"Structuring Matter Over Multiple Length Scales Using the Self-assembly of Colloidal Particles"

Wednesday
April 10, 2019
4:00 pm
David Rittenhouse Laboratory
Room A8

Marjolein Dijkstra
Professor of Science and Physics
Utrecht University

Abstract

In 1960, Feynman challenged us to think "from the bottom up" and to create new functional materials by directing and manipulating the arrangements of individual atoms ourselves. With recent advances in the colloidal nanoparticles synthesis and the bottom-up fabrication of nanostructured materials using colloidal self-assembly, we are tantalizingly close to realizing this dream. In this talk, I will show, using computer simulations, how one can use hierarchical self-assembly to structure matter over multiple length scales, which enables an unprecedented control over the properties and functionalities of these nanomaterials. The ability of atomic, colloidal, and nanoparticles to self-organize into highly ordered crystalline structures makes the prediction of crystal structures in these systems an important challenge for science. The question itself is deceivingly simple: assuming that the underlying interaction between constituent particles is known, which crystal structures are stable? I will describe a Monte Carlo simulation method, combined with a triangular tesselation method, to describe the surface of arbitrarily shaped particles that can be employed to predict close-packed crystal structures in colloidal hard-particle systems. I will show that particle shape alone can give rise to a wide variety of structures with unusual properties, e.g., photonic band gap structures or highly diffusive crystals, but combining the choice of particle shape with external fields, like confinement, can enlarge the number of possible structures even more. I will also discuss how one can reverse-engineer target structures like specific crystal structure and twist-bend and splay-bend nematic phases by tuning the particle shape and interactions. Finally, I will show that the self-assembly kinetics also plays a major role in the prediction and design of new structures.

Bio

Marjolein Dijkstra studied chemical engineering at Wageningen University and physics at Utrecht University. She received her Ph.D. degree at FOM-Institute AMOLF under the supervision of Daan Frenkel. She received an EU Marie Curie individual fellowship to work with Jean-Pierre Hansen in Lyon and Paul Madden in Oxford, as well as an EU Marie Curie individual fellowship with Bob Evans in Bristol. She was a research associate at Shell Research in Amsterdam in 1995. She started as an assistant professor in 1999 at Utrecht University and was appointed as full professor in 2007. Her research focuses on theory and computer simulations of soft condensed matter systems to study physical phenomena like phase transitions, glass and jamming transitions, gelation, and nucleation in bulk systems and systems subjected to external fields.

CBE and Physics Joint Seminar

Penn Engineering