CENTER FOR NANOSCALE MATERIALS (NSF CREST HRD-1137751)

Clark Atlanta University, Atlanta, Georgia

The Center for Functional Nanoscale Materials seeks to address the dual goals of increasing the capacity of Clark Atlanta University to train talented minority scientists in the area of the physical sciences and of advancing human understanding of nanoscale materials science.

Metal Organic Frameworks for Radiation Detection

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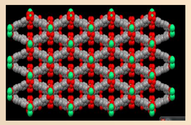
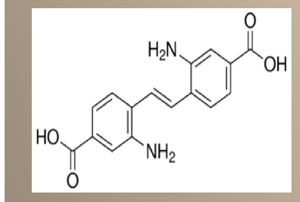
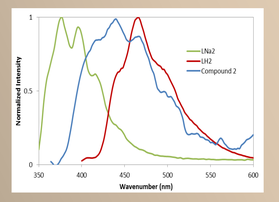


Metal organic frameworks (MOF's) form a special class of porous coordination polymeric materials that are of great significance and of rapidly growing interest due to their promising applications in many areas. Their assembly involves strong coordination of metal ions or metal clusters to organic linkers to produce extended 0D, 1D, 2D or 3D structures.

We have recently synthesized several 3D MOFs, containing large pores. For example, we synthesized a new 3D-luminescent MOF containing the photo-emissive ligand linker, 4,4'-trans-stilbene dicarboxylic acid and a lanthanide metal ion. The structure contains extremely large pores of dimensions 30.7 Å x 14.1 Å and with solvent accessible volume occupying 60-70% percent of the structure (Figure above). The structure has a strongly red shifted ligand-based luminescence emission upon excitation at 341 nm. We anticipate that its open structure will be capable of adsorbing and concentrating targeted analytes.





Summer Nanoscholars Programs

Partners: National Science Foundation
American Chemical Society
Army Research Office

The CFNM Summer Nanoscholars Program is a summer research experience for area high school students and regional undergraduates. The Center partners with the National Science Foundation, the American Chemical Society and the Army Research Office to provide an enriching summer experience. The student participants work in the Center's laboratories on personalized research projects under the direction of a senior scientist and a graduate student mentor. In addition to a immersive laboratory experience the student participate in such enhancement activities as problem-based learning workshops and entrepreneurship and preparing for success workshops.

Self-Assembly of Hairy Nanoparticles

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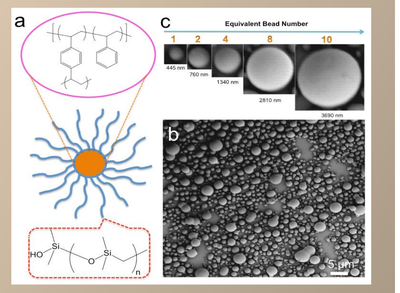
The overall goal is to develop novel thermoplastic elastomers (TPE). We have found that hairy nanoparticles with polystyrene (PS) cores and polydimethylsiloxane (PDMS) shells are an extremely interesting class of TPEs. We employed the living anionic polymerization technique to prepare microphase separated hairy nanoparticles (*m*HNPs) with polystyrene cores and polydimethylsiloxane shells (Fig. a).

The mHNPs self-assemble into multiple-sized spherical morphology (Fig. b) with the diameters ranging from 445 nm to 3690 nm. Remarkably, two small HNPs (ca. 445 nm in diameter) were able to connect and fuse together to form a larger particle (ca. 760 nm in diameter) (Fig. c).



Similarly, the larger particles can combine with other particles to further form a much larger particles (ca. 1340 nm in diameter), and so on. The largest particle (ca. 3690 nm in diameter) is equivalent to fusing together of 10 of the smallest particles. This type of hairy nanoparticles is ables to self-assemble into three different higher ordered structures obtained by imaging an air-dried sample formed by drop-casting a THF solution of the sample with 72 mol.% of PDMS on a silicon wafer plate. The dried sample had a gradient concentration of HNPs ranging from nearly single to many layer thicknesses. THF has a Hansen solubility parameter (δ_{THF} ~ 18.6 (J $cm^{-3})^{1/2}$), except for a high vapor pressure at room temperature.

Nanosheets of Metal-Organic Complexes Grown Out of Hydrogels

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There are two main approches to the formation of nanosheets: top-down or bottom up. The bottom-up approach tends to yield smaller 2D structures that are ideal for biological applications. Metal complexes containing organic ligands, in particular 2,2' -dicarboxylic acid-4,4'-bipyridine, yield coordination polymers (CP). Here we describe a novel method which invovles a hydrogel matrix in which nanosheets are generated on the surface of biocomaptable hydrogels such as pHEMA.

These nanosheets have a unique size of 11 μm (length) and a rhombus-like geometry. The formation of nanosheets via this method is highly modifiable. SEM images show pores on the surface of pHEMA hydrogel prior to the formation of nanosheets (Figure on left), and nanosheet formation on surfaces of the pHEMA hydrogel (top Figure). XRD (second Figure) demonstrate the high crystallinity of nanosheets compared to pHEMA which is obviously amorphous as evident with a broad XRD peak