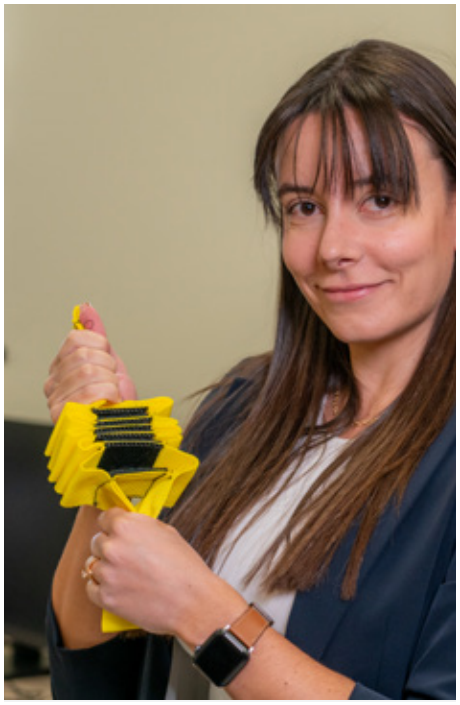
Bio-Inspired Research is a Pearl of an Idea. **By Kathlyn Swantko**

TOUGH MOTHER

Nature is inspiring a new era of textile research that explores biomaterials with remarkable properties. Some of this research has been inspired by spiders, beetles, geckos and even clams. Bio-Inspired Materials (BIM) can lead to the development of sustainable textiles, which don't require the use of toxic chemicals and can improve the performance in specific applications.

One of the more interesting biomaterials is nacre, also known as mother of pearl, also known as nature's toughest material. Nacre is being mimicked by Texas A&M University, partnering with Dr. Ramses Martinez, associate professor at Purdue University, to create a more sustainable and stronger replacement for existing hook-and-loop fasteners. Texas A&M's BIM Lab aims to create bio-inspired materials focusing on the way the proteins in the nacre develop sacrificial bonds (bonds that break before the main structural link is broken).

"Our technology, inspired by the mechanical behavior of the natural nacre's interface and its layered structure possesses a unique combination of toughness and lightweight qualities, arising from the nacre's lattice-like structure," explains Vanessa Restrepo, Ph.D./Assistant Professor, and leader of the Texas A&M's BIM Lab team. "This biomaterial, found in the inner shell of some mollusks, exhibits an impressive ability to dissipate energy and resist impact, making it an excellent model for designing a resilient, durable textile material for industrial applications."



Professor Vanessa Restrepo, leader of Texas A&M's BIM Lab team.

The nacre has a multi-level structure ranging from nanoscale (100,000 times smaller than the width of a human hair) to macroscopic (visible with the naked eye), which gives nacre biomaterials' superior mechanical properties. At the nanoscale level, the layered nacre structure increases tensile fracture resistance. This inspires the creation of artificial materials that mimick the structure of the nacre to improve damage resistance, compared to weaker or more brittle materials.

The Research

In the Fall-Protection device prototype, Restrepo and her team uses non-linear adhesives instead of conventional hook & loop fasteners. This combines non-linear adhesive materials and opposite-facing magnets to form sacrificial bond composites, similar to the matrix proteins found in the nacre's interface. After undergoing large strains and even mechanical failure, the designed composites mimic the natural biological nacre systems, creating a self-healing/self-repairing quality.

Restrepo explains, "The significant sustainable feature of our current model lies in its reusability. Unlike traditional systems that rely on one-time breaking bonds typically used in high-altitude fall protection gear, our

hook & loop mechanism proposes multiple attachment and detachment cycles, prolonging the product's lifespan and reducing waste. Regarding the fabric construction, we are exploring various woven and knitted patterns that will optimize the strength and durability of the hook & loop interface, ensuring that it will meet specific needs for the targeted applications."

Currently, the research team utilizes commercially available hook & loop polypropylene fabrics, but their future goal is to transition into using recycled polymers to manufacture its products, thus enhancing the product's sustainability. Texas A&M's research is targeted towards creating a variety of versatile products for end-use applications that require energy dissipation, along with rapid and reliable fastening solutions.

Restrepo notes, "Our technology could be used in cargo securing systems. In healthcare, it could impact medical braces and other orthopedic supports, providing adjustable yet strong fastening mechanisms. Environmental science applications could include the utilization of our technology for protective barriers or systems that require frequent adjustments and resilience to various physical stresses."

The team's goal is to significantly enhance the strength and durability of traditional hook & loop products. Restrepo adds, "Our intention is not just to match, but to exceed the performance of existing market options by integrating the mechanical principles of nacre, but to develop a product that can sustain considerably more cycles of attachment and detachment without losing functionality, thereby providing a more sustainable and cost-effective solution."

A closer look at the prototype Fall-Protection device.

Texas A&M and Purdue are optimistic about the potential for their bio-inspired materials. Restrepo states, "Our commitment remains dedicated to advancing bioinspired materials and their applications for various industries. We're enthusiastic about these materials, as well as their potential impact and contribution to more resilient and sustainable product development!" ■