Nano-architecture for Improving Fuel Cell Efficiency

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One of the suggested methods of modifying the way we power our automobiles is to switch from a combustion based fuel source to a fuel cell system. These fuel cells work by creating a current through the exchange of electrons inside the cell. The current or electricity from the cell and use it to power the vehicle. Improving the efficiency of such a system is a pursuit by many companies and research groups. Here is an example of such research by the U.S. Office of Naval Research and their research on the structure, or architecture, of the electrode used in the fuel cell or other applicable uses.

Research done by the U.S. Office of Naval Research has begun looking at the use of different substances to use in the electrodes of high-performance electrochemical capacitors. Although capacitors are different than the fuel cell system, the research being done to improve the efficiency of the electrodes can be transposed to the fuel cell system. The U.S. Office of Naval Research is looking at different metallic oxides and their efficiencies as a membrane of the carbon rods, or nanoforms. The membranes are then applied over the carbon form and are applied at a thickness of 10 – 20 nm thick. The common metallic oxides that are used are manganese oxide and iron oxide. The U.S. Office of Naval Research is modifying the structure of the electrode to make it extremely porous. This would greatly increase the surface area of the electrode and the amount metallic oxide membrane that is in contact with the solution in the capacitor. This increase in the amount of metallic oxide and porous structure greatly increases infiltration and transport of ions in the capacitor.

To test their modifications, a half-cell cyclic voltammetry was done to look at the voltage potential versus the capacitance of the two different metal oxides. Their research shows that applying this type of membrane material and structure doubled the amount of capacitance and therefore doubling the amount of energy stored in the capacitor than the bare carbon. Manganese oxide also showed a higher capacitance than iron oxide and also worked at a higher voltage. The U.S. Office of Naval Research is already looking at other modifications to the electrode such as a membrane protective coating and altering the structure of the carbon nanoform. This is just one example of the research being done in the fast-paced and complex area of fuel cells and alternative energy for automobiles.

Reference: Megan B. Sassin, Jeffrey W. Long, Azzam N. Mansour, Anne E. Fischer, Katherine A. Pettigrew, and Debra R. Rolison. *Multifunctional Metal Oxide–Carbon Nanoarchitectures as Electrode Structures for High-Performance Aqueous Asymmetric Electrochemical Capacitors*. Code 6170, Surface Chemistry Branch, U.S. Naval Research Laboratory, Washington, D.C. 20375, U.S.A