Polymer mediated assembly of fullerenes into non-closed packed two-dimensional arrays

Shani Eliyahu and Rachel Yerushalmi – Rozen

Department of Chemical Engineering and the Ilze Kats Institute for Nanoscale Science and Technology, Ben-Gurion University of the Negev, Beer-Sheva, Israel

Non-closed-packed morphologies, such as networks of polygonal cells or alternating stripes patterns may be favorable for a variety of applications. However, most of the thermodynamic stable morphologies of spherical nanoparticles that are confined into a plain are of a close-packed array. By addition of non-adsorbing amphiphilic tri-block copolymers to dispersions of colloids and nanoparticles one can tune the inter-particle potential and the resulting phase diagrams. Here we show that a three component system comprising of a fullerene derivative, a non-adsorbing amphiphilic block copolymer and a common solvent spread at the solution-air interface evolves via evaporation of the solvent into oriented micron long filaments, co-aligned micron-sized stripes, and multi-scale networks of polygonal cells. The observed morphologies are determined by strength and range of the depletion interaction induced by the polymer and the kinetics of the combined system. The latter is found to be sensitive to the concentration of a polymer dissolved in the subphase, offering an additional parameter for morphological control. Though the formed patterns represent metastable states, the observed morphologies are reproducible, tunable, and may be trapped and transferred onto different substrates with a high degree of fidelity.