

Quantitative Analysis of Pt on Industrially-Relevant Catalyst Supports

Eric J. Peterson, Andrew DeLaRiva, Deepak Kunwar, Griffin Canning, Christopher R. Riley and Abhaya K. Datye

The University of New Mexico, Albuquerque, NM 87131

Platinum group metals (PGMs) are commonly used as catalysts in applications such as automobile catalytic converters, gasoline refinement in the petrochemical industry and in chemical industry processes such as the production of nitric acid, plastics, fertilizers and pharmaceuticals. Due to their high cost, the efficient use of PGMs entails the synthesis of high surface area catalyst/support systems with PGM particles that are as small and as stable as possible. In catalytic reactions, being surface phenomena, atoms on the interior of a catalyst particle do not participate in chemical reactions and merely occupy space. Achieving small catalyst particle size enables the most efficient use of expensive PGMs. In conjunction with small size, particle stability is also important. As catalyst particles grow via sintering, less surface area is available for catalytic reactions, eventually necessitating catalyst regeneration or replacement.

It has recently been shown that highly dispersed, stable and catalytically-active PGM single atoms can exist on various high-surface area supports. Quantification of the amount of atomically-dispersed PGMs present in a given catalyst system is obviously of interest. One approach is to quantify bulk PGM concentration using a bulk chemical analysis technique such as ICP or XRF analysis, determine the PGM crystalline fraction using quantitative XRD, and complete the PGM balance using STEM EDS in regions of the support showing no visible PGM to estimate the atomically-dispersed PGM fraction. Our work has focused on Pt on a range of high surface area supports, including ceria, spinel, porous silica and gamma -alumina. While Rietveld analysis is straightforward for systems composed of crystalline material having little absorption contrast between phases, such as Pt/ceria, absorption contrast is large in the Pt/spinel, Pt/silica and Pt/gamma-alumina systems. An additional complication is the amorphous structure of porous silica in the Pt/silica system. The most challenging system to deal with is Pt/gamma-alumina, having high absorption contrast as well a structure that is not quite crystalline yet not quite amorphous. Approaches to quantifying Pt crystalline/atomically-dispersed states in these systems will be described in this presentation.