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Bioinspired Surfaces for Solar Cells

Many nano- and microstructured surfaces found in nature can serve as an inspiration for improving technical applications. Although most biomimetic archetypes can be replicated with advanced techniques on a lab-scale, it remains a challenge to develop processes for large-scale fabrication techniques appropriate for commercial applications. Here, I review some of our recent approaches suitable for the improvement of solar cells with high potential for up scaling.

The super-hydrophobic surfaces of water ferns like *Salvinia* and *Pistia* can be mimicked with nanofur, a dense fur of nanoscale hair hot pulled from polymer surfaces. This fractal surface can be utilized as a coating for solar cells and OLEDS. It enables self-cleaning while improving optical efficiency at the same time [1, 2].

Motivated by leaf and petal surfaces, we developed a mechanically directed self- assembly process to create micro- and nanosized surface wrinkles in an all-polymer bi-layer system based on a shape-memory polymer substrate. It provides a large-scale, mold-free, and very cost-effective way for the full-polymer fabrication of micro and sub-microstructures with adjustable structure size and intrinsic irregularity [3].

The scales of the black butterfly *Pachliopta aristolochiae* are micro- and nanostructured and harvest sunlight over a wide spectral and angular range. We fabricated such bio-inspired absorbers using a scalable, self-assembly patterning technique based on the phase separation of a binary polymers mixture. Such nano-patterned absorbers achieve a relative integrated absorption increase of 90% at normal incident angle of light to as high as 200% at large incident angles [4].

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[2] F. Vüllers, B. Fritz, A. Roslizar, A. Striegel, M. Guttmann, B. S. Richards, H. Hölscher, G. Gomard, E. Klampaftis, M. Kavalenka, *Self-Cleaning Disordered Microcavity Array for Photovoltaic Modules*, ACS Appl. Mater. Interfaces **10**, 2929 (2018)

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PD Dr. Hendrik Hölscher studied physics at the University of Hamburg and obtained his Ph.D. in 1999. Focusing on the development of advanced atomic force microscopy techniques, he worked for different research institutes as Post-doc before he established his own research group at the Center for NanoTechnology (CeNTech) of the University of Münster, Germany, in 2003. From 2006 to 2007 he stayed the Department of Mechanical Engineering at Yale University as visiting assistant professor. Since 2008 he is head of the Biomimetics and Scanning Probe Technologies Group at the Karlsruhe Institute of Technology (KIT). His research focusses on bio-inspired smart surfaces.