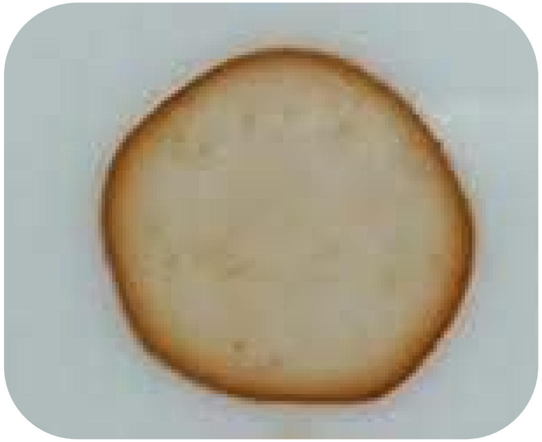
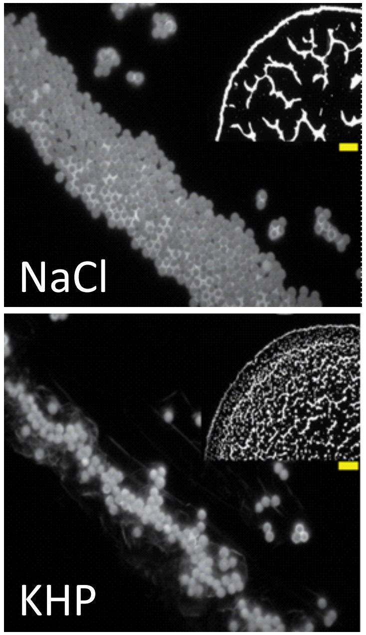
Controlling the 'coffee ring effect' to design coatings, cosmetics, and spray drying

Penn State MRSEC DMR-1420620: Darrell Velegol, Raj Guha, Farzad Mohajerani, Ayusman Sen





Coffee rings form during the evaporation of colloidal suspensions. In spray painting, inkjet printing, and thin-film deposition the rings are problematic, while in nanostructured self-assembly and lithographic patterning, modulation of the ring pattern would be beneficial. But current methods have limited control over coffee ring patterns. MRSEC researchers have achieved spatial control of particle distributions in evaporating droplets by adding millimolar concentrations of salts. As water evaporates from the droplet, the ion concentration increases fastest near the peripheral contact line. The resulting radial salt gradient produces an electric field that transports particles and fluid. The relative diffusivity of the cation and anion controls whether particles are deposited in an intense circular band, a broken circular band, or dispersed throughout the evaporating droplet: a **coffee ring number** dictates the patterning. This work extends to colloidal motors that take advantage of gradients of *fuel* within the droplet arising from the same differential evaporation.