Colloids under external electric and magnetic fields

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Abstract

The multiscale self-assembly of atoms, molecules, and particles is the origin of all physical mesoscopic matter. The spatial organization, symmetry, and physical properties of the assembled structures are determined by thermodynamic characteristics of their building blocks. Colloidal particles are emerging as models for understanding governing principles of directed-assembly and non-equilibrium response of advanced materials. Here, I will present the concept of using external field driven interactions to direct the assembly and spatial migration of colloids. First, I will present the principle of using magnetostatic interactions to direct surface patterning using sessile drop drying. In droplets of magnetite nanoparticles, magnetic establish a microconvection from droplet edge to center. This magnetostatic convection is used to assemble secondary nonmagnetic particles in droplets, allowing for the assembly of four distinct kinetically stable states, and enabling a new route for surface patterning. Second, I will introduce the concept of directing spatial motion and non-equilibrium behavior of metal-dielectric patchy colloids using external electric field. The electric field drives a local force imbalance around the particle, resulting into its direction motion. I will demonstrate that the particle's velocity, chirality, and its 3D trajectory can be programed by engineering the patchy particle/cluster size and shape. I will show that the coupling of translation and rotational component of the energy enables programming helical motion in spherical colloids, and

provides an alternative mode of navigating through complex cross-linked matrices. This approach introduces a new method of engineering the assembly and self-propulsion of microparticles, which could lead to the development of advanced micro-motors and miniature robots capable of navigating through complex biological environments.

Bio

Bhuvnesh Bharti is an Assistant Professor in the Cain Department of Chemical Engineering at Louisiana State University. He received his B.S. (Hons.) in 2007 and M.S. (Hons.) in 2009 from Panjab University Chandigarh, India, and his Ph.D. in 2012 at Technische Universität Berlin, Germany. He did his postdoctoral work at North Carolina State University (2012-2016) and Shinshu University, Japan (2014). Dr. Bharti's current research interests include directed and self-assembly of colloids, transport of active matter through crowded environments, and development of biocompatible materials for 3D printing.