SUPERHYDROPHOBIC SURFACES BY SELF-ASSEMBLY OF HYDROPHOBIC MONOLAYERS ON NANOSTRUCTURED SURFACES

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Superhydrophobic surfaces have recently attracted interest due to their potential applications in design and preparation of self-cleaning surfaces [1]. A well-known example of a naturally occurring superhydrophobic surface is a Lotus plant leaf, where the interplay of surface microstructure and chemical composition causes water droplets to remain spherical on the surface. Consequently, the droplets roll off easily, cleaning the surface. [2]

In this study, nanostructured superhydrophobic surfaces were prepared by self-assembly of hydrophobic n-octadecyltrimethoxysilane ($H_3C(CH_2)_{17}Si(OCH_3)_3$, ODS) and (3,3,3-trifluoropropyl)trimethoxysilane ($F_3C(CH_2)_2Si(OCH_3)_3$, FAS3) monolayers from gas phase on porous alumina, ZnO nanowire and GLAD (glancing angle deposition) surfaces. The nanostructured superhydrophobic surfaces were studied by scanning electron microscopy and water contact angle measurements.

The porous alumina surfaces were prepared by electrochemical etching of aluminum thin films in acidic solutions and subsequent pore widening in H_3PO_4 solution. The resulting surfaces were transparent, and had ordered pore structures with pore diameters ranging from about 10 to about 120 nm (Figure 1).

The ZnO nanowire surfaces were prepared in aqueous $Zn(NO_3)_2$ solutions with a help of hexamethyltetramine [3]. The ZnO nanowires had diameters between about 30 and 150 nm. The GLAD structures were prepared by evaporation. Porous, helically shaped structures were formed by rotating the substrate at an oblique angle (82-89°) during the evaporation (Figure 2).

High water contact angles (above 120°) were measured on all types of surfaces. For comparison, the highest contact angles for the ODS and FAS monolayers on planar Si(100) surfaces were 103° and 102°, respectively. This indicates that the hydrophobicity of the nanostructured surfaces results from both the self-assembled monolayers and from the structure of the surface. Generally, surfaces with ODS monolayers showed higher contact angles than surfaces with FAS3 monolayers.

The highest water contact angles for the ODS monolayers on the ZnO nanowire surfaces and on the GLAD surfaces were 144°. Water contact angles on the transparent porous alumina surfaces showed a strong dependence on the dimensions of the underlying porous structure. The highest contact angle (146°, see Figure 3) was measured on an ODS monolayer on a porous alumina surface that had a pore diameter of about 50 nm. The porous alumina surfaces are transparent and probably mechanically more durable than the nanowire surfaces which widens the range of their potential applications.

References:

[1] R. Blossey, *Nature Materials,* **2** (2003) 301
[2] W. Barthlott and C. Neinhuis, *Planta*, **202** (1997) 1
[3] L. E. Greene, M. Law, J. Goldberger, F. Kim, J. C. Johnson, Y. Zhang, R. J. Saykally and P. Yang, *Angew. Chem. Int. Ed.,* **42** (2003) 3031

Figures:

a) b)

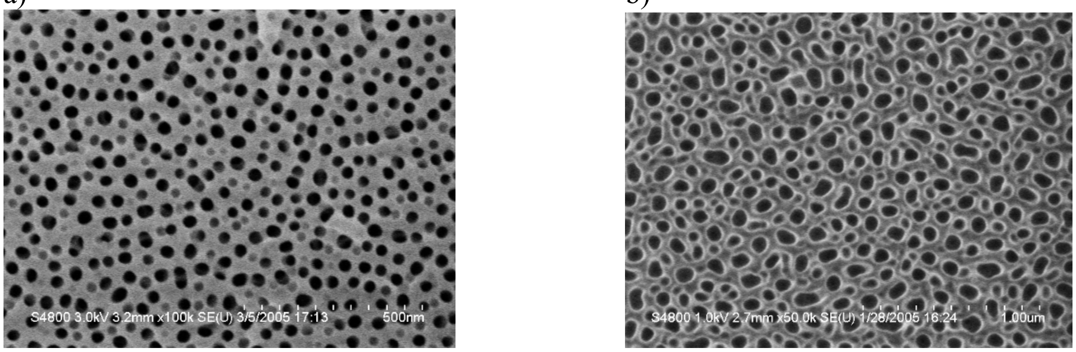

Figure 1. FESEM micrographs of transparent porous Al_2O_3 films on soda lime glass. Preparation conditions: a) 25 V, 0.3 M H_2SO_4, pore widening 1 min. b) 80 V, 10 wt.% H_3PO_4, pore widening 5 min.

a) b)

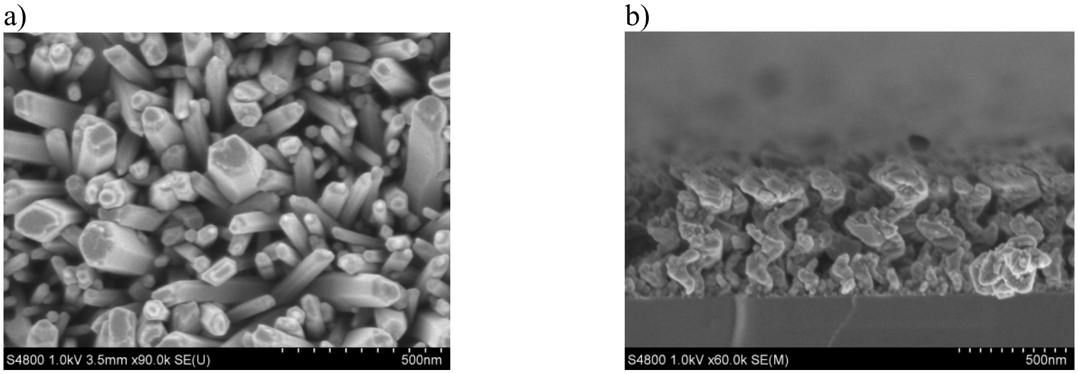

Figure 2. FESEM micrographs of a) ZnO nanowires and b) a GLAD structure

Figure 3. A water droplet on an ODS monolayer on porous alumina surface, showing the high contact angle of 146°. Preparation conditions: 25 V, H_2SO_4, pore widening 5 min.