Exploring the lateral order of the liquid-air interface by GiSAXS measurements

D.C.F. Wieland[1], I. Kiesel[1], M. Paulus[1], P. Degen[2],S. Bieder[2], B. Struth[3], H. Rehage[2] and M. Tolan[1]

[1]TU Dortmund, Fakultät Physik/DELTA, Otto-Hahn Straße 4, 44227 Dortmund, Germany

[2]TU Dortmund, Fakultät Chemie, Otto-Hahn Straße 6, 44227 Dortmund, Germany

[3]Desy, Hasylab, Notkestraße 85, 22607 Hamburg, Germany

Aqueous interfaces are of great interest as their physical and chemical characteristics can significantly alter compared to that of the bulk phases. As a result of the changed conditions at this phase boundaries adsorption and self organization processes can appear. We have studied the lateral organization of proteins and nano particles adsorbing at the solution-air interface by grazing incidence small angle scattering (GiSAXS) experiments at the beamline BW1, DORIS III, Hamburg, in order to analyze the lateral organization of the adsorbed particles.

In organisms biochemical and physical processes are controlled by proteins. Therefore, understanding the proteins behavior in natural environments is an essential key aspect to determine the function and interplay of cellular activities.[1,2] In living cells processes can either take place in the cytoplasma or at the cell membrane. The interaction of proteins with interfaces is of fundamental interest because these proteins moderate the exchange between inner cell and outer cell compartments, respectively.

X-ray reflectivity studies explored the vertical film structure of proteins adsorbed to the liquid-air interface but no information on lateral organization was gained.[3] In order to examine if proteins exhibit a lateral ordering when adsorbing to interfaces the adsorption of the model protein lysozyme to solution-air interface was studied. Furthermore, a Langmuir layer of stearic acid was prepared at the interface in order to simulate the cell membrane. Figure 1 shows a GiSAXS pattern obtained from a lysozyme film adsorbed to a stearic acid mono layer. The image shows a week increase of intensity (marked by an arrow) indicating an ordering of the proteins. However, the data evaluation is still in progress.

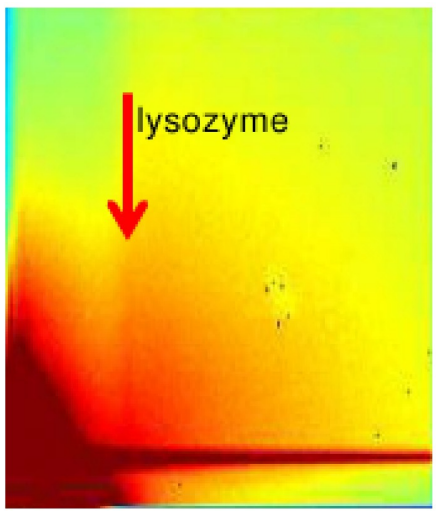

Figure 1: GiSAXS signal of lysozyme adsorbing at the solution-air interface

Furthermore, the adsorption of gold nano particles to the aqueous solution-air interface was studied. Solutions of electrostatically stabilized gold particles (negative surface charge) were mixed with a

solution containing the cationic surfactant cetyltrimethylammoniumbromid (CTAB). Because of the opposed charge of the single components composite nano particles form in the sample solution with enhanced surface activity.[4] X-ray reflectivity measurements proved the formation of an inorganic monolayer consisting of nano particles at the liquid–air interface.

Consequently the liquid-air interface of a solution containing gold nano particles and CTAB was investigated in-situ, whereby every minute a GiSAXS pattern was recorded. By this, the time dependent adsorption process could be monitored. Figure 2 shows the initial (left) and final (right) state of nanoparticle film. The integrated intensity of the correlation peak as function of time is shown in figure 3. The experiment shows that the film formation process took 80 minutes until a stable state was reached.

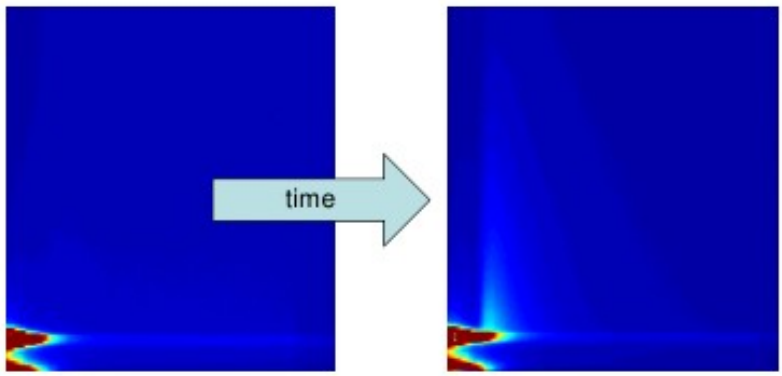

Figure 2: GiSAXS patterns of gold nano particles adsorbing to the solution-air interface resulting in a film.

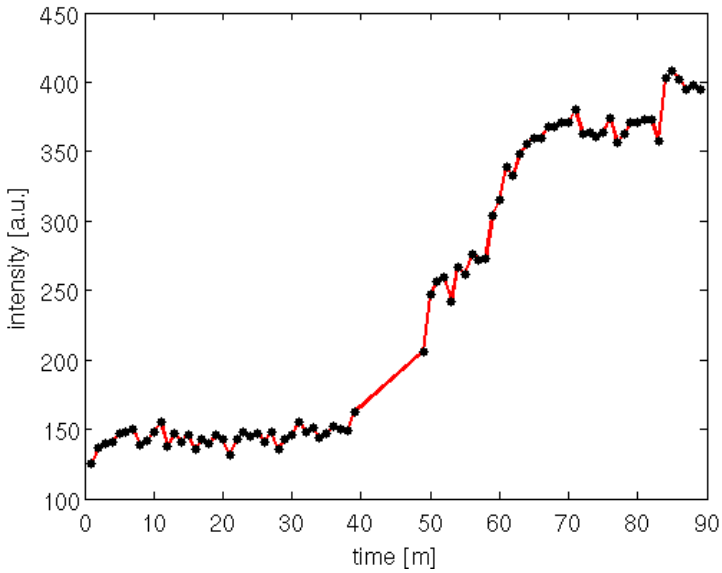

Figure 3: Intensity of the correlation peak as function of time

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