Homogeneous hollow carbon nano-spheres from renewable resources as novel supports for PEM fuel cell electro-catalysts.

Andrew M. Herring,* Bryan D. McCloskey, J. Thomas McKinnon.

Department of Chemical Engineering
Colorado School of Mines, Golden, CO 80401
* e-mail: aherring@mines.edu

There is an ongoing need for new supports for Pt and other precious metals in fuel cell electrodes that will enhance the performance of these expensive catalysts. We report here a novel method for the synthesis of extremely homogeneous samples of carbon nano-spheres from cellulose char and their use as catalyst supports for fuel cell applications.

We have shown that when cellulose is charred under an inert gas that it forms a structure containing polycyclic aromatic hydrocarbon, PAH, moieties that anneal with charring time into larger and larger arrays. When the cellulose is charred with 10wt% Nickel chloride and subsequently irradiated with a CO$_2$ laser hollow carbon nano-spheres are formed together with other carbon materials. These carbon nano-spheres are readily purified from the mixture by a digestion with hot concentrated HNO$_3$ overnight to give extremely homogeneous samples of hollow carbon nano-spheres, diameter 40nm, Figure 1, in relatively good yields, >10% in relation to the starting uncharred cellulose.

Figure 1. TEM of carbon hollow nano-spheres

Platinum supported catalysts were prepared by analogous methods to those that have been employed for single-walled carbon nano-tubes. The purified carbon nano-spheres are functionalized by a weak oxidation, using a mixture of dilute nitric and sulfuric acids to give a material with carboxylic acid functionalities. Pt particles are attached by reduction of K$_2$PtCl$_4$ in ethylene glycol. The resultant material contains 5nm Pt particles attached to the 40nm carbon nano-spheres, Figure 2.

Figure 2. TEM of Pt supported on hollow carbon nano-spheres.

Results of the characterization of these catalysts by XRD and TEM will be discussed as well as preliminary measurements as the anode of a PEM fuel cell.

References

3 Lordi, V.; Yao, N.; Wei, J. Chemistry of Materials, 2001, 13, 733