

Roll-to-roll Fabrication of Biomimetic Surfaces

Weiser P¹, Guttman M^{1,2}, Kietz R¹, Schneider M^{1,2}, Worgull M^{1,2} and Hölscher H¹

1 Institute of Microstructure Technology (IMT), Karlsruhe Institute of Technology (KIT), P.O. box 36 40, 76021 Karlsruhe, Germany

2 Karlsruhe Nano Micro Facility for information-driven Material Structuring and Characterization (KNMFi), Karlsruhe Institute of Technology (KIT), Hermann-von-Helmholtz-Platz 1, 76344 Eggenstein-Leopoldshafen, Germany

Abstract

Biomimetic surfaces are inspired by several fascinating effects found in nature. Among these, self-cleaning surfaces utilizing the so-called lotus effect are a famous example which gained significant technical importance during the last twenty-five years. The lotus effect is commonly achieved by hierarchical nano- and micro-structuring of surfaces made from low surface energy materials leading to very high contact angles and low roll-off angles. Multiple techniques exist to prepare self-cleaning surfaces such as direct laser writing and electron beam lithography, various (soft) lithography techniques, dry/wet etching including electrochemical HF etching, metal assisted etching and reactive ion etching or the use of silica-based films. All these methods are either limited in area, use potentially harmful chemicals, or lack durability. A much simpler and cheaper option is the fabrication of thin polymeric nanofur. Its surface is covered with many tiny, hair-like structures and has a high potential for up-scaling because it can be produced with minimal, very simple and cost-effective tools and moulds. On the lab-scale, the fabrication of nanofur can be easily achieved with sand-blasted steel plates serving as form inserts in a hot embossing machine. However, in this case the fabrication is limited to areas of some cm². These sizes are not sufficient for commercial applications. To overcome this hurdle and to allow for the cost-effective fabrication of thin polymeric nanofur, we developed a continuous roll-to-roll (R2R) process enabling large-scale production. For that we combine classical film extrusion with a special roll-to-roll structuring process. The overall process relies on common tools frequently used in industry, thereby enabling the cost-effective upscaling of nanofur fabrication for commercial applications. Nanofur can be produced with a variety of different polymers including biodegradable types such as PLA. The developed R2R process can also be used to imprint other biomimetic or technical surfaces directly, i.e., directly into the extruded polymer melt, to obtain nano- and micro-structured surfaces on large scales.

Large scale structuring, Nanofur, Roll to roll, Self-cleaning
