

# UNIVERSITY OF CALIFORNIA, IRVINE

## DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING

IS PROUD TO HOST A SEMINAR BY

### ***“GRAIN BOUNDARY ENGINEERING IN NANOCERAMICS”***



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**PROFESSOR & CHAIR  
DEPARTMENT OF MATERIALS SCIENCE  
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LEHIGH UNIVERSITY,**

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**2:00 PM - 3:20 PM**

**McDonnell Douglas Engineering Auditorium**



**Abstract:** Nanoscale materials differ from their bulk counterparts not only in size, but because a significant fraction of their atomic volume lies within interfacial regions. Consequently, many properties of nanomaterials arise from the complexities of atoms primarily located at surfaces or grain boundaries. In nanoceramics, this makes grain boundary characteristics critical for understanding and tailoring their properties. While there are various ways to analyze grain boundaries, a thermodynamic approach provides an inclusive measure that naturally accounts for physicochemical and mechanical stresses. In this presentation, we explore how grain boundary energies—measured via rigorous microcalorimetric experiments—can serve as a powerful design tool for enhancing the mechanical performance of nanoceramics. Using yttria-stabilized zirconia as a model system, we demonstrate how hardness and the inverse Hall–Petch behavior correlate directly with systematically increasing grain boundary energies for grain sizes below 30 nm. We further show that grain boundary energies can be deliberately modified by segregation-prone dopants to fine-tune mechanical properties. By introducing lanthanum or gadolinium ions, not only is the absolute grain boundary energy affected, but so too is the grain boundary distribution, leading to macroscopic improvements in toughness through crack-deflection mechanisms. These findings suggest that grain boundary engineering is indeed feasible in nanoceramics—albeit in ways that differ from conventional approaches.

**Bio:** Ricardo Castro is the Department Chair and Professor of the Department of Materials Science & Engineering at Lehigh University. Before this appointment, Castro was at the University of California-Davis for over 14 years, where he also was the Associate Dean of Research and Graduate Studies. Castro holds a Ph.D. in Metallurgical and Materials Engineering from the University of Sao Paulo, Brazil, and joined Lehigh earlier in 2023 when he founded the Lehigh Nanoceramics Thermochemistry Laboratory (LNTL). Castro is the author of over 130 peer-reviewed papers and is passionate about sintering and all interface related topics in ceramics. He is a Principal Editor of the Journal of Materials Research, and the Editor in Chief of the IJCES, a new open-access journal of the American Ceramic Society. Castro has been awarded several awards along his career the Robert L. Coble Award by the American Ceramic Society, the Global Young Investigator Award by the Engineering Ceramic Division in ACerS, and the Stig Sunner Award by the Calorimetry Conference. Outside work, Castor is father of two boys who often join him in his adventures imagining and discovering the 'impossible engineering' behind superheroes.

