Modulation Excitation PDF for Studying Dynamic Changes in Ni based Catalyst

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Ni nanoparticles supported on γ-Al_2O_3 are the widest used catalysts for CO_2 methanation. However, when planning industrial processes involving renewable energy and designing a catalyst, unsteady supply of feedstock or energy must be considered. A change in operation conditions can lead to a different chemical environment for the catalyst, which can undergo structural changes, formation of interfacial structures and surface reconstruction process. [1]

Cycling between catalytic and dropout conditions during in-situ experiments allows the full potential of modulation excitation (ME) experiments to be used. [2, 3]

In this work we present the first application of Phase Sensitive Detection analysis on X-ray PDF data collected during in-situ catalysis experiments under ME conditions at the I15-1 beamline at the Diamond Light Source in Didcot (Oxford, UK). [4]

We performed in-situ ME-PDF experiments on two different Ni/Al_2O_3 catalysts (an industrial reference and an in-house synthetized one) under CO_2 methanation and full H_2 dropout conditions and while the time resolved data did not show differences, the PSD analysis highlight small structural changes. In the synthetized sample, a metal-support interaction is observed, leading to a stabilization of the Ni active phase. In contrast, the industrial reference catalyst showed no support involvement and undergoes surface oxidation of the Ni nanoparticles during dropout condition (Figure 1).

In conclusion, ME-PDF experiments are a powerful tool for gaining additional insight into structure-property relationships of heterogeneous catalysts.

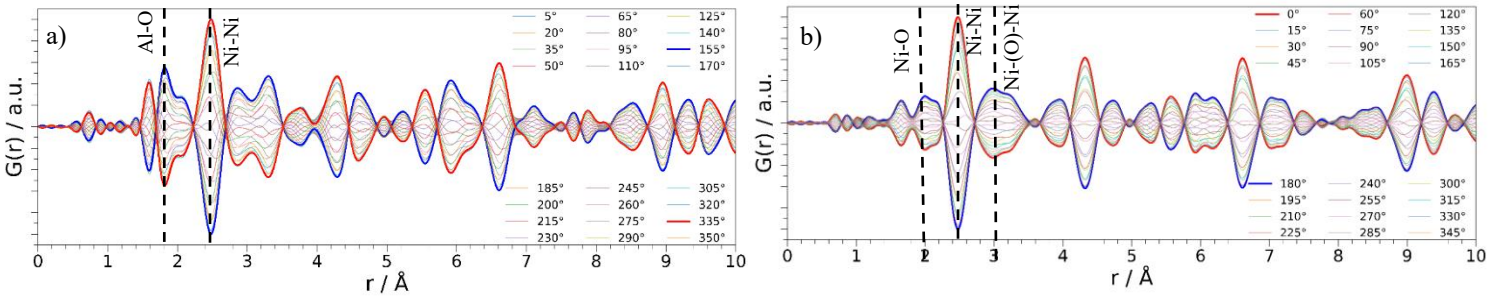


Figure 1 *PSD transformed ME-PDF data for the synthetize sample (a) and the industrial reference (b)*

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