Siemens Competition
Math : Science : Technology
Regional Finalist

Names: Arthur Chen, Lee Blackburn, Justin Lish
High School: Lawrence High School
Mentor: Mrs. Rebecca Isseroff
Project Title: *Optimization of Catalytic Activity in Polymer Electrolyte Membrane Fuel Cells Utilizing Metal-Functionalized Graphene Oxide/Partially Reduced Graphene Oxide Coatings* (Chemical Engineering; Chemistry; Materials Science/Nanoscience)

Polymer electrolyte membrane (PEM) hydrogen fuel cells could replace fossil fuels but exposure to carbon monoxide (CO) poisons its platinum catalyst, reducing efficiency. Operating at high temperatures oxidizes CO but ruins the PEM. This project hypothesized that metal-functionalized graphene oxide (GO) and/or partially reduced graphene oxide (prGO) would catalyze CO oxidation, lowering CO levels and increasing output power at room temperature. GO was functionalized with gold and platinum nanoparticles, producing metalized-GO. Partial reduction with NaBH4 produced metalized-prGO in solution. Raman spectroscopy, FTIR, SEM, and TEM confirmed the synthesis, reduction, dispersion and functionalization. Each solution was coated onto a Nafion membrane and tested in a hydrogen fuel cell. While the prGO increased efficiency by 62%, the metalized-prGO solutions averaged an increase of 71% over the uncoated membrane control and 19% over a gold nanoparticle coating. Metalized-GO solutions averaged an increase of 60% (11% increase over gold nanoparticle coating); and GO increased efficiency by ~80% over plain Nafion, suggesting an unexplored GO mechanism increases efficiency. Future work will test metalized-prGO catalysis in a PEM fuel cell in complete O2 atmosphere; investigate the mechanism of GO; and create a metalized-rGO thin film to replace the Pt catalyst in the PE M fuel cell.