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Building better materials from the natural world

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BY JUNE YANG - 19 HOURS 2 MIN AGO

SINGAPORE — Smaller than a fingernail, alien-shell-green and sharp as a shark's open jaw, the squid's sucker ring teeth look like they could cause a world of harm. But scientists from Nanyang Technological University (NTU) and Singapore's Agency for Science, Technology and Research (A*STAR) have found a way to turn this slice of horror from the deep into a new kind of super-biomaterial.

Led by Assistant Professor Ali Miserez and Dr Paul Guerette from NTU and A*STAR's Dr Shawn Hoon, scientists here have taken the sucker ring teeth and turned them into a bioplastic that is 50 to 70 per cent harder and stiffer than any of the conventional plastics we know today. The research was published in the journal Nature Biotechnology this week. The scientists hope that this non-toxic and biodegradable new material can be used as anything from food packaging to drug capsules to parts for organ implants.

"Nature has many secrets which we have yet to uncover," said Asst Prof Miserez. "This new biomaterial made from squid's sucker ring teeth — which are a set of razor sharp teeth found on squid tentacles used to latch on to prey — can retain its property when wet. It could be a new solution to wear-resistant human implants that are exposed to water on a continuous basis."

This is not the first time the scientists have turned to nature as inspiration for new biomaterials. They have also developed a sticky underwater glue taken from a local species of green mussel, and an extremely elastic and durable material made from the egg capsules of a local sea snail species.

These discoveries were made possible through a multidisciplinary approach, combining material science with cutting-edge study of genetics and protein structure. The scientists identify a naturally-occuring protein that has interesting qualities, isolate it and study both its structure as well as the genes in the organism that go into making the protein. In this way they learn how to recreate and manipulate the protein with the exact structural properties that they want.

“By understanding the structure of the protein in the sucker rings, we were able to reproduce the protein artificially and engineer materials with impressive rigidity, hardness and wear-resistance,” said Asst Prof Miserez.

Developing new structural materials is a process that can take years, but with this approach, discoveries can be achieved in as little as six months to a year. “Both biological and material sciences have developed very sophisticated techniques for characterisation in their respective fields and our work demonstrates that by integrating these technologies, discoveries can be accelerated,” said Dr Shawn Hoon, who is a Research Fellow at A*STAR’s Molecular Engineering Lab.

The new biomaterials are not just a boon for material engineers — the environment benefits as well. Making conventional plastics, for example, usually involves harsh processes and toxic chemicals, and takes a toll on our planet’s resources. NTU’s Dr Guerette pointed out that every year, seven per cent of the world’s oil reserves go into plastics manufacturing.

The genes that code for the squid sucker ring teeth, however, can be put into bacteria, which will then produce the bioplastic material for harvesting — a much more sustainable method of production.

These discoveries are just the tip of the iceberg for nature-derived biomaterials in Singapore. The richness of our local biodiversity provides ample pickings for scientists working here. The corals around Singapore, for example, represent at least one-third of all the coral species that are known, said Dr Guerette. “It is a biodiversity hotspot.”

What Singapore has is a fortuitous marriage of a natural bounty right at the doorstep of a major research hub. “There’s not many places in the world where you can get an interesting tropical invertebrate and start extracting DNA and get some genetic information within a span of a few weeks,” said Asst Prof Miserez.

“It’s a real rallying point for our students who, on the weekends, get out by the ocean and they’re identifying new things and they’re asking, should we study this,” said Dr Guerette. “To see the animals right in your own backyard gives you ideas and inspires you on a regular basis.”