Materials inspired by Mother Nature: A 1-pound boat that could float 1,000 pounds

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Combining the secrets that enable water striders to walk on water and give wood its lightness and great strength has yielded an amazing new material so buoyant that, in everyday terms, a boat made from 1 pound of the substance could carry five kitchen refrigerators, about 1,000 pounds.

One of the lightest solid substances in the world, which is also sustainable, it was among the topics of a symposium here today at the 243rd National Meeting & Exposition of the American Chemical Society, the world's largest scientific society. The symposium focused on an emerging field called biomimetics, in which scientists literally take inspiration from Mother Nature, probing and adapting biological systems in plants and animals for use in medicine, industry and other fields.

Olli Ikkala, Ph.D., described the new buoyant material, engineered to mimic the water strider's long, thin feet and made from an "aerogel" composed of the tiny nano-fibrils from the cellulose in plants. Aerogels are so light that some of them are denoted as "solid smoke." The nanocellulose aerogels also have remarkable mechanical properties and are flexible.

"These materials have really spectacular properties that could be used in practical ways," said Ikkala. He is with Helsinki University of Technology in Espoo, Finland. Potential applications range from cleaning up oil spills to helping create such products as sensors for detecting environmental pollution, miniaturized military robots, and even

children's toys and super-buoyant beach floats.

Ikkala's presentation was among almost two dozen reports in the symposium titled, "Cellulose-Based Biomimetic and Biomedical Materials," that focused on the use of specially processed cellulose in the design and engineering of materials modeled after biological systems. Cellulose consists of long chains of the sugar glucose linked together into a polymer, a natural plastic–like material. Cellulose gives wood its remarkable strength and is the main component of plant stems, leaves and roots. Traditionally, cellulose's main commercial uses have been in producing paper and textiles — cotton being a pure form of cellulose. But development of a highly processed form of cellulose, termed nanocellulose, has expanded those applications and sparked intense scientific research. Nanocellulose consists of the fibrils of nanoscale diameters so small that 50,000 would fit across the width of the period at the end of this sentence.

"We are in the middle of a Golden Age, in which a clearer understanding of the forms and functions of cellulose architectures in biological systems is promoting the evolution of advanced materials," said Harry Brumer, Ph.D., of Michael Smith Laboratories, University of British Columbia, Vancouver. He was a co-organizer of the symposium with J. Vincent Edwards, Ph.D., a research chemist with the Agricultural Research Service, U.S. Department of Agriculture in New Orleans, Louisiana. "This session on cellulose-based biomimetic and biomedical materials is really very timely due to the sustained and growing interest in the use of cellulose, particularly nanoscale cellulose, in biomaterials."

Ikkala pointed out that cellulose is the most abundant polymer on Earth, a renewable and sustainable raw material that could be used in many new ways. In addition, nanocellulose promises advanced structural materials similar to metals, such as high-tech spun fibers and films.

"It can be of great potential value in helping the world shift to materials that do not require petroleum for manufacture," Ikkala explained. "The use of wood-based cellulose does not influence the food supply or prices, like corn or other crops. We are really delighted to see how cellulose is moving beyond traditional applications, such as paper and textiles, and finding new high-tech applications."

One application was in Ikkala's so-called "nanocellulose carriers" that have such great buoyance. In developing the new material, Ikkala's team turned nanocellulose into an aerogel. Aerogels can be made from a variety of materials, even the silica in beach sand, and some are only a few times denser than air itself. By one estimate, if Michelangelo's famous statue *David* were made out of an aerogel rather than marble, it would be less than 5 pounds.

The team incorporated into the nanocellulose aerogel features that enable the water strider to walk on water. The material is not only highly buoyant, but is capable of absorbing huge amounts of oil, opening the way for potential use in cleaning up oil spills. The material would float on the surface, absorbing the oil without sinking. Clean-up workers, then, could retrieve it and recover the oil.

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