**Research Abstract**

# TEM Characterization of Rhodium-based Automotive Three-way Catalysts

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To create a more “eco-friendly” society, further developments in catalytic processes and technologies play an important role, e.g. to substantially reduce emission of ”green-house” gases from power plants and combustion engines. In automotive, oxide-supported noble metals three-way catalysts (TWCs) are nowadays widely used to simultaneously reduce the emission of harmful exhaust gases containing carbon monoxide (CO), nitrogen oxides ($NO_x$), and unburned hydrocarbons (HCs). Among them, Rh-based catalysts have shown exceptional properties, such as enhancing the participation of $NO_x$ in CO and HCs oxidation and thereby better efficiency, making Rh more favorable over Pt and Pd, especially at lower operating temperatures. However, due to the shortage of Rh supply, it is imperative to maximize the efficiency and the lifetime of Rh-based catalysts by understanding the underlying phenomena in catalytic reactions. In this work, Rh-based catalysts will be chosen to study the relationship between microstructure and catalytic activity, also by mimicking real working conditions during characterization.

The goal of present research is to understand the fundamental mechanism of high-temperature deactivation and subsequent regenerability specifically for Rh-based catalysts, one of the utmost important questions in the research community. To achieve this aim, industrial real catalysts and model catalysts are investigated using a systematic advanced characterization approach. The catalytic activity is examined by investigating the conversions of CO, $C_3H_6$, and NO (a typical TWC feed mixture) using FTIR. X-ray diffraction (XRD), X-ray absorption spectroscopy (XAS) are performed to identify overall phase formation and the average local structure of the treated catalysts. Aberration-corrected electron microscopy (TEM) in combination with electron energy-loss spectroscopy (EELS) will be applied to understand the microstructure and chemistry at the atomic scale, revealing the local mechanisms for catalysts deactivation and regeneration.

The significance of this research is in establishing a procedure to systematically examine the mechanism of strong metal-support interactions (SMSI) in heterogeneous catalysts (Rh/$\gamma$-$Al_2O_3$) using the state-of-the-art materials characterization. This fundamental understanding of the microstructure-performance relationship is essential for any further development of next-generation automotive TWC and potentially can be applied in extensive studies of other functional nanomaterials.