Materials Science Seminars

Winter 2021

UCI Samueli School of Engineering | Department of Materials Science and Engineering
UC San Diego Jacobs School of Engineering
UCLA Samueli Materials Science & Engineering

Friday, 12 February 2021

Time:
10:00 AM – 11:00 AM (Pacific time)

Connection:
Zoom meeting ID:
https://ucsd.zoom.us/s/8425066501
Passcode: 587901

Title: Ion beam modification of high-temperature superconductors for nanoscale quantum devices

Presenter: Dr. Shane Cybart
Professor, UC Riverside

Abstract: In Feynman's infamous 1959 lecture entitled, "*There's Plenty of Room at the Bottom* " he inspired and foreshadowed the emergence of nanoengineering. He suggested that finely focused electron, and ion beams would aid our eyes and hands to precisely engineer structures at the atomic level. Currently, electron beam lithography systems and gallium focused ion beams are ubiquitous in nanotechnology and can routinely be used to create structures of the order of tens of nanometers. However, the ability to scale to the sub-10 nm has been a technological challenge until the development of gas field ion sources (GFIS) over the past decade. The GFIS source, utilizes a single crystal tungsten wire sharpened to just 3 atoms. Helium gas is field ionized by one of these atoms, creating a helium ion beam with diameter of only 0.25nm! This instrument is emerging as an important tool for sub-10nm structuring of materials. Helium ion beams have significant advantages. Helium is small and chemically inert which allows it to be used for direct modification of materials properties without etching away material or employing resists.

My research group has been utilizing GFIS for direct patterning of ceramic high-temperature superconducting materials for quantum electronics. The helium ion beam induces nanoscale disorder from irradiation into the crystalline structure which converts the electrical properties of the material from superconductor to insulator. Insulating feature sizes of less than 2nm have been successfully demonstrated and many unique novel devices have been realized. Much of this success is due to the irradiation sensitivity of electrical transport in high temperature superconductors. This sensitivity results from loosely bound oxygen atoms (~1-8ev) in the crystal lattice that are easily displaced into interstitial or anti-site defects. I will describe details of the GFIS materials modification process and discuss new properties of nanoscale superconducting devices. In addition, I will highlight several applications in quantum sensing, and high frequency detection.

Bio: Professor Shane Cybart is the principal investigator of the Oxide Nano Electronics Laboratory at UC Riverside. He obtained a PhD in Materials Science from UC San Diego in 2005 studying high-transition temperature Josephson devices. He continued his work in superconductive electronics as a post-doctoral research at UC Berkeley from 2006-2009. From 2009-2016, he worked as a scientist at UC Berkeley and San Diego developing oxide electronic devices for a diverse range of applications. In June 2016 he joined the Bourns College of Engineering at University of California Riverside. He is currently an Associate Professor of Electrical Engineering and cooperating faculty in the Department of Physics and Materials Science Program. His group studies the basic science and applications of Josephson devices.

Organizers

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