Characterization of strong metal-support interaction using X-ray standing wave technique

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Supported metal catalysts are important functional materials for various applications in, for example, the chemical and petroleum industries, fuel cells and fine chemical production [1, 2]. Catalysts consisting of noble metal nanoparticles (NPs) deposited on a metal-oxide (MeOx) support are specifically interesting to study due to their high activity and tunable selectivity [3, 4]. The phenomenon of strong metal support interaction (SMSI) was observed in catalyst processes when the nanoparticles were encapsulated by reducing oxide support under hydrogen atmosphere at high temperatures [5]. The SMSI involves the diffusion of atoms from a metal oxide support to the surface of metal nano-particles, leading to (sub)-oxide overlayer formation. The study of dynamics of layer coverage formation requires element-sensitive techniques, able to detect atomic restructuring at the nanoscale, and which can be applied in in situ studies (i.e. under hydrogen at 200-600 °C).

The X-ray standing wave technique (XSW) is sensitive to the nanometers-scales changes and can be used in the ambient conditions, and is therefore suitable for the in situ study. To reach the maximum sensitivity of measurements to atom movements of Me from MeOx layer to the surface of NPs, a multilayer mirror (MLM) is proposed for the generation of XSW. In this work we have optimized the MLM/MeOx/NPs system by maximizing the sensitivity of XSW to Me-NPs atomic diffusion. A thermally stable MLM was developed for high-temperature annealing during the catalytic experiment. The results of first measurements and analysis will be reported.

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