergent phenomena in quantum materials via designing and synthesizing materials and measuring their magnetic and transport properties.