Goblins, Brimstone and CHIPs: Unconventional Polymers for Energy, Defense and Sustainability

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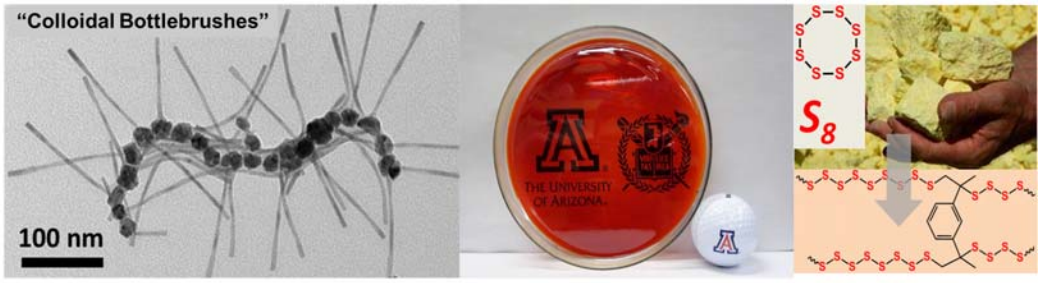
We will present our recent efforts in the polymerization of unconventional monomers to prepare novel polymeric and nanocomposite materials. We will discuss the polymerization of a novel class of polymer-nanoparticle hybrid materials on dipolar cobalt nanoparticles, which were used as "colloidal monomers" in a process termed Colloidal Polymerization. From this process, we have been able to synthesize electroactive cobalt oxide nanowires and heterostructured nanocomposites with either noble metal, or semiconductor inclusions. We will also present our recent work on novel sulfur utilization chemistry for polymeric materials. Elemental sulfur is manufactured at a level of 70 million tons every year, which is primarily produced via hydrodesulfurization of crude petroleum. These types of polymeric materials exhibit very high charge capacity again Li-insertion and have tremendous potential as inexpensive, high performance cathodes for Li-S batteries. Furthermore, these sulfur-rich copolymers exhibit unusually high refractive indices (n = 2.0) and can be easily processed in thin films, or molded objects.



Review papers on colloidal polymers and self-assembling nanoparticles:

"Colloidal Polymers from Inorganic Nanoparticle Monomers," Hill, L; Pinna, N.; Char, K.H.; Pyun, J. *Prog. Polym. Sci.* **2015**, *40*, 85-120.

"Colloidal Polymers via Dipolar Assembly of Magnetic Nanoparticle Monomers," Hill, L.J.; Pyun, J. *ACS Applied Interfaces* **2014**, *6*, 6022-6032.

Review papers on sulfur chemistry and polymers:

"Polymerizations with Elemental Sulfur: A Novel Route to High Sulfur Content Polymers for Sustainability, Energy and Defense," Griebel, J.J.; Glass, R.S.; Char, K.; Pyun, J. *Prog. Polym. Sci.* **2016**, *58*, 90-125.

"Recent Synthetic and Processing Approaches for the Direct Use of Elemental Sulfur for Advanced Materials," Lee, J.; Pyun, J.; Char, K. *Angew. Chem. Int. Ed.* **2015**, *54*, 3249-3258.