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SURFACES WITH A HYDROPHOBICITY GRADIENT: POSSIBLE APPLICATIONS IN BIOLOGICAL TESTING

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INTRODUCTION: Surfaces with well-designed surface properties are important for gaining more information about biological interactions, such as microbial or cell adhesion. Such surfaces also show a potential for applications in various fields, such as diagnostics, nanotribology, biomolecular interactions or cell-motility studies.

In this study a novel method for the preparation of gradient surfaces with varying functionalities based on the formation of self-assembled monolayers has been developed. Gradients are prepared by simple control of the kinetics of thiol adsorption on gold [1].

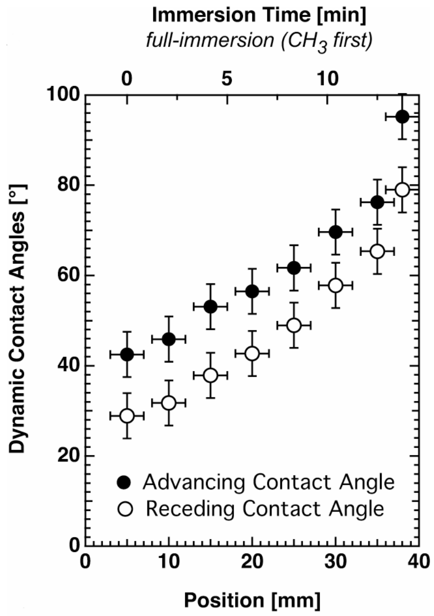
METHODS: Samples, cut from silicon wafers, were coated with a 6-nm-thick Cr adhesion layer and 80 nm Au. Prior to immersion in thiol solution the substrates were rinsed with ethanol and plasma-cleaned for 30 sec in nitrogen plasma. Dodecanethiol ($CH_3(CH_2)_{11}SH$) and 11-mercapto-1-undecanol ($HO(CH_2)_{11}SH$) have been used to prepare wettability gradients.

Wettability gradients were prepared by using a linear-motion drive to control the immersion. In a first step single-component gradients of methyl-terminated thiols were generated. The single-component gradient is then completed by full immersion in a solution of hydroxyl-terminated thiols. The adsorption kinetics can be controlled by the concentration of the solution, the solvent and the immersion time.

Gradients were characterized by dynamic water-contact-angle measurements and x-ray photoelectron spectroscopy.

RESULTS: Fig. 1 depicts a wettability gradient of a length of 4 cm that covers a range of 20° to 85° in water-contact angle. The gradient was generated from a gradual immersion in 0.005mM methyl-terminated solution by a speed of 50 µm/sec and subsequent saturation in 0.005mM hydroxyl-terminated solution. By varying the concentration of the solutions, the sequence of the immersion and the immersion speed of the substrate, wettability gradients of different slopes can be generated.

A gradual change in the composition along the gradient was also monitored by XPS.



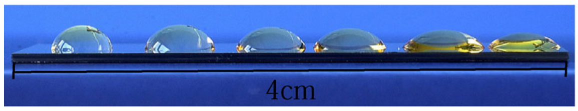


Fig. 1: Results of dynamic water-contact angle measurements and a photo taken of water droplets placed along a wettability gradient.

DISCUSSION & CONCLUSIONS: The preparation of wettability gradients by controlled immersion is easy and reproducible. Gradients with a variable slope are easily generated by changing the immersion speed. Thiols with many different functionalities are commercially available or can be generated, so that the surface properties can be tailored for different purposes.

Preliminary experiments on microbial adhesion to gradient surfaces were carried out and lead to interesting results. Microbes with a variation in surface properties adhered to different wettability regions.

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