Abstract

The structural dynamics of thin films of surfactant molecules can be characterized by their behavior in a Langmuir trough, where the molecules reside at the air-water interface. Parameters such as molecular order, film density, and surface pressure are easily addressed, and multilayer superstructures can be fabricated using this classic surface science strategy. Less common is the use of a Langmuir trough for the fabrication of organized two-dimensional arrays of alkanethiol-capped gold nanoparticles. Here, hydrophobic nanoparticles are introduced to the air-water interface as a solution in hexanes; as the solvent evaporates, the floating nanoparticles can be compressed into a monolayer within the Langmuir trough. Preliminary studies will explore the relationship between film morphology and the length of the hydrocarbon chain, as well as changes in surface pressure as a function of aqueous subphase temperature. The assembled films will be transferred to a solid substrate for direct structural analysis via electron microscopy. Future studies will address biphasic, regioselective ligand exchange reactions and the development of these systems as a new phase transfer catalyst.

Langmuir Films

- Classically, composed of a single layer of surfactant molecules.
- Surfactant is delivered as an immiscible solution to the surface of a liquid.
- Langmuir trough barriers compress molecules into a film having high structural order.

Langmuir Trough

- Compresses molecules into monolayers and measures surface pressure. We propose to use hydrophobic gold nanoparticles in the place of surfactants to make highly ordered 2-D arrays of nanomaterials.

Nanoparticle Synthesis

- Nanoparticle size is dependent upon the thiol : gold ratio.
- Because a phase transfer catalyst is used, nanoparticles must undergo thorough purification before use in Langmuir trough.

Au Nanoparticle Deposition

- Analysis of Au nanoparticle deposition onto TEM grids shows both close packed and spacious “foam” arrangements. Consistency of film morphology can be improved by isometric compression of the barriers to maintain surface pressure during deposition.

Future applications

- Dithiol linkers lock nanoparticles in a more rigid arrangement that is held together by covalent bonds rather than Van der Waals interactions alone. This prevents diffusion of particles into nonpolar solvents and allows the particles to sit at the polar/nonpolar liquid interface. From there, we have the power to selectively manipulate the surface chemistry of the nanoparticles on either side, generating Janus particles.

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