Bio-Enabled Materials

Certain living organisms are remarkably adept at generating materials in complex, three-dimensional (3-D) patterns with a variety and fidelity that have yet to be matched by man-made processes. For example, diatoms (a type of aquatic algae) generate microscopic glass shells, decorated with patterned nanoscale features (pores, channels, protuberances), in thousands of intricate, species-specific 3-D morphologies. Certain species of brittle stars (related to starfish) generate aberration-free calcitic microlenses that allow these organisms to detect light. The Venus’ flower basket (a type of sponge) forms silica-based fibers that act as optical waveguides. The wings of *Morpho* butterflies contain scales with micro-to-nanoscale periodic patterns designed to reflect particular wavelengths of light (for so-called “structural” color). Unlike many man-made processes conducted with harsh, hazardous chemicals or high temperatures, such biologically-formed materials are generated under gentle, ambient conditions through genetically-controlled (reproducible) cellular processes involving specialized biomolecules.

The structural sophistication and diversity of biogenic structures, coupled with the low-energy, sustainable, and often massively-parallel approaches utilized by structure-forming organisms, have inspired materials researchers to explore the adaptation of biological strategies for the syntheses of advanced functional materials. Because synthetic processes provide a palette of non-naturally-occurring inorganic materials with a greater range of chemistries than are found in biogenic structures, the integration of biological fabrication approaches with synthetic chemistries can lead to unique material assemblies with attractive properties designed for man-made applications.

A wide range of cross-cutting bio-enabled materials research efforts affecting the grand challenge topical areas of Energy, Sustainability, Security, Health, and Computing and Electronics are underway at Georgia Tech, a few examples of which include:

- chemical conversion of diatom glass microshells into porous functional materials for use in sensors, water purification, or fuel cells (see figure on previous page)
- chemical tailoring of cellulose-based materials for bio-degradable packaging or solar cell substrates
- incorporation of biomolecules into electronic devices for selective and sensitive detection of chemical or biological agents
- development of bio-inspired/bio-enabled optical materials for anti-counterfeiting, defense, and display applications

http://www.gems.gatech.edu/

www.mse.gatech.edu/research/research-areas-by-type/biologically-enabled-and-bioinspired-materials