# A More Realistic View of Supported Metal Catalysts Using Aberration-corrected Analytical Electron Microscopy

**Christopher J. Kiely**

Department of Materials Science and Engineering, Lehigh University, Bethlehem, PA 18015

Supported gold clusters and gold-palladium nanoparticles are intensely studied materials primarily because of their exciting potential applications in catalysis. The recent availability of aberration corrected analytical electron microscopes is now revolutionizing our ability to characterize the morphology, crystallography and chemical composition of such nanoscopic volumes of materials and for the first time is giving us more realistic views of these catalyst systems.

To illustrate the superior imaging performance of this new generation of electron microscopes, we will present a high angle annular dark field (HAADF) imaging study of a systematic set of gold on iron oxide CO oxidation catalysts, ranging from those with little or no activity, to others with very high activities. Using this approach, we will unambiguously demonstrate that the high catalytic activity for CO oxidation derives from the presence of bi-layer clusters which are ~0.5 nm in diameter. We will also demonstrate that core–shell structures in sub-5nm Au+Pd, Pd{Au} and Au{Pd} bimetallic nanoparticles can be directly visualized using the *Z*-contrast sensitivity of the HAADF imaging technique. In addition we will present a case study showing the how the thermal stability and sintering behavior of such sol- immobilized AuPd bimetallics are affected by the precise nanoparticle morphology, the calcination temperature, and the identity of the support.

To illustrate the chemical analysis capabilities of aberration corrected analytical microscopes, we will describe the potential advantages of combining x-ray energy dispersive spectroscopy (XEDS) spectrum imaging with multivariate statistical analysis (MSA) techniques. Through several case studies of the Au-Pd bimetallic catalyst systems, we will demonstrate that STEM-XEDS can provide invaluable high spatial resolution compositional information on (i) alloy homogeneity and phase segregation effects within individual nanoparticles, (ii) particle size - alloy composition correlations, and (iii) alloy composition changes that can occur as these catalysts are used.