AUTOMATIC SUCCESSIVE IONIC LAYER ADSORPTION AND REACTION METHOD FOR DEPOSITION OF NANOSTRUCTURED ZINC OXIDE ARRAYS ON CARBON FABRIC

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Zinc oxide (ZnO) is a multifunctional wide bandgap semiconductor material with diverse applications. In particular, ZnO nanorod arrays can be coated on carbon fabric (CF) to reinforce the friction material, since the chemical bond -C-O-Zn- between the ZnO nanostructure and the carbon fiber in the thus obtained CF/ZnO fabric provides high strength and stable coefficient of friction. The use of CF/ZnO fabric as a matrix in a multilayer polymer composite has enabled the creation of products with improved mechanical properties and outstanding tribological characteristics, which are used in transmission and braking systems of vehicles. A promising approach is the use of CF to create a triboelectric material CF/ZnO for triboelectric nanogenerators and autonomous shock, pressure and vibration sensors. Herein, we explore two modes of an automatic Successive Ionic Layer Adsorption and Reaction (SILAR) method for growing nanostructured ZnO arrays on carbon fabric. It has been experimentally proven that the automatic SILAR method, depending on the deposition mode, makes it possible to create CF/ZnO materials that differ from each other in the morphology, composition and properties of nanostructured ZnO layers. If the carbon fibers were pre-coated with seed layers of ZnO, a fairly uniform coatings of multidirectional intergrown short ZnO nanorods with rounded ends were formed. However, when the ZnO layers were fabricated by the automatic SILAR method on bare carbon fabric, we obtained arrays of standing zinc oxide nanosheets with a (0002) basal plane of hexagonal wurtzite structure and a unique *a*-axis texture, tightly bonded to each other that have been revealed by scanning electron microscopy studies. The thickness of the ZnO nanosheets was in the range of 50–200 nm, and their width varied from 400 nm to 5 μm due to spatial constraints. Raman spectra confirmed the hexagonal wurtzite crystal structure of both types of ZnO layers and the *a*-axis texture of zinc oxide nanosheets located in the direction perpendicular to the carbon fiber surface. Both types of CF/ZnO fabrics exhibited significant diffuse optical reflections, which is in good agreement with their morphology and thickness of ∼1 μm for the intergrown short ZnO nanorod array and ∼20 μm for the ZnO nanosheets. Both these ZnO arrays have a direct optical bandgap of 3.25 eV, close to that of bulk zinc oxide 3.37 eV. According to Raman studies, both types of nanostructured ZnO arrays contain defects in the form of oxygen vacancies. In addition, ZnO layers in the form of interconnected nanosheets contain a large amount of sulfur from the sulfate solution used in the automatic SILAR method, which is explained by their particularly large specific surface area. It should be noted that the CF/ZnO fabrics are thermally stable, as no shift, broadening, or change in the intensity of the Raman peaks due to local heating by the laser beam was observed in the Raman study.