ROBL-CRG	**Experiment title:** **Structural study of self-assembled film systems composed of metallic nano-clusters by x-ray grazing-incidence methods**	**Experiment number**: **20-02-43** EU M06
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Report:

Multilayer thin films of gold nanoparticles on glass have been prepared via a step-by-step wet-chemical method using aliphatic dithiols of different length (3 to 9 C atoms) as inter-particle linker/spacer molecules. It has been shown by x-ray diffraction line broadening analysis that the gold particles within the films retain their original size of ca. 4-5 nm even in the case of the shortest aliphatic spacer molecule employed (1,3-propanedithiol). Thus, no significant particle destabilization and fusion occurs, and the typically observed spacer dependent differences in the electronic and optical properties of such films can be attributed confidently to the precisely controllable changes in inter-particle distance on a molecular size scale. Film thickness and density have been accurately determined by x-ray reflectometry confirming the previously suggested discrete layer-by-layer growth mechanism of the thin film structures. Preliminary in-plane diffraction studies suggest the existence

of only very small ordered domains of particles within the films. However, this point needs still further extensive studies.

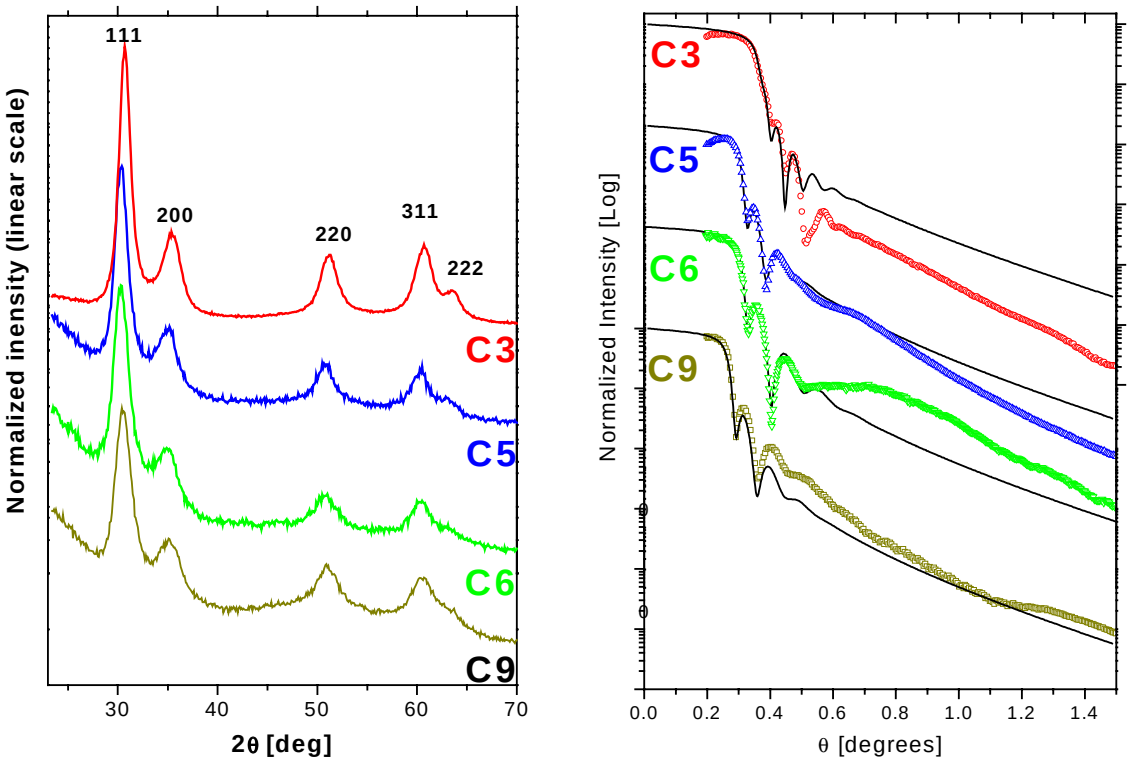

Fig. 1. Left: Recorded x-ray diffraction patterns of samples C3-C9. λ=1.2398 Å, angle of incidence: 0.7 º. Right: Reflectivities of samples C3-C9 (points) as compared with simulated curves (solid lines). *Cn* symbols refer to number of carbon atoms in the dithiol spacer molecules.

Comparison of the reflectivity measurements with various models of the films arrangement revealed that the best fit is obtained for the simplest models, assuming homogeneous in-depth mass density distribution in all investigated nanocluster films. The single-layer model is compared with experimental data in Fig 1. This indicates that the deposition of subsequent cluster "monolayers" leads to a structure with a homogeneous cluster distribution rather than to a "multilayer" structure with a pronounced in-depth periodic structure.

The structural properties of the films obtained in this study form an excellent base to interpretation and calibration of transport measurements.