Thursday, September 26, 2002

Princeton to help new engineering effort based on 'bioinspriation'

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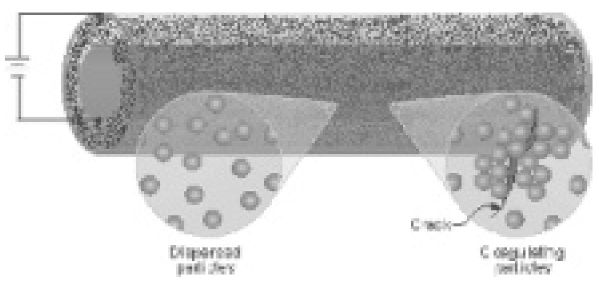

Courtesy of IBIM

The new institute will study biomimetics -- the unique properties of biological materials -- and try to recreate those properties in synthetic materials.

In an effort that may make today's science fiction tomorrow's reality, NASA has asked Princeton and other universities to investigate how to make materials more like living things. The new Institute for Biologically Inspired Materials, led by University professor Ilhan Aksay, was inaugurated yesterday at its first planning workshop.

IBIM's 30-some professors from five schools will be studying biomimetics — the unique properties of biological materials — and trying to recreate those properties in synthetic materials.

Bone, for instance, heals itself — something no man-made material can do.

Airplane wings use hydraulics to raise and lower the flaps that help control the airplane, yet birds do not need such heavy equipment.

"Next generation spacecrafts should mimic the functions of birds or biological systems better than what the present airplanes do," Aksay said.

Living cells are adept at creating polymer-ceramic composites, such as bone tissue, which are not easily created synthetically, University professor Jeffrey Carbeck said. A man-made material that is both flexible and strong — like bone — would be very desirable for aerospace engineering.

Carbeck said he has focused much of his recent research on chemical biology. For example, he found that fibroblast cells become active in healing damaged tissue in response to particular formations of deposited protein. The cells then pull the wound closed and secrete collagen.

It is natural structures and processes like these that Aksay said he hopes will inspire his team — as he calls it, "bioinspiration."

Materials may one day be able to "respond in an active way by sealing cracks before they become catastrophic," Carbeck said.

Aksay said that a weak electrohydrodynamic flow around a damaged material can attract particles to a hole. The particles can plug the hole in the same way blood cells form a clot.

Another application of biomimetics, Carbeck said, is creating materials that respond dynamically to forces applied to them. Bones naturally detect stresses and become stronger in the most stressed regions. A man-made material that can respond this way, Carbeck said, is not only theoretically possible but perhaps not as complex as most researchers believe.

Bones are also multifunctional. In addition to providing strength, they store energy and contribute to the immune system. Ideally, Carbeck said, NASA wants materials like bones — structural, light weight and self healing.

Carbeck said that as with materials research in the past, IBIM research will likely involve undergraduate seniors because many aspects of this new frontier have not been widely explored and can prove unpredictable. Many avenues will prove fruitless, Carbeck said, making some projects unsuitable for a graduate student's fouror five-year commitment to a plan.

Carbeck added that undergraduate seniors often have the interdisciplinary interests necessary for biomimetic materials research.

Aksay said the beginnings of IBIM were in a seminar he gave to NASA's Langley Research Center more than two years ago on biomimetics. Langley's researchers became excited about biomimetic materials' prospects and then formed blueprints of next generation space structures incorporating the yet-unfound results of biomimetic research. Aksay called it "Jules Verne type thinking." That convinced NASA to provide Langley with funding for the research.

Roughly two dozen teams of universities competed for the opportunity to work with Langley.

"Our team has a proven track record," Aksay said.

The winning team includes Princeton, which Aksay said is now one of the leaders in the materials research world, the University of North Carolina at Chapel Hill, Northwestern University and the University of California at Santa Barbara.

Aksay said each university brings a different specialty. UCSB focus will be on the molecular biology side, "functions of the biological systems." Princeton's contribution will be in the engineering of nanocomposites, he said.

IBIM will also work with North Carolina Agricultural and Technical State University on an education and training program.

Carbeck said as early as in the next few years IBIM could find ways to create materials with some form of these biologically inspired properties. But self-healing and self-adapting materials are still a ways off, he said.

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