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High-energy Surface X-ray Scattering for operando studies of electrochemical interfaces

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The need for sustainable energy, reduction of pollutants, and the environmental benign processing of chemicals has spurred worldwide scientific activities in electrochemical energy science and electrocatalysis. These processes occur at the interfaces of solid catalyst materials in contact with complex liquid environments and under conditions involving high reaction rates, pronounced mass transport, and vigorous gas evolution. Because conventional surface analytic techniques cannot directly access these interfaces, the atomic scale surface structure and composition of the catalysts controlling the reactions are notoriously difficult to determine. For a better understanding of structure-property relationships and catalyst degradation mechanisms, experimental approaches are required that provide insight into the atomic and nanoscale interface structure in operando under reaction conditions. We have developed high-energy X-ray scattering methods for in situ and in operando studies of the complex interfaces between electrocatalysts and liquid electrolytes under reaction conditions. These methods allows to obtain very large datasets in short time, from which the interface structure can be determined with unprecedented detail, as demonstrated here by studies of the atomic-scale surface structure of Pt(111), Pt(110), and Pt(100) during oxide formation and reduction in perchloric and sulfuric acid solution. The obtained results on the potential-dependent oxide structure provide insights into the oxidation-induced Pt degradation by Pt dissolution and surface restructuring.

Please select the related topic from the list below

Interfaces during chemical reactions and catalysis

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Session Classification: Charged interfaces, chemical reactions and catalysis