MSE 520: SEMINAR SERIES

MATERIALS SCIENCE & ENGINEERING | AUTUMN 2016

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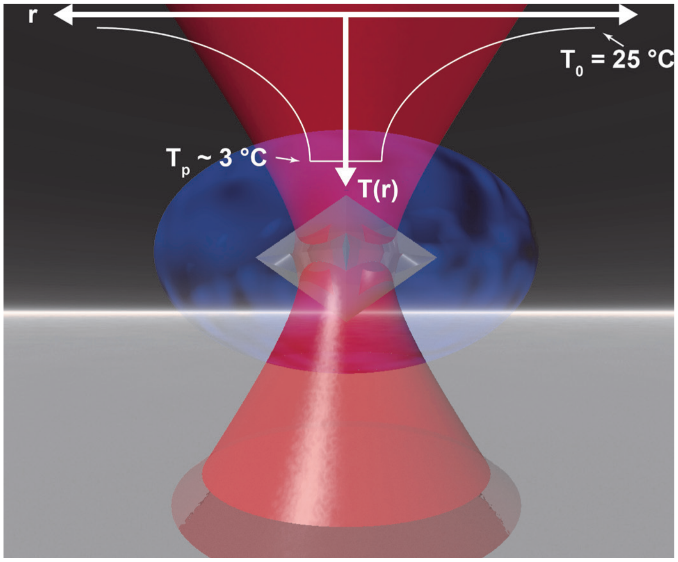
Engineering optoelectronic point defects in nanoscale ceramic materials



Designing point defects within nanoscale materials remains an active area for both basic and applied research. This seminar will present recent results with designing specific point defects in both 1) diamond nanocrystals (NV-, Si-V-) and 2) yttrium-lithium-fluoride nanocrystals (Yb3+, Er3+). In the first half of the seminar high-pressure, high-temperature processing in a laser-heated diamond anvil cell [PNAS (2011), v.108 p.8550] will be presented as a promising strategy for creating both the nitrogen-vacancy center and silicon di-vacancy center within nanocrystalline diamond materials. In the second half of the seminar recent results [PNAS (2015), v.112, p.15024] will be presented showing that it is possible to cool colloidal dispersions of yttrium-lithium-fluoride nanocrystals (YLiF4 or YLF) in liquid water based on anti-Stokes photoluminescence from Yb3+ point defects. Although solid-state laser-refrigeration materials have been developed in the last 10 years that are capable of cooling to cryogenic temperatures without mechanical vibrations, to date it has remained an open question whether solid-state laser refrigeration materials can also be used to refrigerate condensed phases such as liquid water. We use single-beam laser trapping experiments to show that the temperature of water surrounding individual YLF crystals decreases by nearly 20°C from room temperature based on interferometric measurements of a particle's Brownian motion, suggesting a range of potential applications for solid-state laser-refrigeration at nanometer length scales. For instance, these materials have enabled the first experimental demonstration of "Cold-Brownian-Motion" since Einstein's seminal work on Brownian motion published in 1905 and suggest the potential of using fluoride nanocrystals for applications in localized optoelectronic device cooling or physiological laser refrigeration.

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Peter Pauzauskie received BS degrees in chemical engineering, chemistry, and mathematics from Kansas State University in 2002 after pursuing undergraduate research in the chemistry laboratory of Prof. Ken Klabunde where he focused on understanding complex surface reactions between magnesium oxide nanocrystals and methyl iodide molecules. After being recognized with the Barry M. Goldwater Scholarship and the National Science Foundation's Graduate Research Fellowship he pursued a Ph.D. in physical chemistry with Prof. Peidong Yang at the University of California, Berkeley where his dissertation focused on the synthesis, characterization, and optoelectronic integration of inorganic nanowires. After graduating in 2007 he started a post-doc in the Chemical Sciences Division of the Lawrence Livermore National Laboratory as a DOE Lawrence Fellow under the direction of Dr. Joe H. Satcher, Jr. where he focused on novel diamond- and graphene-based carbon aerogel materials. Since 2010 Prof. Pauzauskie has served as an assistant professor in the Materials Science & Engineering at the University of Washington.

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