MAR13-2012-020620
Abstract for an Invited Paper
for the MAR13 Meeting of
the American Physical Society

Spontaneous Motion in Hierarchically Assembled Active Cellular Materials

DANIEL CHEN, Brandeis University Department of Physics

With exquisite precision and reproducibility, cells orchestrate the cooperative action of thousands of nanometer-sized molecular motors to carry out mechanical tasks at much larger length scales, such as cell motility, division and replication. Besides their biological importance, such inherently far-from-equilibrium processes are an inspiration for the development of soft materials with highly sought after biomimetic properties such as autonomous motility and self-healing. I will describe our exploration of such a class of biologically inspired soft active materials. Starting from extensile bundles comprised of microtubules and kinesin, we hierarchically assemble active analogs of polymeric gels, liquid crystals and emulsions. At high enough concentration, microtubule bundles form an active gel network capable of generating internally driven chaotic flows that enhance transport and fluid mixing. When confined to emulsion droplets, these 3D networks buckle onto the water-oil interface forming a dense thin film of bundles exhibiting cascades of collective buckling, fracture, and self-healing driven by internally generated stresses from the kinesin clusters. When compressed against surfaces, this active nematic cortex exerts traction stresses that propel the locomotion of the droplet. Taken together, these observations exemplify how assemblies of animate microscopic objects exhibit collective biomimetic properties that are fundamentally distinct from those found in materials assembled from inanimate building blocks. These assemblies, in turn, enable the generation of a new class of materials that exhibit macroscale flow phenomena emerging from nanoscale components.