Architecture of Multifunctional Nanostructures

Abstract: We have recently recognized that innovative fabrication of nanocrystal architectures that contain more than one type of functional nanoscale components can create a new class of advanced multifunctional materials. In particular, folding atomically-layered 2D-materials can facilitate scalable assembly of programmable multifunctional nanostructures. Mechanical principles of folding 2D surfaces or structures are the main subjects of ruga mechanics. The multiscale-assembly strategy of using ruga mechanics of 2D-materials relies on physical chemistry and mechanics of self-organization in three levels. Those are synthesis and characterization of nanocrystals, density functional theory of quantum-flexoelectric crinkles in 2D-materials, and variational analysis of interactions among the nanocrystals and the crinkles. The test material system is a hybrid architecture of gold nanocrystals and CdSe-CdS core-shell quantum dots for plasmon-exciton coupling, aligned by crinkles in multilayer graphene and or hexagonal boron nitride. This interdisciplinary effort offers some new insights into the mechanics and physics of materials at the nanoscale and methods of creating novel multifunctional materials. This new fundamental knowledge elucidates the distinct roles of nano- and micro-mechanics of materials in developing novel advanced materials.

Bio: Kyung-Suk Kim has 39 years of experience as an engineering scientist and is currently a Professor of Engineering at Brown University. He received his Ph.D. in Solid Mechanics from Brown University. He taught at TAM Department, University of Illinois, Urbana-Champaign for 9 years until he joined Brown. His research interests are in scale-bridging mechanics and nano- & micro-mechanics of solids. For his research, he has invented numerous new scientific instruments, including various interferometers and analytical. His research on “New Math for Designer Wrinkles” was selected as one of the Top 100 Science Stories, in Discover.