Squid-inspired 'invisibility stickers' could help soldiers evade detection in the dark

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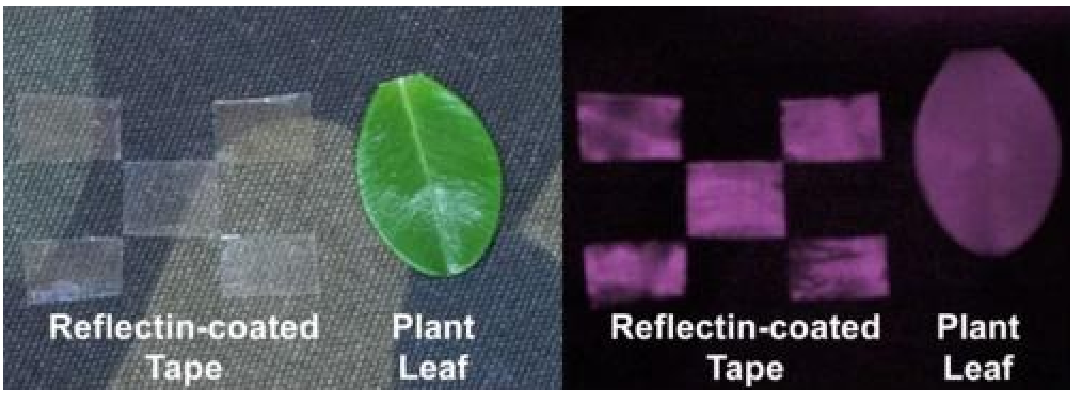

Squid are the ultimate camouflage artists, blending almost flawlessly with their backgrounds so that unsuspecting prey can't detect them. Using a protein that's key to this process, scientists have designed "invisibility stickers" that could one day help soldiers disguise themselves, even when sought by enemies with tough-to-fool infrared cameras.

The researchers will present their work today at the 249th National Meeting & Exposition of the American Chemical Society (ACS).

"Soldiers wear uniforms with the familiar green and brown camouflage patterns to blend into foliage during the day, but under low light and at night, they're still vulnerable to infrared detection," explains Alon Gorodetsky, Ph.D. "We've developed stickers for use as a thin, flexible layer of camo with the potential to take on a pattern that will better match the soldiers' infrared reflectance to their background and hide them from active infrared visualization."

To work toward this effect, Gorodetsky of the University of California at Irvine (UCI) turned to squid skin for inspiration. Squid skin features unusual cells known as iridocytes, which contain layers or platelets composed of a protein called reflectin. The animal uses a biochemical cascade to change the thickness of the layers and their spacing. This in turn affects how the cells reflect light and thus, the skin's coloration.

Gorodetsky's group coaxed bacteria to produce reflectin and then coated a hard substrate with the protein. To induce structural—and light-reflecting—changes just like those of iridocytes, the film needed some kind of trigger. An initial search revealed that acetic acid vapors could cause the film to swell and disappear when viewed with an infrared camera. But these conditions won't work for soldiers in the field.

"What we were doing was the equivalent of bathing the film in acetic acid vapors—essentially exposing it to concentrated vinegar," Gorodetsky says. "That is not practical for real-life use."

Now Gorodetsky has fabricated reflectin films on conformable polymer substrates, effectively sticky tape one might find in any household. This tape can adhere to a range of surfaces including cloth uniforms, and its appearance under an infrared camera can be changed by stretching, a mechanical trigger that might more realistically be used in military operations.

Although the technology isn't ready for field use just yet, he envisions soldiers or security personnel could one day carry in their packs a roll of invisibility stickers that they could cover their uniforms with as needed.

"We're going after something that's inexpensive and completely disposable," he says. "You take out this protein-coated tape, you use it quickly to make an appropriate camouflage pattern on the fly, then you take it off and throw it away."

Gorodetsky says that some major challenges remain. The team will have to figure out how to increase the brightness of the stickers and get multiple stickers to respond in the same way at the same time, as part of an adaptive camouflage system.

He's also working on ways to make the stickers more versatile. The current version reflects near-infrared light. Gorodetsky's team is continuing to tweak the materials, so variants of the stickers could also work at mid- and far-infrared wavelengths. These could have applications for thwarting thermal infrared imaging. They also could have uses outside the military—for example, in clothing that can selectively trap or release body heat to keep people comfortable in different environments.

Moreover, in collaboration with Francesco Tombola, Ph.D., and Lisa Flanagan, Ph.D., from the UCI School of Medicine, Gorodetsky's lab has shown that reflectin supports cell growth. This could have implications for making new types of bioelectronic devices and even growing "living" semi-artificial squid skin.

More information: Infrared invisibility stickers inspired by cephalopods, 249th National Meeting & Exposition of the American Chemical Society (ACS).

Abstract
The skin structure of cephalopods endows them with remarkable

dynamic camouflage capabilities. Consequently, much research effort has focused on understanding and emulating these animals' color changing abilities in the visible region of the electromagnetic spectrum. In contrast, despite the importance of infrared signaling and detection for many industrial and military applications, few studies have attempted to translate the principles underlying cephalopod adaptive coloration to infrared camouflage. We have drawn inspiration from nanostructures implicated in cephalopods' camouflage abilities and developed strategies for the self-assembly of unique cephalopod structural proteins into dynamically tunable biomimetic camouflage coatings on both transparent and flexible substrates. Our substrates can adhere to arbitrary surfaces, and their reflectance can be reversibly modulated from the visible to the near-infrared regions of the electromagnetic spectrum with both chemical and mechanical stimuli. Thus, we can endow common objects with any shape or form factor with tunable camouflage capabilities. Our work represents a key step toward the development of wearable biomimetic color and shapeshifting technologies for stealth applications.

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