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MATERIAL INNOVATIONS VIA NON-EQUILIBRIUM LASER NANOFABRICATION

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ABSTRACT

One of the most effective ways to achieve novel functionalities in nanomaterials is by adopting fabrication methods far-from-equilibrium conditions. Using high energy laser and ion irradiation based non-equilibrium approaches, atomically disordered nanoscale structures are designed, demonstrating highly superior functionalities. A new metastable phase of carbon, Q-carbon, was recently discovered by our collaborative team via laser-induced ultrafast melting and quenching of amorphous carbon. While Q-carbon shows numerous interesting characteristics such as superior hardness than diamond, room-temperature ferromagnetism etc., an important achievement comes in the field of high-temperature superconducting upon B-doping. By incorporating extremely high B-doping (~27 at%) concentration, Q-carbon exhibits superconducting nature below Tc at 55 K, which is the highest among BCS superconductors (40 K in MgB_2) and significantly higher than that of B-doped diamond (4 K). Using energetic ion irradiation, the fabrication of atomically disordered complex oxides ($A_2B_2O_7$) nanochannels is demonstrated that act as selective pathways for fast oxygen conduction in the solid-oxide fuel cells. With guided irradiation, the phase transitions and sculpting of function nanochannels are further presented. With these discoveries, I present the non-equilibrium nanomanufacturing as the pathway to address the toughest challenges in condensed matter physics.

SPEAKER

Dr. Ritesh Sachan is an assistant professor, Department of Mechanical and Aerospace Engineering at Oklahoma State University. His research interests primarily lie in developing a quantitative understanding of the structure-property correlations in highly non-equilibrium nanostructures and thin films using the approach of laser-induced nanofabrication and advanced electron microscopy. Previously, Dr. Sachan worked at Army Research Office as an NRC Research Associate (2016-2018) and Oak Ridge National Laboratory as a Postdoctoral Researcher (2013-2016). His research efforts have resulted in 60+ journal papers, 700+ citations, 1 book chapter and numerous invited/contributed talks to date. He has received the prestigious NRC fellowship by National Academy of Sciences in 2016 and was also named for Young Leader Professional Development Award in 2015 by The Minerals, Metals and Materials Society (TMS).

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