UC San Diego
JACOBS SCHOOL OF ENGINEERING
Aiiso Yufeng Li Family Department of Chemical and Nano Engineering

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Distinguished Seminar

Wednesday, February 25, 2026
11:00am – 12:00pm PT
SME 248

Dr. Nicholas A. Kotov, PhD

"Complex Chiral Nanostructures"

Joseph B. and Florence V. Cejka Professor of Chemical Engineering
University of Michigan

Abstract: Chiral nanostructures represent a large and rapidly evolving class of biomimetic materials with high complexity. They may change the perception of chirality in chemistry, but they also offer previously impossible technological venues for information and biomedical technologies described in this talk. Studies from multiple groups indicated that the size, geometry, and composition of chiral nanostructures can be tuned to resonate with a wide range of photon energies from ultraviolet to terahertz [1,2]. Unlike organic, inorganic or biological molecules, chiral nanostructures display giant ellipticity [1,2] (Fig. 1a). Also, chiral nanostructures display a continuum of chiral states instead of the binary chirality of, for instance, L- or D-amino acids [1-3] due to the hierarchical organization with multiscale chirality that can be captured by graphs (Fig. 1b). Based on the current knowledge about chiral nanostructures, academically and technologically exciting research directions might be the following. First, self-assembly pathways of chiral nanoparticles are likely to be essential for understanding the complexity and functionality of biological matter [4] because nanoscale chirality enforces reproducible self-assembly patterns while affording the structural adaptability. Second, circularly polarized light emission (CPLE) has high data content. CPLE can also be very intense and highly elliptical as demonstrated by black body radiation from chiral nanostructures [5]. Evolving from biosensing with circular dichroism based on absorption, CPLE can boost the development of new biological sensors and perception systems based on emission. Third, chiral nanostructures can be engineered similarly to protein assemblies to selectively interact with biological counterparts of a similar scale. The strength and selectivity of their interactions can be varied by nanoparticle geometry, and surface ligands, with subsequent utilization in medicine [6], and perhaps, most importantly, the early detection of 'black swan' diseases [7].

Bio: Nicholas A. Kotov pioneered the development of complex biomimetic nanomaterials, represented by layered composites and chiral nanostructures. He demonstrated that geometrically asymmetric nanoparticles can self-assemble into superstructures with structural complexity that may exceed that of evolution-optimized biomaterials and organelles. The graph-theoretical (GT) representations of biomimetic composites and the giant ellipticity of chiral nanostructures are the focal points of his current work. Nicholas founded several start-ups that commercialized self- assembled nanocomposites and chiral superstructures for energy and healthcare technologies. Nicholas Kotov is a recipient of over 60 national and international awards, including the Centenary Prize from the Royal Society of Chemistry, the Chirality Medal from the Società Chimica Italiana, the Colloids and Surface Award from the American Chemical Society, and the Newton Award from the US Department of Defense. Nicholas Kotov is a Fellow of the National Academy of Engineering, the American Academy of Inventors, and the American Academy of Arts and Sciences.

Seminar Host: Jesse Jokerst