High Performance One Dimensional Nanocable Catalysts for Fuel Cells

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The sluggish oxygen reduction reaction is a long-standing scientific challenge, that dramatically reduces the efficiency of fuel cells. This ACS-PRF grant aims to study a novel concept 1-D Fe core- Pt Shell nanowire electrocatalysts with improved activity, enhanced durability and reduced cost, and to develop a general solution-phase synthesis method to accurately prepare metallic nanostructures for electrochemical energy-related reactions. Success of this research will acquire fundamental understanding of controlled wet-chemistry synthesis of multi-metallic nanocatalysts at the nano and atomic scale, and deepen our insights into the structure-catalytic function relationships. This research will open a new avenue for design and preparation of efficient catalytic materials, and help our efforts to diversify the current energy supply status and reduce our dependence on foreign petroleum.

We optimized the solution phase catalyst synthesis method to preparation of 1-D PdFe nanowire structures (Fig.1), and extended this solution phase method to prepare Ag/C (Fig. 2), Au/C and Au/CNT catalysts (Fig. 3). Ag/C demonstrated high anion exchange membrane glycerol fuel cell performance), and Au catalysts showed unique electrocatalytic oxidation of polyols in fuel cell reactors. We published 5 papers in high-profile journal s, and gave 10 oral presentations in ACS and AIChE meeting. Partially supported by this ACS-PRF grant, Zhiyong Zhang defended his Ph.D. dissertation in August 2012, and he is currently a postdoc researcher in the Oak Ridge National Lab at DOE.

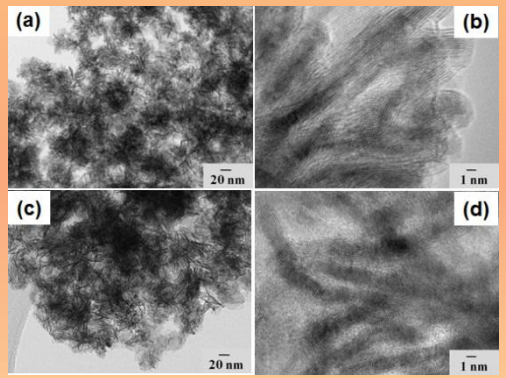

Fig. 1 TEM and HRTEM images of PdFe-NWs prepared with different conditions (a)(b) injection of $Fe(CO)_5$ at 60°C; (c)(d) immediately increasing temperature to 160°C after injection of $Fe(CO)_5$ at 105°C.

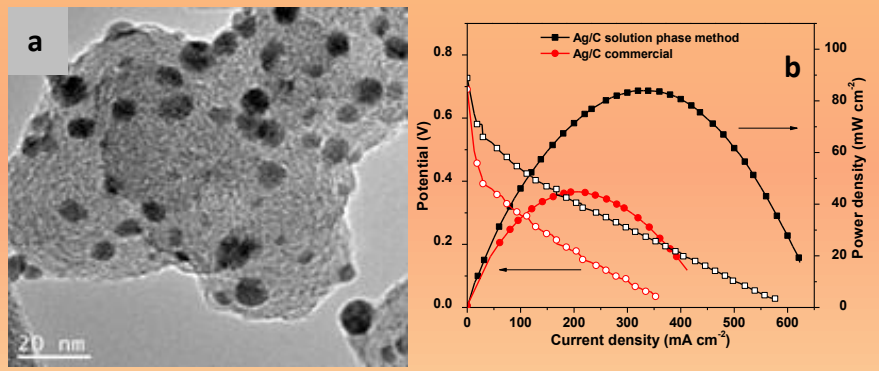

Fig. 2 TEM image (a) of Ag/C prepared by the solution phase method, and high anion exchange membrane glycerol fuel cell performance with Ag/C cathode catalyst (b).

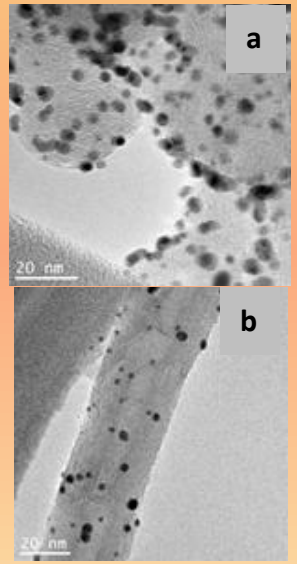

Fig. 3 TEM image of Au/C (a) and Au/CNT (b) with a particle size of 2-6 nm using the solution-phase method.

In our future research, we will study the mechanisms of metallic nanostructure formation through this solution-phase method , and explore this synthesis method to prepare nanostructured non-precious metal catalysts, such as Cu, Pb, etc for electrochemical energy applications.