

Hey, bacteria, get off of my boat!

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Submerge it and they will come. Opportunistic seaweed, barnacles, and bacterial films can quickly befoul almost any underwater surface, but researchers are now using advances in nanotechnology and materials science to design environmentally friendly underwater coatings that repel these biological stowaways.

"Sea water is a very aggressive biological system," says Gabriel Lopez, whose lab at Duke University studies the interface of marine bacterial films with submerged surfaces. While the teeming abundance of ocean life makes [coral reefs](#) and tide pools attractive tourist destinations, for ships whose hulls become covered with slime, all this life can, quite literally, be a big drag. On just one class of U.S. Navy destroyer, biological build-up is estimated to cost more than \$50 million a year, mostly in extra fuel, according to a 2010 study performed by researchers from the U.S. Naval Academy and Naval [Surface](#) Warfare Center in Maryland. Marine biofouling can also disrupt the operation of [ocean sensors](#), heat-exchangers that suck in water to cool mechanical systems, and other underwater equipment.

Traditionally, a ship's manufacturer could apply biocide-containing paint, designed to poison any colonizing organisms, to the underside of the hull. However, these paints often contain [heavy metals](#) or other toxic chemicals that might accumulate in the environment and unintentionally harm fish or other [marine organisms](#). To replace toxic paints, scientists and engineers are now looking for ways to manipulate the physical properties of surface coatings to discourage biological colonization. "Our end goal is to develop greener technology," Lopez says.

Lopez and his group focus on a class of materials called stimuli-responsive surfaces. As the name implies, the materials will alter their physical or chemical properties in response to a stimulus, such as a temperature change. The coatings being tested in Lopez's lab wrinkle on the micro- or nano-scale, shaking off slimy colonies of [marine bacteria](#) in a manner similar to how a horse might twitch its skin to shoo away flies. The researchers also consider how a stimulus might alter the chemical properties of a surface in a way that could decrease a marine organism's ability to stick.

At the AVS Symposium, held Oct. 30 – Nov. 4 in Nashville, Tenn., Lopez will present results from experiments on two different types of stimuli-responsive surfaces: one that changes its texture in response to temperature and the other in response to an applied voltage. The voltage-responsive surfaces are being developed in collaboration with the laboratory of Xuanhe Zhao, also a Duke researcher, who found that insulating cables can fail if they deform under voltages. "Surprisingly, the same failure mechanism can be made useful in deforming surfaces of coatings and detaching biofouling," Zhao said.

"The idea of an active surface is inspired by nature," adds Lopez, who remembers being intrigued by the question of how a sea anemone's waving tentacles are able to clean themselves. Other biological surfaces, such as shark skin, have already been copied by engineers seeking to learn from nature's own successful anti-fouling systems.

The model surfaces that Lopez and his team study are not yet in forms suitable for commercial applications, but they help the scientists understand the mechanisms behind effective texture or chemical changes. Understanding these mechanisms will also help the team develop materials and methods for controlling biofouling in a wide range of additional contexts, including on medical implants and industrial surfaces. As a next step, the team will test how the surfaces are able to

shake off other forms of marine life. Eventually the team hopes to submerge coated test panels in coastal waters and wait for the marine life to come, but hopefully not get too cozy.

More information: The AVS 58th International Symposium & Exhibition will be held Oct. 30 – Nov. 4 at the Nashville Convention Center.

Presentation MB-MoM-9, "Micro to Nanostructured Stimuli-Responsive Surfaces for Study and Control of Bioadhesion," is at 11 a.m. on Monday, Oct. 31.

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