Karlsruhe Institute of Technology

Division III – Mechanical and Electrical Engineering

Institute of Microstructure Technology (IMT)

Biomimetic Surfaces

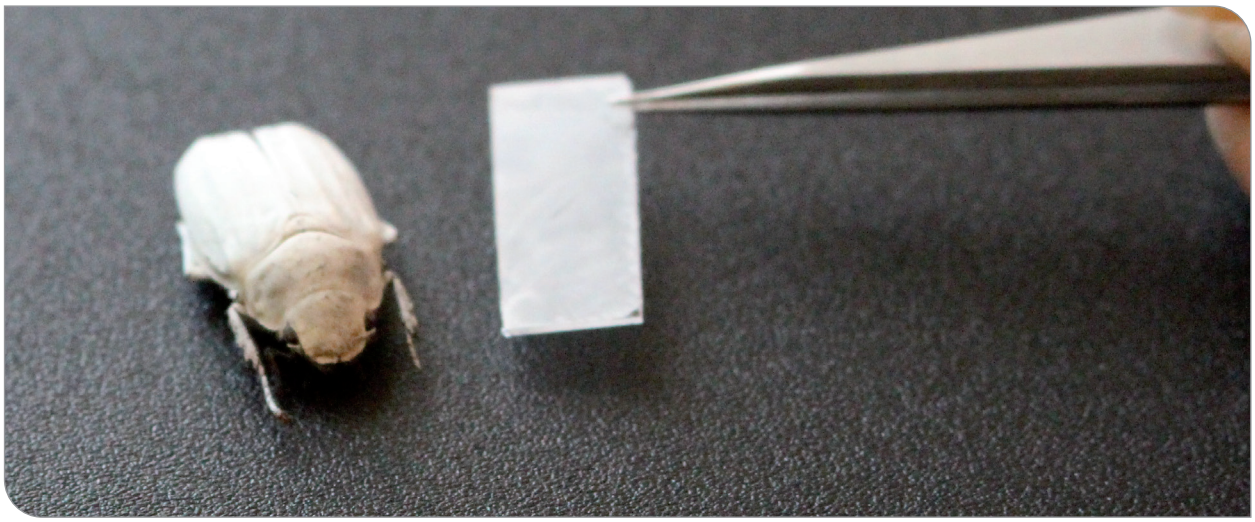
Nano- and Microstructured Surfaces Inspired by Nature

In the course of the evolution, many plants and animals have developed nano- and microstructured surfaces with fascinating properties. The idea of biomimetics is to understand and imitate these natural solutions in order to make them technically usable. Ideally, biomimetics saves development work or leads to completely new solutions that may never have been found by any other means. Many of nature's solutions are based primarily on the structure, and the variation of the basic materials in nature is amazingly low. While engineers often develop solutions that contain materials from many different chemical elements, nature usually restricts itself to a single basic material whose complex three-dimensional structure gives it interesting mechanical, optical, or physico-chemical properties.

Nanoparticle-free White Surfaces

Titanium dioxide has become the standard pigment for white coloring of plastics, lacquers, and paints, but also for foods, cosmetics, and pharmaceuticals. This is due to the fact that due to the characteristically high refractive index of the titanium dioxide particles, incident light is almost completely reflected such that the processed product exhibits a brilliant white surface. However, this metal oxide has been criticized because its nano- or microparticles do not degrade and thus pollute the environment in the long term. In addition, there have been repeated concerns that titanium dioxide could be harmful to health.

We avoid the use of environmentally and health-damaging pigments by producing porous polymer structures with comparably high scattering. The process is biomimetically inspired by the white beetle *Cyphochilus insulanus*, whose scales appear white thanks to their special nanostructure. Based on this model, solid porous nanostructures, which resemble a sponge, are produced from polymers. The polymer films produced by using our process can be applied industrially to various products. The extremely thin, yet mechanically stable polymer structures are characterized by a high scattering efficiency and consequently by a brilliant white appearance. The new technology permits a cost-effective and harmless white appeaance and can be applied to a wide variety of surfaces.

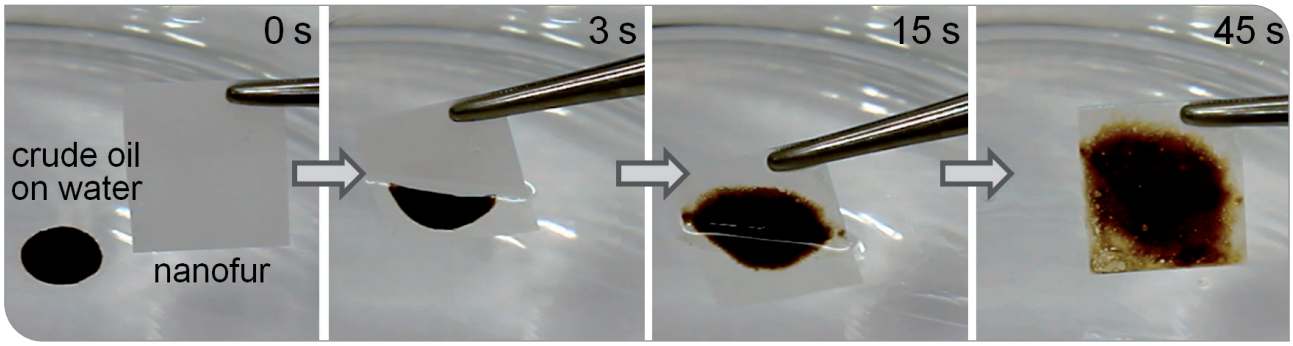


Following the example of the white beetle *Cyphochilus insulanus*, a nanostructured polymer film produces a brilliant white coating.

Oil-water Separation with Nanofur

After accidents on water or on high seas, the environmentally compatible removal of spills is a major technical challenge. Various methods are currently being used to remove oil spills: The combustion of the oil and the acceleration of its decomposition through the addition of dispersing agents usually result in environmental pollution. For this reason, oil spills are absorbed with various natural and artificial materials wherever possible. In this way, however, not only the oil but also a large proportion of water is absorbed, which is very ineffective.

Inspired by aquatic plants, we have therefore developed a "nanofur", which effectively and in an environmentally friendly manner separates oil and water. Nanofur uses a variation of the Salvinia® effect investigated at KIT. Thanks to a special arrangement of microstructures, this effect ensures that the leaves of the water fern *Salvinia* remain dry even under water. Nanofur reproduces a similar surface on a plastic film and absorbs oil and repels water. Nanofur can also be produced on an industrial scale using a roll-to-roll process.



Nanofur absorbs a small crude oil spill within a few seconds.

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