

FROM SUB-MONOLAYER TO MONOLAYER TRANSITION OF SILVER NANOPARTICLE LANGMUIR FILM AT THE AIR-WATER INTERFACE – PILOT APPLICATION OF A NEW GISAXS LABORATORY SET-UP

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Compression of a silver nanoparticle template at the air-water interface from sub-monolayer to monolayer was studied by a newly developed laboratory GISAXS set-up [1]. The X-rays were delivered by a high-brilliance X-ray source (Incoatec Microfocus Source, I μ STM) with integrated focusing Montel optics [2]. The focal spot diameter is 250 μ m, the focal length is 56 cm and the corresponding divergence is 5 mrad. The nanoparticles were spread onto aqueous surface in a Langmuir-Blodgett trough with high-compression ratio (KSV-NIMA HC) and subjected to mechanical compression and decompression. The velocity of barriers was set to 6 mm²/s. An on-line monitoring of the nanoparticle layer evolution was necessary to avoid relaxation processes in the formation of the Langmuir film. Therefore, GISAXS patterns were recorded every half second during the barrier movement by a 2D X-ray detector (DECTRIS, PILATUS 100K) [3]. The behavior of the first lateral peak in the GISAXS pattern during the compression process indicates a minor increase of the interparticle distance (Fig. 1a). After the decompression, the interparticle distance does not return to the original value. Therefore, the nanoparticle layer remembers the compression process on the nanoscopic scale. The integral intensity under the peak is in direct relation to the number of scatterers in the volume probed by GISAXS. The evolution of the area under the peak during the compression and decompression shows full reversibility which is in agreement with reversibility of the surface pressure measured with the Wilhelmy plate. The time-resolved GISAXS measurements obtained in our laboratory were compared with experimental results obtained at the ID10B beamline at ESRF (Grenoble). An agreement between the results of the two types of measurements was found, proving performance and reliability of our laboratory set-up.

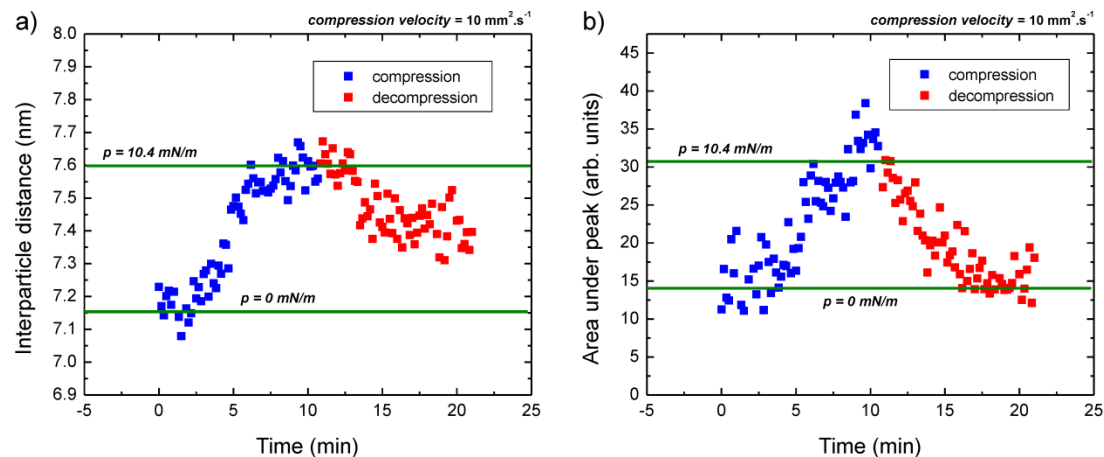


Figure 1. Time evolution of the interparticle distance (a) and area under the first lateral peak (b) during the compression and decompression of the nanoparticle monolayer formed at the air-water interface

- [1] P. Siffalovic *et al.*, Meas Sci Rev **10**, 153 (2010).
- [2] J. Wiesmann *et al.*, Part Part Syst Char **26**, 112 (2009).
- [3] P. Kraft *et al.*, J Synchrotron Radiat **16**, 368 (2009)