In-situ EQCN and AFM Probing Mass Fluxes and Morphological Changes at Nanostructured Films

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A key challenge in exploring the electrochemical functional properties (e.g., electrocatalysis, ion gating or interfacial mass fluxes) of nanoparticle assemblies as electrode nanomaterials is the development of capabilities for in situ interfacial probing. This work is aimed at applying two types of in-situ methods for probing the interfacial mass fluxes and morphological changes at nanostructured thin films on electrode surfaces. The thin films are derived from gold nanocrystals of different core sizes and molecular linkers of different functionalities. The first method involves the use of electrochemical quartz-crystal nanobalance (EQCN), which is shown to unravel interfacial mass fluxes during electrocatalytic activation, pH-tuning, ionic incorporation and redox reaction across the nanostructured thin films. The second method involves the use of atomic force microscopy (AFM). By coupling the ability of patterning nanoparticle films on electrodes with the capability of AFM mapping at nanometer resolution, we are able to detect topographical changes accompanying the above interfacial processes. The correlation of the in-situ probing results from both EQCN and AFM techniques has provided important insights into factors controlling the nanostructured electrochemical processes. Implications of the results to developing strategies for interfacial nanoscale manipulation will also be discussed.