Karlsruhe Institute of Technology

Division V – Physics and Mathematics

Institute of Applied Physics (AHP) and
Institute of Nanotechnology (INT)

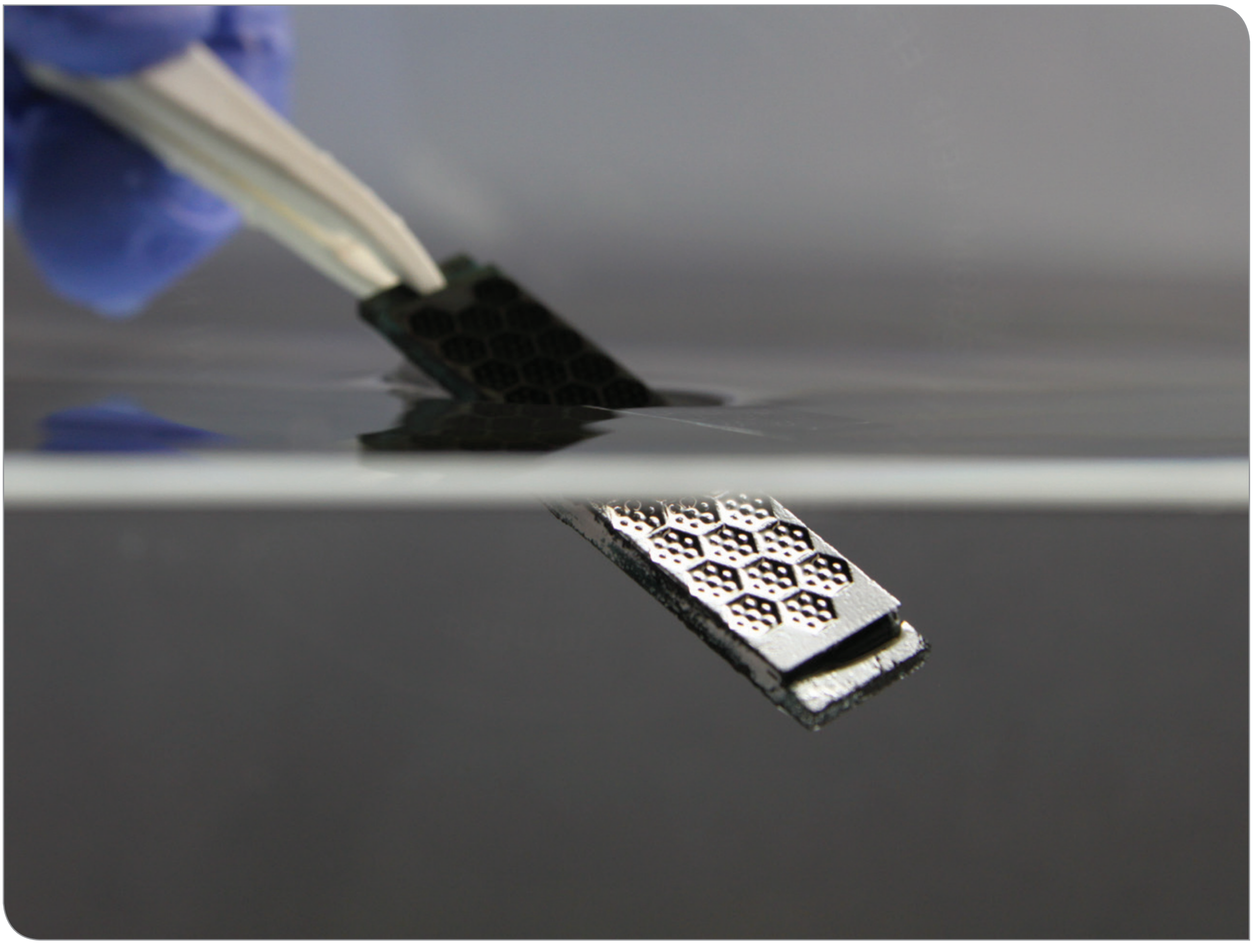
Ships Gliding in an Envelope of Air:

Drag Reduction and Antifouling with Bionic Coating

Approx. 90% of the worldwide international trade is covered by ships. However, ships cause severe damage to the environment: According to a study by the University of Delaware, ship exhaust into the atmosphere has been known to be responsible for up to 60,000 deaths per year since 2013 already. The 15 largest ships are claimed to produce more SO_2 than all cars in the world together. In addition, large quantities of highly toxic substances that are meant to avoid biofouling of the ships' surfaces are released into the water. Furthermore, huge amounts of energy are wasted due to ship hull friction against the water.

Three key problems which ships are facing are related to the fact that the ship hull is in contact with water:

- **Drag** – the largest part of the fuel consumption is due to friction of the hull with the surrounding water.
- **Corrosion** – a phenomenon which is also largely related to the fact that the ship is in direct contact with the surrounding sea water with its high content of salt.
- **Fouling** – sea organisms would not grow if the ship was surrounded by air instead of water.



