Building custom materials using nature's prized secrets

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The tip of a squid's beak is harder than most metals but the end closest to the animal's mouth is a fleshy 100 times softer.

So light yet so strong, a strand of spider web as thick as a pencil could stop a Boeing 747 midflight.

The lining of an oyster shell is layers of brittle calcium carbonate - the stuff of limestone - and layers of a flexible glue-like protein. The result is a mother of pearl nacre 3,000 times tougher than the limestone material itself.

So different in function, the materials are not so unlike deep down.

"These are all made with amino acid building blocks," said LaShanda Korley, a professor of macromolecular science and engineering.

Korley will spend the next five years studying the order and structures that are responsible for the incredible attributes, then building new materials from what she learns.

After spending her first two years at Case School of Engineering laying groundwork and preparing her lab for the quest, she has received a $498,000 National Science Foundation CAREER Award to fund the effort. Korley won the CAREER grant, the NSF's most prestigious award in support of junior faculty who exemplify the role of teacher-scholars through outstanding research, excellent education and the

integration of education and research, on her first application.

She plans to build custom materials ranging from scratch-resistant coatings and durable fabrics to scaffolding for tissue engineering and wall panels that absorb the impact of an explosion.

"I don't want to necessarily mimic one type of material but to understand what nature's strategies are and to utilize those strategies," Korley said.

Nature's strategies begin small.

"At the molecular level, there are different levels of organization that produce different properties," Korley explained. For example, the entire squid beak is the same basic material but is constructed in a gradient in which there is virtually no water at the knife-like tip used to snare fish, to the water-rich gelatinous end that meshes seamlessly with the mouth.

"We can change the way the building blocks are configured, change the way they're processed and tailor new materials for their mechanical properties."

As part of her project, Korley and her graduate and undergraduate researchers will partner with Citizens' Academy, a nearby K-5 charter school. They will provide students a glimpse into the life of a macromolecular science and engineering professor and opportunities to explore the world of polymer science and engineering through hands-on activities and curriculum support.

Provided by Case Western Reserve University