Stimuli-Responsive Spiky Tendril Particles

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Particle stability in a broad array of fluid environments is critical for the application of colloids in catalysis, sensing, and composites. Hedgehog particles (HPs) inspired by the spiky geometry of pollen grains enable excellent dispersion stability regardless of whether their polarity matches that of the solvent or not. For a stimuli-responsive material, the presence of a tunable spiky shell allows for control of stabilization in a rapid manner. In order to create a flexible polymer-based HP or Tendril particle (TP), polyallylamine films were crosslinked with glutaraldehyde. Hollow, flexible polymer spikes with controlled zinc oxide content are formed which can be loaded with small molecules and nanoparticles. TPs contain a flexible shell but retain remarkable dispersion properties including in heptane and high ionic strength media. Additionally, by adding Poly(N-isopropylacrylamide-co-acrylic acid) (PAA-NIPAM) subunits, controlled film formation is observed in response to high temperature. TPs have been applied to plugging condenser in-leakage, where contaminants in cooling water pollute the condensate system resulting in electric losses, and plant shutdowns. The combination of oppositely charged TPs show over a 500 times reduction in the leak rate over a 72 hour time period in a model condenser pipe. Reinforcement of the film with multiple crosslinking sites and targeting using temperature responsive subunits is ongoing. Additionally, tendril particles represent an ability to disperse and incorporate various functional nanoparticles for plasmonic, chiral, and viscoelastic composites.