Nucleation, redox reactions and transport at surfaces and nanoscale interfaces

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Electrochemical equilibrium and the transfer of mass and charge through interfaces at atomic scale are of a fundamental importance for the microscopic understanding of elementary physicochemical processes. Approaching atomic dimensions, phase instabilities and instrumentation limits restrict the resolution. Control over surfaces at the atomic scale is of primary interest for a wide range of fields, including energy conversion, nanoelectronics and information technology, and nanoionics

New phase consisting of a few to some tens of atoms in contact with foreign substrate is expected to be thermodynamically instable (as far it can be physically defined as a phase). The charge, transferred in the elementary act(s) during redox processes cannot exceed these tens of e– which is beyond the sensitivity limits of modern instrumentation. An uncertainty is additionally introduced by the fact that the well-defined macroscopic quantities are averaged and even single crystalline substrates show local structural defects leading to microscopic inhomogeneities of the material properties. Therefore, the atomically resolved measurements of electrochemical processes require: i) a high precision in detecting mass and charge flow, ii) a stabilisation of thermodynamically meta-stable clusters of few atoms and iii) a knowledge of the local atomic structure and topography.

In this presentation an alternative approach with highest lateral and charge/mass resolution for studying electrochemical phenomena at interfaces will be presented. The discrete character of the properties of such systems will be shown. The specifics of transport of charged species in nanoscale films from macroscopic insulators will be highlighted focusing on their ionic and electronic conductance.