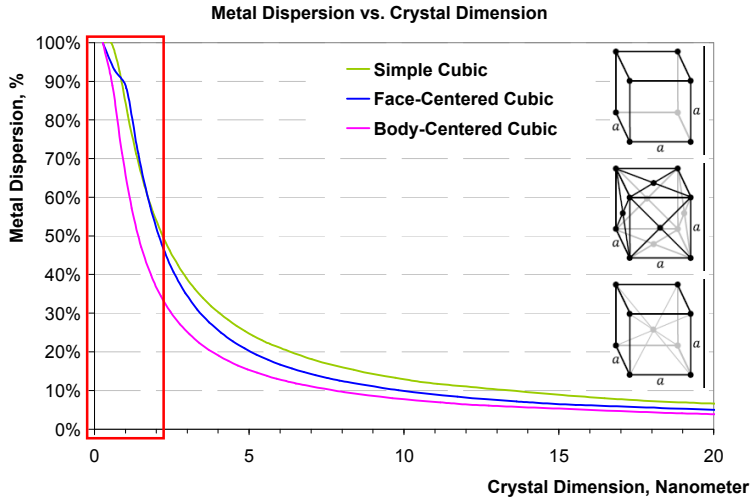
Highly Dispersed Metal Catalysts with sub-Nanoscale Structure

Highly dispersed platinum on electrical conductive porous supports is being studied in sub-nanometer particle and ultimately single atom or mono layer, using similar approaches used in catalyst industry. A metal dispersion of 1.00 is defined as that 100% of the metal atoms are available for catalysis. Values less than 100% may indicate crystallite growth or a surface interference. The following illustration shows that metal dispersion can increase by a factor of 10 if 10 nm particles are all dispersed into single atoms or mono layer. On the other hand, the usage of noble metal could be reduced by the same factor still maintaining the catalytic activity, if every platinum atom is active for catalytic reaction, rather than being stacked over each other. Our interest is in the catalyst fine structure from single atom to 2 nm. Catalytic activity is expected to be enhanced remarkably simply by dispersing the noble metals to the catalyst support.

The group has made catalysts at about 90% metal dispersion, which corresponds to 0.65 nm particle size. A special technique is developed to characterize the catalysts by direct interacting with selective probe molecules to indicate the number of accessible metal atoms, in contrast to electron microscopic or X-ray diffraction techniques used commonly in nanotechnology research.



This approach has the potential to reduce the cost of fuel cells significantly, as well as application in direct fuel cell (DFC) electrodes. An issue of the methanol DFC is the limited current density. It can generate a small amount of power over a long period of time. If the electrical current density were increased by magnitudes, it would be able to power transportation vehicles or vessels. This would also solve the hydrogen storage issue since each methanol molecule has 4 hydrogen atoms. Once the concept is proven, the scale up of this electrode fabrication at high volume is not difficult since metal loading and shaped catalyst are commercially achieved in the catalyst industry. The researchers hope the investigation can break barriers between know-how of commercial catalyst industry and fuel cell research.

Literature citation: X. Xiao et al, unpublished

Patents or other steps toward commercialization: _____

Contributing Agency: DOE