Organization of Natural Molecular Machines in Soft Nanostructures

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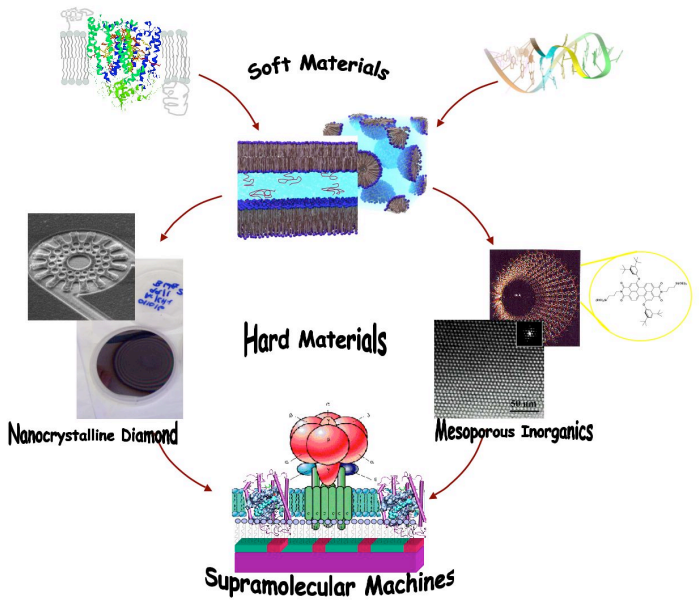
Motivation

Nature has evolved molecular machines (e.g., proteins, DNA) that create and sustain life. Duplicating the sophistication of these nanoscale devices would represent an enormous leap in current synthetic capabilities. One promising approach towards harnessing the functioning of biomolecules is to extract them from nature and to integrate them with synthetic materials.



ANL's Approach to Harnessing Nature's Work

The goal of this project is to design and synthesize nanostructured biocomposites that exploit the ability of biomolecules to store and transduce energy as the basis of supramolecular machines.

- The CNM will offer facilities to enable the merger of "bottom-up" (self-assembly) and "top-down" (lithographic) approaches to the fabrication of nanostructured materials.
- World-class instrumentation uniquely available at APS and IPNS enables the characterization of these complex systems.

Scientific Challenges:

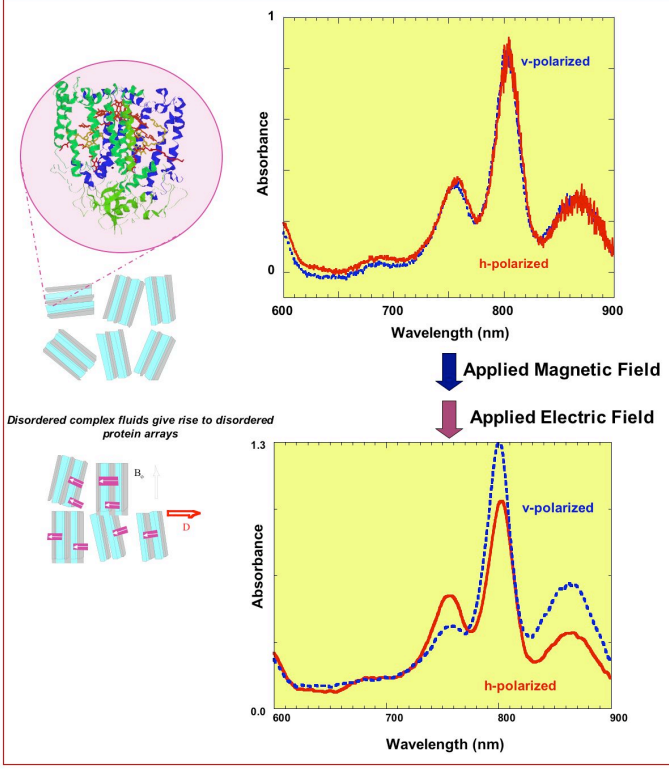
- Formation of functional arrays of soluble and membrane proteins
- Integration of soft and hard materials
- Sequential coupling of processes to create functional components and supramolecular machines

Scientific Achievement

- Soft materials that encapsulate both aqueous-soluble and membrane proteins have been synthesized.
- Post-self-assembly processing using magnetic and electric fields can yield ordered arrays of proteins.
- Small Angle X-ray scattering is used to determine field-induced ordering of the complex fluids
- LD spectroscopy can be used to *in-situ* monitor the field-induced alignment of the encapsulated proteins.

Future Work

- Use fluorescence and second-order nonlinear optical spectroscopy to evaluate the anisotropic ordering of the proteins
- Develop synthetic approaches to couple proteins to biocompatible, nanostructured diamond electrodes and to mesoporous inorganic frameworks.
- Attainment of these milestones lays the foundation for coupling soft/natural systems with hard/artificial materials and ultimately, will allow for the development of next-generation nanoscale functional devices.



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