

## The Cephalo-Inspired Technology Of The Future

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Cephalopods have an array of fascinating—and bizarre—features. Researchers have seen octopuses sprint across ocean floors on two arms; flamboyant cuttlefish pulse black bands across their bodies; and squid squirt ink to attract mates. And though cephalopods’ behaviors and biology are curious in their own right, materials scientists and engineers see these amazing tentacled creatures as a never-ending source of ideas for their biomimetic designs.

“Cephalopods are such exciting sources of inspiration,” says Alon Gorodetsky, a materials scientist at the University of California, Irvine. “The things they do, how they move, even their brains—it’s like science fiction stuff.”

Here are just some of the ways applied cephalopod science could benefit humanity:

### Camouflage on Command

It’s difficult—sometimes impossible—to spot cephalopods in the wild. These soft-bodied creatures have mastered the art of camouflage, and can seamlessly blend into bedrock or coral reefs with just a quick change of the pigments in their skin.

Gorodetsky and a team of researchers at UC Irvine are studying cephalopods’ sneaky color-shifting abilities to see if similar tricks could be used to create adaptive camouflage clothing. One of the molecular tools squid and other cephalopods rely on for their technicolor displays is a protein called reflectin, which serves as a building block for color-changing structures in cephalopod cells. Gorodetsky says that in some of these structures, layers of the protein and other materials alternate like the stack of beef patties and buns in a Big Mac.

Cephalopods can manipulate the layered proteins (like instantly changing the texture and thickness of beef patties or buns) to quickly shift their color. Gorodetsky is trying to replicate this process with artificial materials. In the future, he says, these techniques could be used to create garments that can change colors on demand, or military uniforms that can adapt their appearance by sensing the environment.

### Self-healing Fabric of the Future

Squids can be swift predators. They are armed with sharp, rigid beaks, strong tentacles, and many suction cups—each inner ring lined with tiny teeth. These protein-based teeth are like nails and help a squid latch onto its prey. Materials scientists at Pennsylvania State University have discovered that these teeth are not only tough, but can also self-heal.

Battles with prey and predators may damage of the ring teeth, which may be the reason for the protein’s regenerative properties, explains Melik Demirel, an engineering professor at Pennsylvania State University leading the research project. In fact, the protein that make up the teeth share similarities to those found in silk, and could be used to make materials that can self-assemble. As demonstrated in the video above, Demirel’s team created a squid ring protein “glue” that—with just a little water, heat, and pressure—can mend tears and rips in fabrics.

## **Tiny, Powerful Jets**

Squid are always on the move. Mainly because, just like humans, squid will sink if they don't swim, explains Diana Li, a doctoral candidate at Stanford's Hopkins Marine Station. They have evolved unique and efficient ways to stay afloat in the water column.

One way: flapping the graceful wings on the side of their bodies, as if flying underwater. The other is a method of locomotion more commonly associated with the sky and space: jet propulsion. The torpedo-shaped creature has an impressive force behind its push, and can even accelerate as fast as a rollercoaster or Formula One racecar.

"They're like underwater rockets," Li says.

Li studies how squids large and small propel themselves, which gives insight to engineers like Kakani Katija of the Monterey Bay Aquarium Research Institute. "We can look at these tiny organisms and maybe be able to elucidate something about physics we didn't know before," Katija says. And perhaps new industrial or aerospace innovations might result, from studying this underwater jet set.