Enhancing the performance of PEM fuel cells using nano-platelet shaped particles

Proton exchange membrane fuel cells (PEMFC) are an attractive source of energy because of their clean emissions and high power density. In fuel cells, power is generated via the conduction of H+ ions through a polyelectrolyte membrane, commonly composed of sulfonated tetrafluoroethylene based fluoropolymer-copolymer (Nafion). The function of the fuel cell constitutes a balance between hydrogen oxidation and oxygen reduction. Two major challenges need to be overcome in order to increase the popularity of this form of energy; (a) The reactions at both the anode and cathode are catalyzed primarily by Pt nanoparticles, which increase cost. (b) Under ambient conditions where CO2 is present, CO is one of the byproducts of the fuel cell operation which poison the Pt catalyst and drastically reduce power output.

We have developed a method for fabrication and coating of the membranes of PEM fuel cells with nanoparticle platelets. Incorporating the coated membranes into the fuel cell MEA enhanced the maximum power output by more than 50% when operated under ambient conditions. An enhancement of more than 200% was observed when 0.1% CO was incorporated into the H2 input gas stream. DFT calculations were carried out to understand the origin of improved output power. The results indicated that the nanoparticles interacted synergistically with the membrane functional groups, serving the same function in a two step catalysis scheme as previously reported for metallic oxides.

Miriam Rafailovich received her PhD from Stony Brook University in Applied Nuclear Physics. She then did her postdoctoral work at Brookhaven National Laboratory and the Weizmann Institute. Miriam was associate professor of Physics and Astronomy at CUNY, Queens College and is currently a distinguished professor at Stony Brook University in the Department of Materials Science and Engineering. Miriam is the director of the Garcia Center for Polymers at Engineered Interfaces. Her research interests span a broad spectrum, which includes, Polymer nanocomposites for additive manufacturing, biopolymers, biosensors, tissue engineering scaffolds, nanotoxicology, flame retardant composites, and polymers for green energy applications.

Miriam is also known as a pioneer in the integration of research with education. She has graduated more than 60 PhD and Masters students and mentored several hundred undergraduate and high school students from across the United States and abroad. She is the co-author of more than 360 publications in peer reviewed journals and technical review articles, a Lady Davis Foundation Scholar and a fellow the American Physical Society.