

# Non-toxic hull coating resists barnacles, may save ship owners millions

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North Carolina State University engineers have created a non-toxic "wrinkled" coating for use on ship hulls that resisted buildup of troublesome barnacles during 18 months of seawater tests, a finding that could ultimately save boat owners millions of dollars in cleaning and fuel costs.

The research conducted by Dr. Kirill Efimenko, research assistant professor in the Department of Chemical and Biomolecular Engineering, and Dr. Jan Genzer, professor in the same department, shows for the first time that surface coatings containing nests of different-sized "wrinkles" are effective in preventing barnacles from firmly latching on to the coatings.

"The results are very promising," Efimenko said. "We are dealing with a very complex phenomenon. Living organisms are very adaptable to the environment, so we need to find their weakness. And this hierarchical wrinkled topography seems to do the trick."

Researchers created the coatings by stretching a rubber sheet, applying an ultra-violet ozone treatment to it, and then relieving the tension, causing five generations of "wrinkles" to form concurrently. The coatings were further covered with an ultra-thin layer of semifluorinated material. During ocean tests performed in Wilmington, N.C., the wrinkled materials remained free of barnacles after 18 months of [seawater](#) exposure, while flat coatings with the same chemical composition showed barnacle buildup after just one month in seawater.

Engineers and scientists have strived for decades to uncover ways to keep barnacles off ship hulls. Barnacle colonization on a ship bottom increases the ship's "drag" in the water, forcing the engine to burn more fuel to maintain the same speed. After six months in the water, a ship's [fuel consumption](#) increases substantially, Efimenko said. That costs ship owners — including the military — plenty of extra cash.

"It's like running your air conditioner with the windows open," Genzer said.

Barnacle buildup also forces owners to remove ships from the water and place them on dry docks for cleaning. This expensive procedure costs ships valuable time at sea when they could be making money.

For many years, ship owners fought barnacles by [coating](#) their hulls with toxic substances that resisted barnacle buildup. But those substances killed fish and other marine life in harbors, causing governments around the world to ban ships from using them.

That led to increased interest in endowing the ship coatings with wrinkled topographies. The coatings share traits with surfaces found in nature, where rough surfaces such as shark skin generally stay free of debris buildup. In contrast, other marine species, such as whales, have smooth skin but often carry barnacles as unwanted hitchhikers.

More information: The group's findings are published in the May 27 issue of the journal *ACS Applied Materials and Interfaces*. The work is also highlighted in the May 8 edition of *Science*.

Source: North Carolina State University ([news](#) : [web](#))

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