Large production of nitrogen-doped multiwall carbon nanotubes using banded iron-formation: Electrochemical and sensing applications.

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Abstract

Natural catalyst is being an important route to obtain low-cost and massive production of carbon nanostructures. Here, we have used Band Iron Formation (BIF) powders (natural and ball milled) as catalyst for the large production of nitrogen-doped multiwalled carbon nanotubes (N-MWCNTs) in an aerosol assisted catalytic chemical vapor deposition (AACCVD) experiment. The morphology and composition profiles of BIFs powders and N-MWCNT samples were analyzed by scanning and transmission electron microscopies, X-ray diffraction, X-ray photoelectron (XPS), Raman spectroscopies, and thermogravimetric analysis. XRD characterizations revealed that BIF is mainly constitute of quartz and hematite. This result was also confirmed by Raman spectroscopy. Efficiency of 340 % wt./wt. in the yield production of N-MWCNTs was obtained for ball milled BIF powder for 1 h. The specific surface area of N-MWCNTs reached up to 37.87 m2/g. The type of nitrogen doping, oxygen functional groups, silicon and carbon species (sp^2 and sp^3) hosted at the surface of N-MWCNTs were quantified by the XPS. Electrochemical response of N-MWCNTs were evaluated by cyclic voltammetry to assess their applications as energy storage devices. Sensors based on N-MWCNTs were used for detecting solvent vapors. Magnetic hysteresis loops measurements revealed high coercive fields of N-MWCNTs, temperature dependence of the magnetic properties were also studied. Acid and thermal treatments on N-MWCNTs revealed an outstanding increase of the surface area.