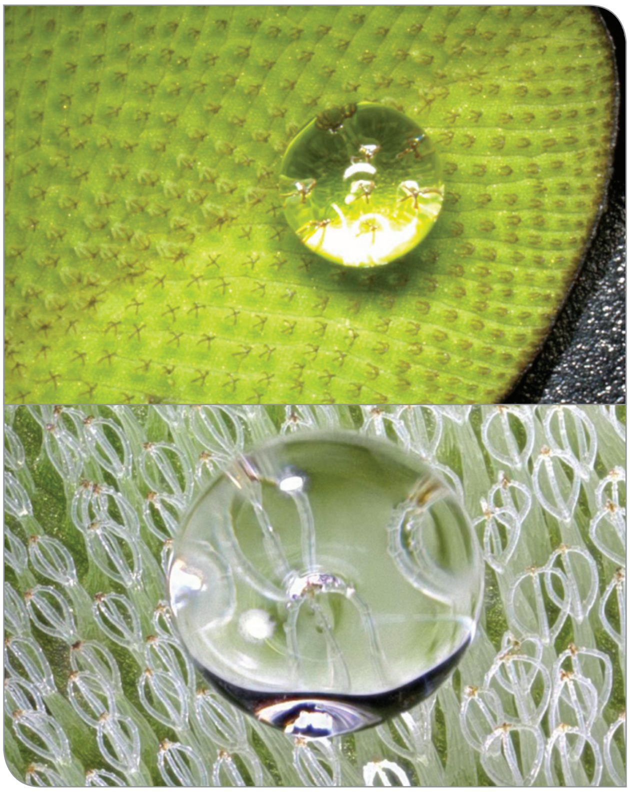
Artificially prepared polymer sample with structured surface retaining air under water. The reflection of the light at the air layer makes the black polymer surface appear silvery under water.

Our approach, which was validated as part of a cooperation between the universities of Karlsruhe (KIT), Bonn and Rostock in the framework of the BMBF project ARES and is now being implemented in the EU project AIRCOAT within the Horizon 2020 program, opens a promising way to solving the above problems:

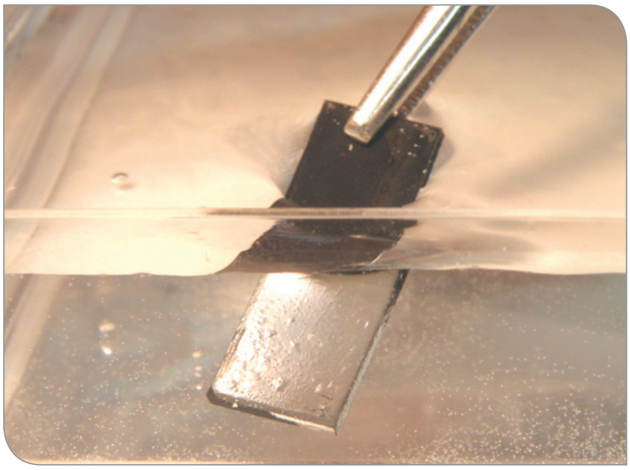
- The air layer shows a much lower viscosity than water and serves the ship as a "sliding layer".
- Enveloping the hull with a permanent layer of air under water also impedes direct contact of the ship with the water and thus prevents corrosion and fouling.

Meanwhile, KIT's prototype artificial surfaces are capable of keeping air layers under water even for several years. Surfaces which remain dry under water open enormous application perspectives, e.g. for ships, oil platforms and water pipelines, and fouling-free water containers.

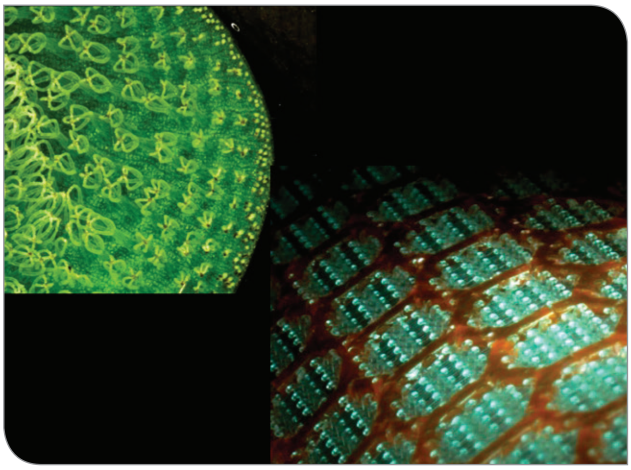
The AIRCOAT project currently receives funding by the EU under the Horizon 2020 program, another project is funded by the Baden-Württemberg Foundation, and the ARES (Air Retaining Surfaces) project was funded by the BMBF VIP+ program. The scientific coordinator of the three projects is Prof. Dr. Thomas Schimmel, KIT.



Natural surface of floating fern Salvinia molesta with a drop of water standing on the tips of special tiny hairs and not touching the leaf surface. Clearly visible in the lower part of the picture is the whisk shape of the hairs.



Polymer sample with structured surface retaining air under water.



Comparison between biological model (Salvinia molesta, left) and technical implementation (artificial polymer surface keeping air under water, right).

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