DISTINGUISHED LECTURE

MECHANICAL & MATERIALS ENGINEERING

Emergence of Complexity in Chiral Nanostructures

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WEDNESDAY, DECEMBER 8, 2021

2:30 p.m. | 110 Jorgensen Hall

Nicholas A. Kotov received his degrees from Moscow State University with his diploma and Ph.D. studies centered on bioinspired harvesting of solar energy. His postdoctoral studies at Syracuse University encompassed the synthesis and self-assembly of biomimetic nanocomposites.

After taking an Assistant Professor position at Oklahoma State University, he expanded the field of biomimetic processes and materials by establishing a vigorous research program on self-assembly of nanostructures.

Kotov is currently Irving Langmuir Distinguished University Professor of Chemical Sciences and Engineering at the University of Michigan. He heads the laboratory and international team of scientists working on practical implementations and theoretical foundations of biomimetic nanostructures. Self-assembly and optical properties of chiral nanoparticles and their superstructures represent a focal point for the continuum of bioinspired nanoscale materials with multidisciplinary significance to physics, chemistry, biology, and medicine.

He is a co-founder of five startups and a passionate advocate for scientists with disabilities.

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Co-sponsored by the Nebraska Center for Materials and Nanoscience

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Keywords: supraparticles, self-assembly, chirality transfer, graph theory, chiral photonics, biomimetic

The structural and functional complexity of biomimetic materials arises from the spontaneous hierarchical ordering of inorganic building blocks over multiple scales. Empirical observations of complex nanoassemblies are abundant, but physicochemical mechanisms leading to their geometrical complexity remain puzzling, especially for non-uniformly sized components. These mechanisms are discussed in this talk taking an example of hierarchically organized particles with twisted spikes and other morphologies from polydisperse Au-Cys nanoplatelets [1]. The complexity of these supraparticles is higher than biological counterparts or other complex particles as enumerated by graph theory (GT). Complexity Index (CI) and other GT parameters are applied to a variety of different nanoscale materials to assess their structural organization. As the result of this analysis, we determined that intricate organization Au-Cys supraparticles emerges from competing chirality-dependent assembly restrictions that render assembly pathways primarily dependent on nanoparticle symmetry rather than size. These findings open a pathway to a large family of colloids with complex architectures and unusual chiroptical and chemical properties. The design principles elaborated for nanoplatelets have been extended to engineering of other complex nanoassemblies. They include polarization-based drug discovery platforms for Alzheimer syndrome,[3] materials for chiral photonics,[5] biomimetic composites for energy and robotics [2,4], CO2-dispersable catalysis[6] and chiral antiviral vaccines.[7] Yet, the work on the generalization of the engineering principles for chiral biomimetic nanostructures is incomplete; further directions of these efforts will be discussed.

References

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