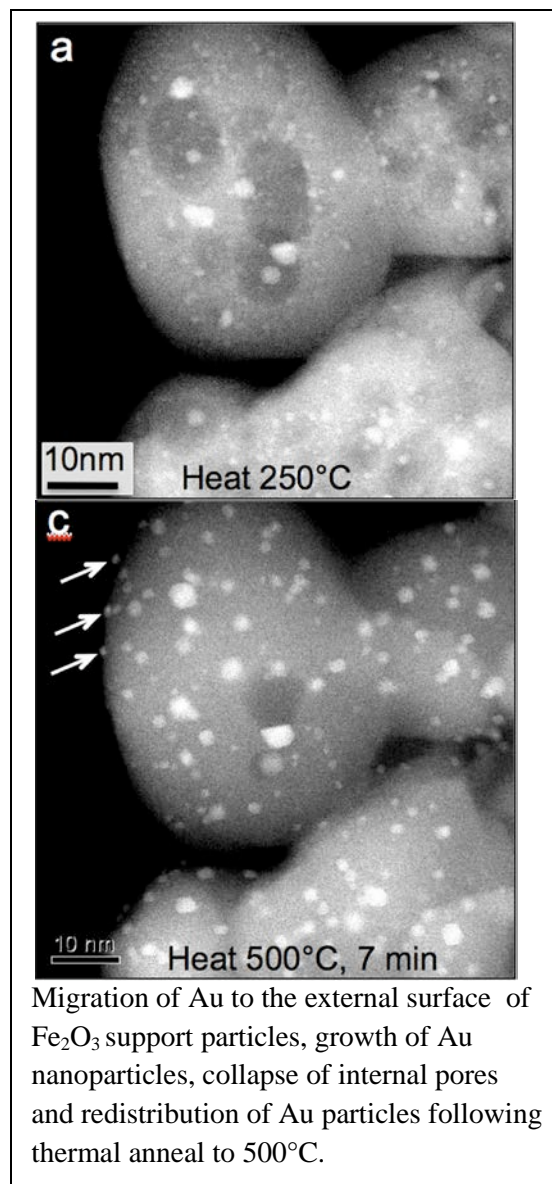
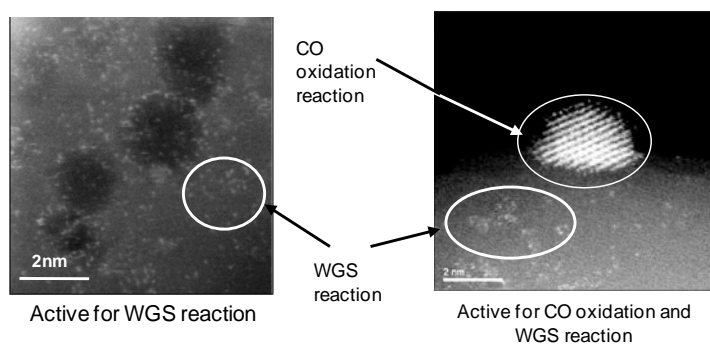


Direct Imaging of Catalyst Evolution with Atomic Resolution

Description: It is well known that the properties and structure of a catalyst can change by heating the catalyst in air. What happens during this process, however, has remained a mystery. Though microscopes have been able to resolve images at the atomic level for several years, thermal expansion has prevented imaging while the catalyst is being heated. Researchers at ORNL, in collaboration with researchers at Tufts University, are pioneering a new technique that enables imaging during heating. They have used this to gain new insight into how the gold (Au) catalyst works, and how it changes as it is prepared and heated.

Starting with gold catalysts supported by iron oxide, they leached the sample until the outer layer of Au was removed. They found Au cations and 1-2 nm sized Au nanoparticles (NPs) embedded in the iron oxide and, through timed images obtained by aberration-corrected electron microscopy, watched them rise to the surface and aggregate into gold particles as it was heated. There were also voids in the oxide that collapsed during heating. By using these images and corresponding catalytic studies, they found the active sites for CO oxidation reactions and water-gas shift reactions.

Significance: *In-situ* microscopy now permits direct observation of the evolution of catalyst structure with atomic resolution, as a result of elevated temperature treatments. This approach has been applied to determine the active sites in supported Au catalysts, potential catalyst for fuel cells, emission control and biofuel conversion.



L. F. Allard; A. Borisevich; W. Deng; Rui. Si; M. Flytzani-Stephanopoulos; S. H. Overbury, *Evolution of Gold Structure During Thermal Treatment of Au/FeO_x Catalysts Revealed by Aberration-Corrected Electron Microscopy*, *Journal of Electron Microscopy* **58(3)**: 199-212 (2009).

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