The future of manmade materials

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(PhysOrg.com) -- There's nothing ordinary about the materials being designed in the Stupp Laboratory at Northwestern University. Many of the futuristic fibers, films, gels, coatings and putty-like substances have led to important advances in areas of research such as regenerative medicine and energy technologies.

These advances are part of an emerging field focused on using functional supramolecular polymers to unlock previously unknown functions of materials. A review article to be published in the Feb. 16 issue of the journal *Science* details this field and highlights some of the key developments made in the past decade.

“This field shows great promise for designing new materials, including highly sustainable forms of materials and highly bioactive materials, for medicine, renewable energy and sustainability,” said Northwestern’s Samuel I. Stupp, the corresponding author of the review article.

Stupp is the Board of Trustees Professor of Materials Science and Engineering, Chemistry, and Medicine at Northwestern. The other two co-authors of the article are Takuzo Aida of the University of Tokyo and E.W. Meijer of Eindhoven University of Technology. These three researchers -- on three different continents -- are the pioneers in the functional supramolecular polymers field.

Some recent discoveries from Stupp’s lab include a novel nanostructure that promotes the growth of new blood vessels, an injectable gel that promotes the growth of new cartilage and gel "strings" of aligned supramolecular polymers that could be surgically placed to repair tissues such as the heart and the brain.

“Over the past decade my lab has demonstrated some of the most bioactive materials that have ever been reported by making supermolecular polymers and giving them structures that can signal cells,” Stupp said. “They have produced very highly bioactive materials for regenerative medicine.”

Polymers currently used in everyday technologies are made of very large molecules called macromolecules, which are made up of small units connected by covalent bonds. Supramolecular polymers consist of molecules connected by weaker, non-covalent bonds.

Because of their weaker bonds, researchers can create supramolecular polymers with unique combinations of order and flexibility, which allow their building blocks to interact dynamically with their environments. This could allow the spontaneous repair of defects, easy recycling of materials, signaling to cells on their complex surfaces and optimal charge transport for electronics.

The future of functional supramolecular polymers will include exploring hybrid materials with covalent polymers and or inorganic structures, the authors write. The field could also transition into 2-D and even 3-D complex systems to craft novel materials of interest in sustainability, electronics and health.

More information: "Functional Supramolecular Polymers," by T. Aida et al., *Science*, 2012.

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