4.4 Characterisation of Alkyl-silane Surface Assembly Monolayers by Means of Scanning Force Microscopy

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Surface assembly monolayers (SAM) are one of our new and interesting fields of research with potential applications for both the wet-chemical control of surface reactivity and for the surface functionalization in molecular growth processes. Octadecyl-trichlorosilane (OTS) and other SAM molecules were used to chemically modify the surfaces of silicon, pyrex and mica. Since mica consists of a layered structure providing low-energy surfaces, only ($\gamma_{sl} \approx 100$ mJ/m^2) the adsorption process had to be altered in order to obtain uniform OTS films that are free of defects.

A scanning force analysis revealed the smooth and uniform character of the chemisorbed OTS layer on a large scale (some µm). On the molecular scale, however, the correlation length for molecular ordering was found to extend only over 5-10 intermolecular distances (~5 nm) indicating the amorphous packing of OTS molecules in the 2D phase. Several authors would have expected the OTS layer to perfectly crystallize in a 2D solid (due to the high ordering of the long alkyl-chains) as is the case for most Langmuir-Blodgett molecules compressed into the solid phase.

Our investigations by SFM further proved an aging effect that alters the structure of the formerly uniform and smooth OTS layer. After some weeks the OTS layer shows defects of a few nanometers in width and of molecular height. On other spots the SAM film appears as a continuous layer with good chances for molecular resolution imaging by SFM.

The most probable explanation for the observed aging effect bases on the fact that water from the surrounding atmosphere penetrates into the loosely bound OTS layer enhancing both the mobility and the solubility of the OTS molecules. The molecules therefore may rearrange on the surface into a molecular arrangement that has minimal surface energy and leads to a porous surface layer.