Carbon and Composite Nanostructured Materials for Energy Applications

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Carbon nanostructured materials are widely used in different energy applications: fuel cells, supercapacitors, Li-ion batteries etc [1, 2]. Several synthetic approaches can be used for preparation of CNTs, graphene etc, such as: CVD, exfoliation. At the present work we adopted the sacrificial support method (SSM) developed at UNM group [3-10].

Several types of CNTs were synthesized by combination of CVD with SSM. The morphology control was achieved by variation of initial seeds sizes, atmosphere of CVD, alloying of several transition metals. After successful synthesis of CNTs the sacrificial support was leatched by means of concentrated HF. The later step involved the dissolution of metal and metal oxides nanoparticles. In order to decrease amount of amorphous carbon two types of etching were used: gas phase and wet chemical etchings.

The synthesized CNTs were used as a support for highly active bi-functional catalysts in the reactions of oxygen reduction (ORR) and oxygen evolution (OER). Figure 1 represents SEM image of MWCNTs grown on iron seeds.

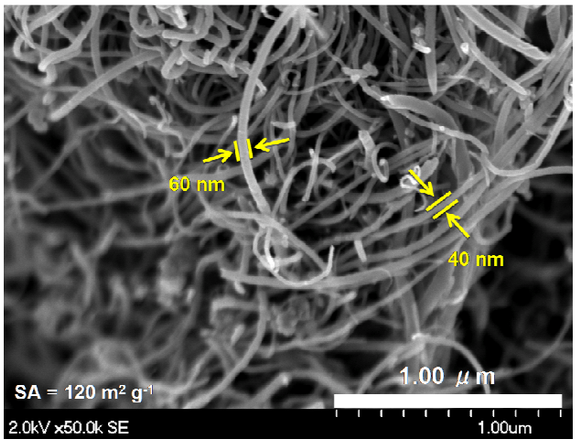

Figure 1: SEM image of CNTs grown on iron seeds.

Wet impregnation method followed by thermal decomposition of several nitrates was used for deposition of transition metal oxides onto the surface of carbon nanotubes (Fig. 2-3).

It has been observed that nickel and cobalt oxides can be dispersed on CNTs without substantial agglomeration in contrast to CuO and Fe_2O_3.

Electrochemical performance of different metal oxides/CNTs hybrid materials is shown on Figure 4. It was found that most active in ORR catalysts is based on MnO_2, while NiO has a superior activity in OER. The work on synthesis of MnO_2+NiO/CNT is ongoing.

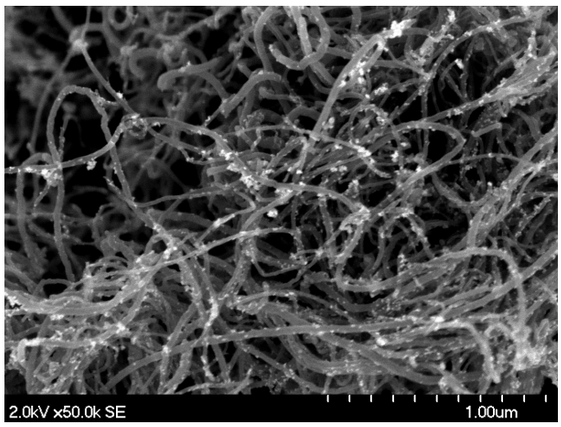

Figure 2: SEM image of NiO/CNTs hybrid material.

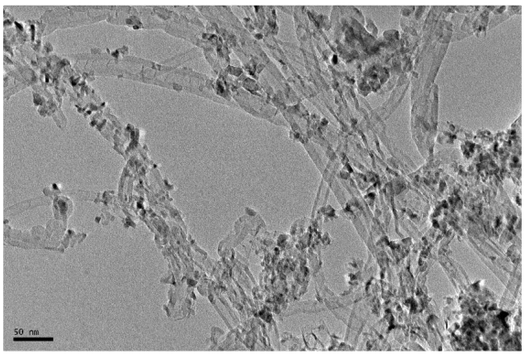

Figure 3: TEM image of NiO/CNTs hybrid material.

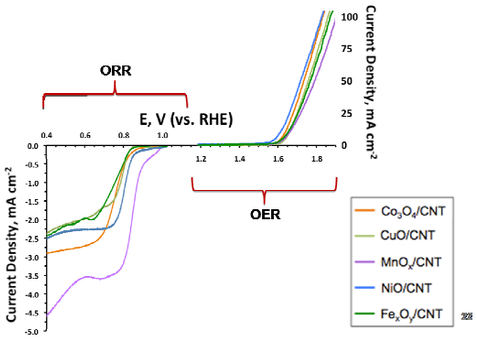

Figure 4: RDE data on ORR and OER of M_xO_y/CNTs.

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