Nanoscience Paths to Metal-Support Interactions in Fuel Cell Catalysts

Polymer fuel cells are being developed worldwide for applications ranging from automotive propulsion systems to portable power. One of the major costs of polymer fuel cells is the platinum catalysts needed for the oxidation of hydrogen and the reduction of oxygen. The oxygen reduction reaction is the primary focus of fuel cell catalysis research, as it is a relatively slow reaction, and requires the most platinum catalyst. Researchers at the Naval Research Laboratory (NRL) have been making strides in improving the activity of oxygen reduction catalysts through leveraging metal-support interactions of the metal (platinum) with either a support or ligand. NRL studied phosphine ligands on nanoscale platinum catalysts, and through characterization with X-ray absorption spectroscopy, found that the phosphine ligands improve oxygen-reduction catalysis through changing the hydrophobicity of the platinum surface. NRL is also working with industry to optimize the interaction of platinum with oxide and phosphate based supports. The oxide and phosphate based supports impart an apparent electronic effect on the platinum, resulting in up to a >2x increase in the platinum activity.

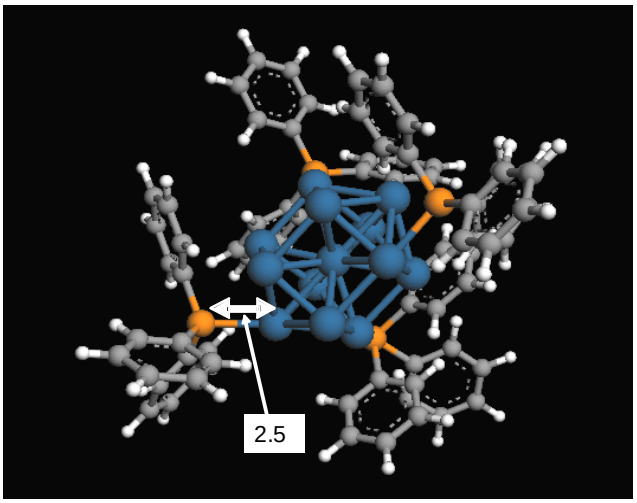

Illustration of a 13-atom platinum cluster (blue) and 4 triphenyl phosphine triphosphate ligand groups linked through the phosphorous atom (yellow). A platinum-phosphorous bond distance of 2.5 Å was determined by X-ray absorption spectroscopy.

Literature Citations:

D. S. Gatewood, et. al, *J. Phys. Chem. C* ***112*** (13), 4961–4970 (2008).

O. A. Baturina, et. al, *J. Electrochem. Soc*. **155** (12), B1314-B1321 (2008).

Patents or other steps toward commercialization: provisional patent: 61/151,576 and CRADA with the Automotive Fuel Cell Collaborative Corporation.

Contributing Agency: DoD / NRL