THE MATERIALS SCIENCE AND ENGINEERING DEPARTMENT
FALL COLLOQUIUM SERIES PRESENTS:

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Chirality and Complexity of Self-Assembled Nanostructures

Chiral nanostructures are a large and rapidly evolving class of biomimetic materials. Besides fascinating optical, catalytic, and biological properties, the studies of chiral nanostructures revealed something more. Micro- and macrostructures obtained by the self-assembly of chiral nanoparticles demonstrated emergence of complexity, that is spontaneous increase of structural sophistication seemingly prohibited by thermodynamics. These observations mirror the structural evolution of biological materials and particles that combine nano-, meso- and microscale chirality. Taking an example of hierarchically organized particles with twisted spikes and graph theoretical (GT) measures of complexity, we found that:

(a) complex structures does not require monodispersity;
(b) synthetic particles can have higher complexity than biological prototypes; and
(c) complexity emerges from competing chirality-dependent assembly restrictions.

The GT description can be expanded to include other nanoscale structures, such as complex porous particles and open superlattices, creating analogs of chemical formulas for particle systems.

The deciphering of chirality-complexity relations enabled the design of hierarchically organized bowtie-shaped particles with variable twist, size, and thickness and length. They represent the first example of chiral chemical structures with chirality continuum as opposed to chemical molecules with binary chirality, such as L- or D-amino acids. The implementation of the chirality-optimized bowtie-shaped nanostructured microparticles as covert IR tags for LIDARs will be shown. Voltage-modulated photonic devices based on IR-active chiral nanoparticles and conductive nanocomposites will also be discussed.

Nicholas A. Kotov is Irving Langmuir Distinguished University Professor in Chemical Sciences at the University of Michigan. He is pioneer of theoretical foundations and practical implementations of complex systems from ‘imperfect’ nanoparticles. Biomimetic nanocomposites, chiral nanostructures, and graph theoretical representations are the focal points in his current work. Nicholas is a recipient of more than 60 awards and recognitions. Together with his students, Nicholas founded several startups that commercialized self-assembled nanostructures for energy, healthcare and automotive industry. Nicholas is a Fellow of America Academy of Arts and Sciences and National Academy of Inventors. He is an advocate of scientists with disabilities.

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In person only; no Zoom
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