Squid supplies blueprint for printable thermoplastics

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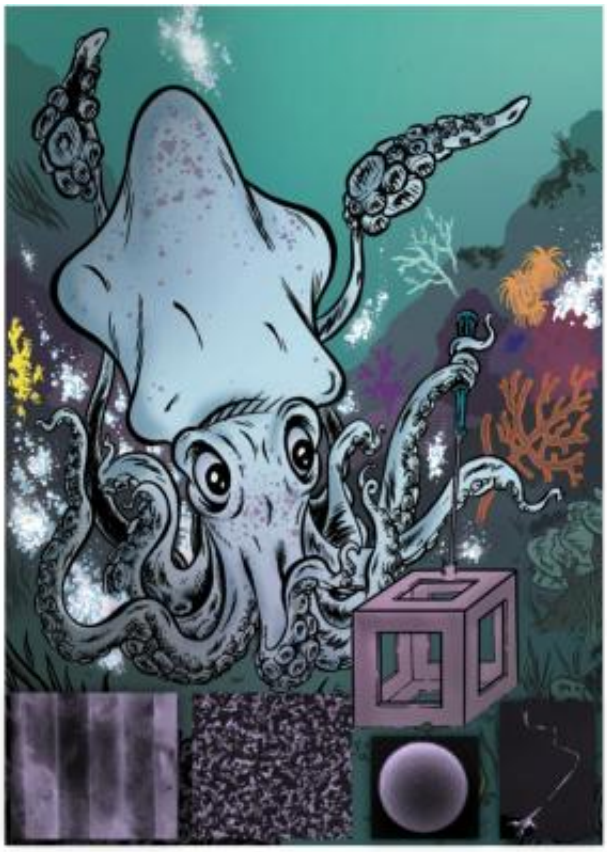

Whimsical image of a squid creating 3-D printed devices. Credit: Adriás Bago

Squid, what is it good for? You can eat it and you can make ink or dye from it, and now a Penn State team of researchers is using it to make a thermoplastic that can be used in 3-D printing.

"Most of the companies looking into this type of material have focused on synthetic plastics," said Melik C. Demirel, professor of engineering science and mechanics. "Synthetic plastics are not rapidly deployable for field applications, and more importantly, they are not eco-friendly."

Demirel and his team looked at the protein complex that exists in the squid ring teeth (SRT). The naturally made material is a thermoplastic, but obtaining it requires a large amount of effort and many squid.

"We have the genetic sequence for six squid collected around the world, but we started with the European common squid," said Demirel, who with his team collected the cephalopods.

The researchers looked at the genetic sequence for the protein complex molecule and tried synthesizing a variety of proteins from the complex. Some were not thermoplastics, but others show stable thermal response, for example, the smallest known molecular weight SRT protein was a thermoplastic. The results of their work were published in today's (Dec. 17) issue of *Advanced Functional Materials* and illustrates the cover.

Most plastics are currently manufactured from fossil fuel sources like crude oil. Some high-end plastics are made from synthetic oils. Thermoplastics are polymer materials that can melt, be formed and then solidify as the same material without degrading materials properties.

This particular thermoplastic can be fabricated either as a thermoplastic, heated and extruded or molded, or the plastic can be dissolved in a simple solvent like acetic acid and used in film casting. The material can also be used in 3D printing machines as the source material to create complicated geometric structures.

To manufacture this small, synthetic SRT molecule, the researchers used recombinant techniques. They inserted SRT protein genes into E. coli, so

that this common, harmless bacteria could produce the plastic molecules as part of their normal activity and the thermoplastic was then removed from the media where the E. coli lived. Wayne Curtis, professor of chemical engineering and Demirel collaborating on this project together with their students worked on this aspect of the project.

"The next generation of materials will be governed by molecular composition—sequence, structure and properties," said Demirel.

The thermoplastic the researchers created is semi-crystalline and can be rigid or soft. It has a very high tensile strength and is a wet adhesive; it will stick to things even if it is wet.

This thermoplastic protein has a variety of tunable properties, which can be adjusted to individual requirements of manufacturing. Because it is a protein, it can be used for medical or cosmetic applications.

"Direct extraction or recombinant expression of protein based thermoplastics opens up new avenues for materials fabrication and synthesis, which will eventually be competitive with the high-end synthetic oil based plastics," the researchers report.

Provided by Pennsylvania State University

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