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MICROSTRUCTURED BIOMIMETIC SURFACES FOR CONTROLLED WETTING

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INTRODUCTION: The water-repellency of biological systems has attracted considerable interest in the last decade due to the thorough investigation of the lotus flower [1]. The superhydrophobic effect of the lotus flower as well as other plants with an apparently smooth surface results from the topography of the leaf, i.e. its combined micro- and nanoroughness. A second category of plants which have hair on their surface also exhibit a strong hydrophobic behavior. For this type of plants a model has been proposed where the elasticity of the plant hair accounts for the water-repellency of the leaf surface. As a representative the lady's mantle surface has been closely investigated [2]. The hair has a medium diameter of 10 µm, a height of 1 mm and an average distance of 500 µm. In the following it is described how to mimic the lady's mantle surface with polymer networks for a systematic study of the influences of elasticity and hair distribution on the hydrophobic effect (see Fig. 1).

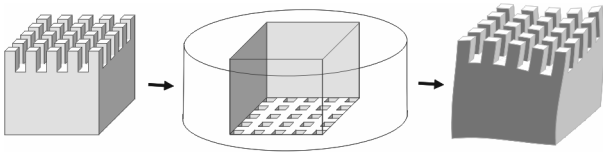

Fig. 1: Concept for the microreplication of a surface. First a plant leaf or a metal master are molded against an elastomer. Second an elastic network can be grown by radical polymerisation in the negative.

METHODS: Materials. 2-Hydroxyethylmethacrylate (HEMA) was purified using an Alox B column, distilled under vacuum from copper(I) chloride and stored under nitrogen at –30°C. All other chemicals were used as received (p.a. grade). **Molding of leaves.** All leaf surfaces were treated with an 0.5 mM solution of 3-(N,N-Dimethylmyristylammonium)sulfonate prior to molding with Sylgard 184 (Dow Corning) and subsequent curing at 70 °C. Then the PDMS master was peeled off the leaf. **Polymerizations.** Polymerizations were per-formed in HEMA/methanol mixtures (1/2 v/v) at 50 °C with 0.01 mol % AIBN as radical starter and 1.0 mol % Ethylene glycol dimethacrylate as crosslinker. All solutions were degassed through at least three freeze-thaw cycles to remove all oxygen traces. After polymerization the swollen network was released from the PDMS master.

RESULTS & DISCUSSION: The hairy lady's mantle surface can be reproduced using polymer networks in combination with two molding steps. First a master is generated by molding a leaf against PDMS. After curing and removal of the leaf the master is filled with degassed monomer solution under vacuum. The polymerization is performed at 50 °C for ~ 2 h until a swollen PHEMA network has formed which is peeled off the master. Figure 2 shows an optical micrograph of an experiment and it can be seen that the polymeric hair has the expected dimensions.

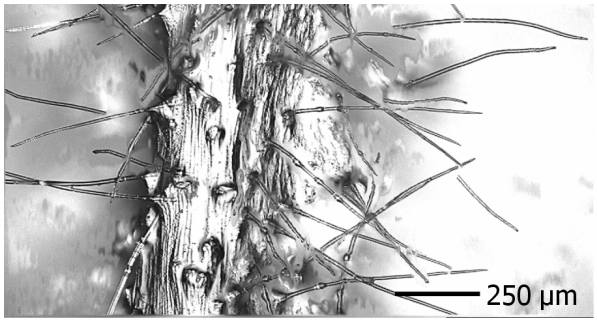

Fig. 2: Extended Focal Microscopy Imaging picture of a PHEMA leaf vein.

CONCLUSIONS: It has been shown that it is possible to mimic biological surfaces using a molding approach which results in the formation of swollen polymer networks even for very high aspect ratios. In order to replicate large surface areas for systematic investigations of the wetting behavior further experiments are necessary.

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