4.1 Scanning Force Microscopy at the Liquid/Air Interface

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A scanning force microscope (SFM) was developed to investigate the air water interface, in particular to image Langmuir films floating on the water surface. The SFM was constructed as a standalone, remote-controlled and water-tight microscope which approaches the floating Langmuir film from the water side. This allows working at very low forces due to the absence of capillary forces. Furthermore, the chromophores are facing the water side due to their hydrophilic wetting character. They are also investigated by optical methods mounted on top of the Langmuir-Blodgett (LB) trough.

The first test measurements were performed with this submarine scanning force microscope (SAFM) scanning the surface of polycrystalline samples (i.e. gold Au and highly oriented graphite HOPG) in air and water. The resulting images are comparable with those measurements obtained with a commercial SFM in air. Next, test measurements were initiated to check the possibility of high resolution imaging with the SAFM. The results obtained on mica were of an excellent quality.

Finally, Cadmium arachidate (CdA) LB molecules were chosen to perform experiments on a floating Langmuir film. CdA is known to exhibit a very well ordered solid phase with the molecules then separated for only 0.5 nm. First, we measured the force acting on the cantilever when approaching such a floating LB film. The result shows that cantilevers with a strong force constant (k = 0.64 N/m) push through the film exerting a enormous repulsive force onto the film which even lifts it up. For small force constants, however, the measured force - distance curves are comparable to those obtained on solid interfaces (i.e. Au, HOPG). With such cantilevers it is then possible to maintain a constant feedback signal and hence to scan the surface of the floating LB film in order to obtain a picture of the real 3-dimensional surface of the CdA monolayer. From such images we deduced the headgroup area of the CdA molecules to occupy 0.55 x 0.55 nm^2 surface area. This is in good agreement with other surface sensitive techniques which, however, will always measure the average value integrating over a large number of molecules. Here even a 20 x 20 nm^2 surface area shows to be very well ordered.