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Platinum nanoparticles supported on bi-metal oxide grown carbon nanostructure as ethanol electro-oxidation electrocatalyst

Divya P. and Ramaprabhu S.*

Alternative Energy and Nanotechnology Laboratory (AENL), Nano Functional Materials Technology Centre (NFMTC), Department of Physics, Indian Institute of Technology Madras, India. * Phone: +91-44-22574862; E-mail: ramp@iitm.ac.in

1. Material Synthesis

1.1 Synthesis of carbon nanostructure.

A simple sol-gel technique was applied to synthesize Fe-Sn-O catalyst particles. Initially, required molar ratios of $FeCl_3$, $SnCl_2$, and $C_6H_8O_7$ H_2O were mixed with ethanol to make the sol. Thereafter, the sol was heated at 80 °C to convert to gel. The prepared gel was heated at 700 °C around 2 hour to get Fe-Sn-O particles. The obtained catalyst particles were sprinkled on a quartz boat and it was placed at the middle of a quartz tube. Further the quartz tube was inserted into a furnace. Ends of the quartz tube were closed with coupling arrangements. The flow rate of Argon (Ar), hydrogen (H_2) and acetylene (C_2H_2) maintained was 60, 40 and 40 sccm respectively. Argon gas was allowed throughout the experiment. Initially argon gas was flowed for 5 minutes to make an inert environment. Then furnace temperature was set to 700 ºC. Further acetylene (C_2H_2) and hydrogen (H_2) gases were flowed through the quartz tube at 700 °C for 20-25 minutes. The furnace was cooled down to room temperature and as-grown sample was taken out.

1.2 Synthesis of multi walled carbon nanotube

$MmNi_3$ alloy hydride catalyst has been synthesized by hydrogen decrepitation of $MmNi_3$ alloy which is synthesized by arc melting technique. The catalyst sprinkled quartz boat was inserted to

a quartz tube. Further, the quartz tube was inserted into a tubular furnace. Ends of the quartz tube were closed with coupling arrangements. The flow rate of Argon (Ar), hydrogen ($H_{2)}$ and acetylene (C_2H_2) maintained was 160, 50 and 50 sccm respectively. Argon gas was allowed throughout the experiment. Initially argon gas was flowed for 5 minutes to make an inert environment. Then furnace temperature was set to 500 ºC. Further hydrogen (H_2) gases were flowed through the quartz tube at 500 °C for 45 minutes. After 45 minutes hydrogen has been stopped. Further, furnace temperature was set to 700 ºC. Acetylene (C_2H_2) gas was flowed through the quartz tube at 700 °C for 30 minutes. Acetylene has been stopped after 30 minutes. The furnace was cooled down to room temperature and as-grown sample was taken out.

2. Results and discussion

Figure S1 Shows the XRD of Pt/C. Figure S2 shows the SEM image, EDX spectrum and TEM image of commercially available platinum on Vulcan XC-72. Figure S3 shows the cyclic voltammogram of Pt/C, Pt/MWNT and Pt/CNS-FSO.

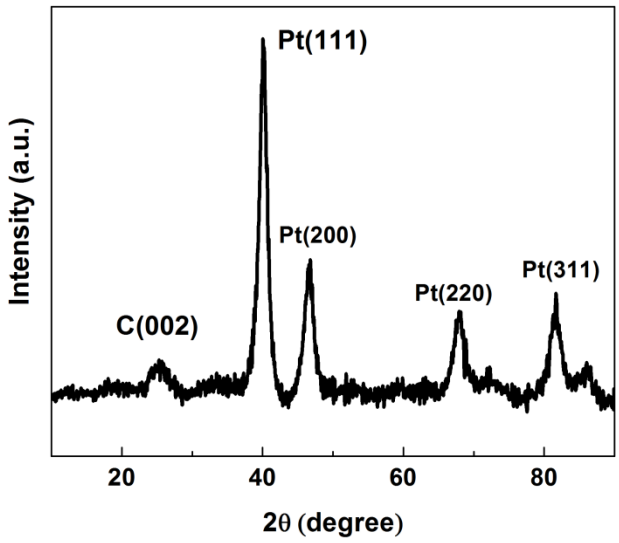

Figure S1. XRD of commercial Pt/C

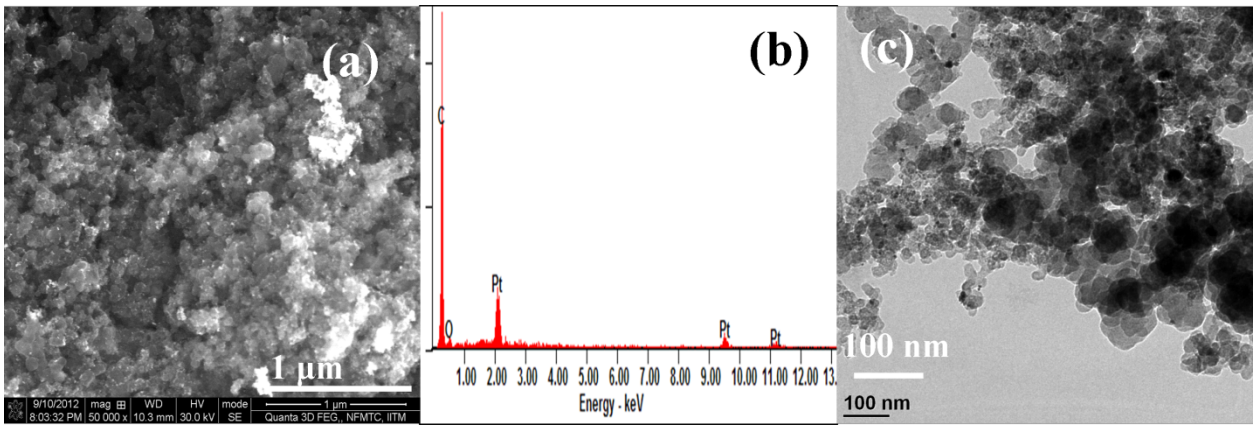

Figure S2. (a) SEM image, (b) EDX spectrum and (c) TEM image of commercially available platinum on Vulcan XC-72

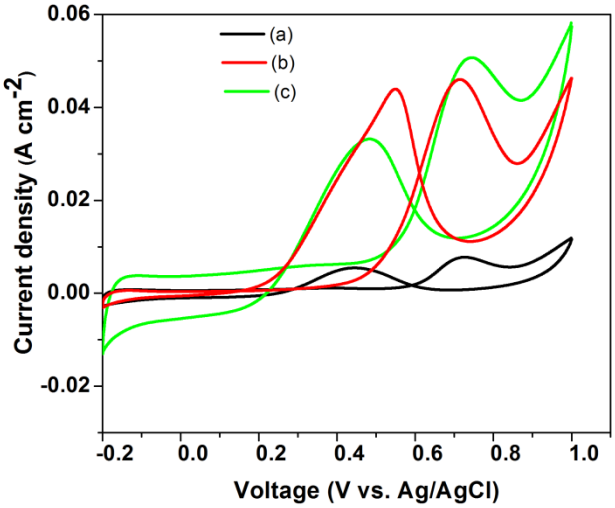

Figure S3. Cyclic voltammogram of (a) Pt/C, (b) Pt/f-MWNT and (c) Pt/CNS-FSO.