Free-standing hybrid structure of vertically aligned carbon nanofibers onto three dimensional graphene for energy storage application

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A hybrid structure consisting of three dimensional (3D) graphene and carbon nanofibers (CNFs) is of great importance for a varieties of applications such as energy storage, gas adsorption, filtration,field emission and sensors. Doping heteroatoms, like nitrogen into such kind of structure enhances its functionality. Here we report the synthesis of a free standing structure comprising of nitrogen doped CNFs (N-CNF), which are vertically aligned onto nitrogen doped, three dimensional graphene (N-3DG). A nickel catalyst framework was used to grow N-3DG using ammonia (NH_3) and methane (CH_4) at 825^oC by thermal chemical vapor deposition (CVD). Further, N-CNF was synthesized by plasma enhanced CVD (PE-CVD) with NH_3 and acetylene (C_2H_2) as precursors for N and C, respectively. Field emission scanning electron microscope (FE-SEM) images showed highly aligned CNFs grown on 3DG by tip growth mechanism. The diameter ranges between 50-150 nm depending on synthesis conditions. Raman spectroscopyand X-ray photoelectron spectroscopy (XPS) revealed the level of nitrogen doping into the hybrid structure. The electrochemical behavior of this novel materialwas studied using cyclic voltammetry and electrochemical impedance spectroscopy, which showed promising results for its application as a supercapacitor.