Supplementary Material

Study of water adsorption and capillary bridge formation for SiO$_2$

nanoparticle layers by means of a combined in-situ FT-IR reflection

spectroscopy – QCM-D set-up

Boray Torun$^a$, Christian Kunze$^a$, Chao Zhang$^b$, Thomas D. Kühne$^b$, Guido Grundmeier$^a$*

a: Technical and Macromolecular Chemistry, University of Paderborn, Warburger Str. 100, 33098 Paderborn, Germany

b: Institute of Physical Chemistry and Center for Computational Sciences, Johannes Gutenberg University Mainz, Staudinger Weg 7, 55128 Mainz, Germany

*Corresponding author: guido.grundmeier@tc.uni-paderborn.de

1. AFM measurements of PE-CVD SiO$_2$ layer

![AFM images A and B](image)

$Figure\ 51$: Intermittent contact mode AFM measurement of as prepared SiO$_2$ plasma polymer surface on PVD-Au (A) and Mica template stripped Au (B) surfaces. RMS roughness was found to be 1.70 nm (A) and 0.3 nm (B) indicating a very smooth surface. The roughness seems to be mainly governed by the underlying substrate morphology.
2. Grazing incidence FT-IR data of PE-CVD SiO$_2$ surface

![FT-IR spectrum](image)

**Figure S2:** Grazing incidence FT-IR measurement of an as prepared SiO$_2$ plasma polymer on a QCM-crystal. Reference data was taken from an octadecyl-thiol covered gold surface. The peak position at 1232 cm$^{-1}$ corresponding to the Si-O-Si mode of oscillation indicates an inorganic glasslike film. Moreover the absence of the Si-CH$_3$ Signal at 1277 cm$^{-1}$ shows that the precursor has been exhaustively oxidized.

3. XPS analysis of PE-CVD SiO$_2$ layer and SiO$_2$ nanoparticles

![XPS spectrum](image)

**Figure S3:** XPS analysis of as prepared SiO$_2$ plasma polymer on a QCM-crystal substrate. Survey spectrum was acquired with a pass energy of 50 eV and details spectra were acquired at 10 eV for higher energy resolution. The absence of Au related signals indicate a closed layer of SiO$_2$ fully covering the surface. Moreover only a small content of carbon based contaminations was found indicating that the precursor was fully oxidized.
**Figure S4:** XPS analysis of SiO$_2$ particles using a monochromatic Al-$k_α$ source. Survey spectrum (top) measured with a pass energy of 50 eV revealed a high degree of chemical purity with only minor carbon contamination. The two peaks visible around 450 eV correspond to the indium substrate used for sample preparation. O 1s peak measured with 10 eV pass energy features a shoulder towards higher binding energies attributed to the presence of surface OH groups.

**4. Schematic of fundamental cell for hcp spheres**

**Figure 5:** Schematic of the fundamental lattice in a hexagonal closed packing of perfect spheres. The indicated parallelogram has an edge length of 2r and contains one complete sphere. The ratio of surface area between one sphere and the parallelogram is found to be $2\pi/3^{1/2} \approx 3.6$. 