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***In situ* Characterization of Heterogeneous Catalysts**

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To understand the function of catalysts for heterogeneous catalysis and improve catalytic properties, a fundamental insight into structure-functionality relationships is required. As catalysts may change their structure with respect to the environment, it is essential to investigate the catalysts under reaction conditions. Furthermore, structural and compositional information have to be acquired on different length scales and such *in situ* studies require dedicated complementary techniques. *In situ* X-ray diffraction (XRD) and X-ray absorption spectroscopy (XAS) are eminent to follow the average catalyst's structural and electronic changes during synthesis and reaction conditions. In order to follow the dynamics (stability, topography, etc.) of the surface and interfaces, imaging is often the solution. Nanoscale imaging and spectroscopy of catalysts in a gaseous environment is traditionally performed in an environmental transmission electron microscope (ETEM). Spatially resolved information on the meso scale (50 nm–1 μ m) can be obtained by X-ray microscopy, which enables *in situ* studies at both ambient and elevated pressure. Furthermore, due to the much higher penetration depth of X-rays compared to electrons, X-ray based characterization techniques are more suited for realistic samples and conditions.

This study illustrates how catalyst properties can be elucidated by the combination of X-ray and electron based methods in general. Several material systems have been investigated and diffraction, imaging and spectroscopic methods have been applied both with x-rays and electrons. The results clearly underlined the need for complementary techniques and highlight the potential of these for application in catalysis.