Poster Presentation

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From Atoms to Layers: Gold Cluster Growth Kinetics during Sputter Deposition

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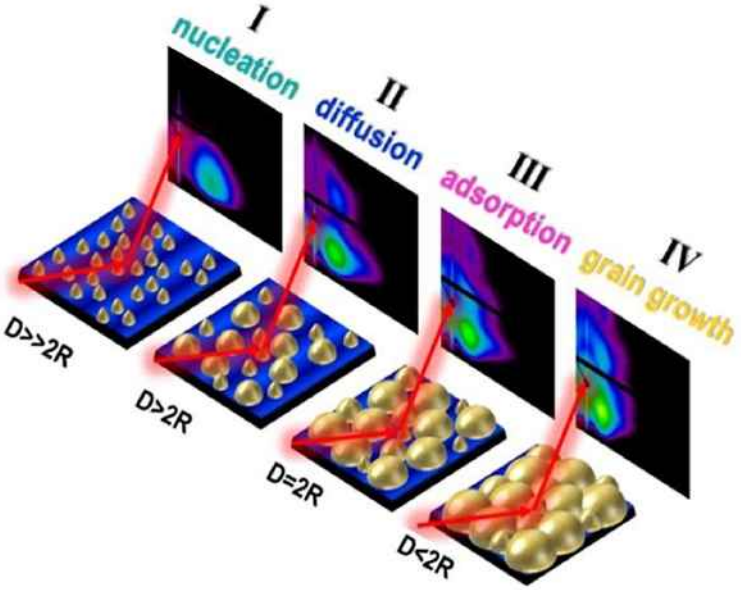
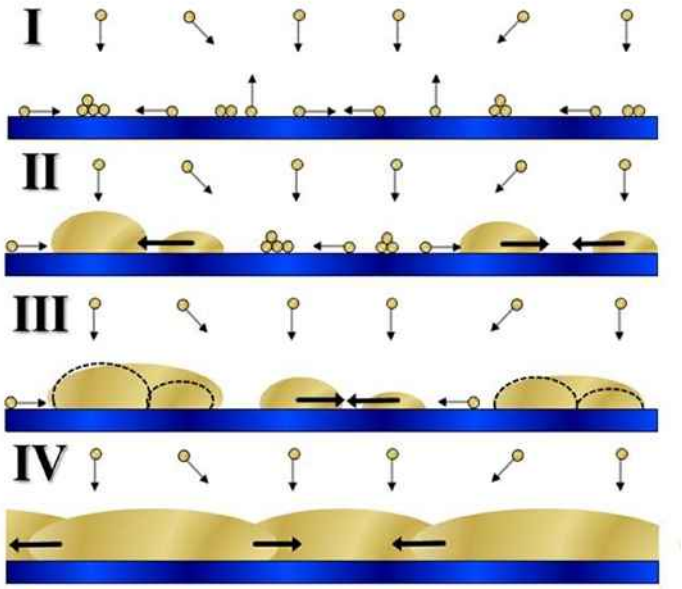
The adjustment of the size-dependent catalytic and optoelectronic properties of gold cluster assemblies is a very significant topic in modern applied nanotechnology [1]. For an efficient and controlled production of active nanostructured cluster surfaces, sputter deposition plays an important role [2]. In order to characterize the self-organization during nanocluster film formation, it is mandatory to understand how growth kinetics influences the cluster film morphology during sputter deposition. The first real-time investigations of gold nanocluster growth kinetics into a gold layer are enabled by combining sputter deposition and surface sensitive X-ray scattering (GISAXS). High frame-rate 2D X-ray detectors in combination with the high photon flux of micro beam spot size, available at the PETRA III beamline P03, enables a non-invasive in situ and real-time investigation of gold growth during sputter deposition. With an acquisition throughput of 67 frames per second, we were able to identify 4 different stages of growth including their thresholds with sub-monolayer resolution and concomitant phase transitions. Each stage can be characterized by a predominant surface process and its intrinsic kinetic: nucleation, diffusion, adsorption and grain growth. Moreover we introduced a flexible geometrical model to extract morphological real space parameters, such as cluster size, correlation distance, layer porosity and surface coverage, directly from the reciprocal space scattering data. The model allowed simulating, visualizing and interpreting gold cluster growth kinetics in terms of nanoscopic processes. Furthermore, we were able to deduce wetting angle on the nanoscale and onset of long-range connectivity during the deposition process [3]. This approach is a prerequisite for future investigations of the influence of different process parameters on thin metal film morphology, which is essential for optimization of manufacturing parameters, saving energy and resources.

[1] *P. Pyykkö, Angew. Chemie Int. Ed., 2004, 116, 4512–4557,* ***[2]*** *F. Faupel, V. Zaporojtchenko, T. Strunskus et al, Adv. Eng. Mater., 2010, 12, 1177–1190,* ***[3]*** *M. Schwartzkopf, A. Buffet, V. Körstgens et al, Nanoscale, 2013, 5, 5053–62*





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