Structural and electrical studies on carbon-silica nanocomposites elaborated by sol-gel method

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Abstract:
The general class of organic/inorganic nanocomposites materials is a fast growing area of research. Their electrical properties can be engineered by tuning the fabrication method, processing conditions and filler's geometric and physical properties. In this work, carbon-silica nanocomposites were elaborated by sol-gel technique. Silica aerogel nanoparticles are first prepared in supercritical conditions of the solvent after dissolving tetraethoxysilane (TEOS) as a precursor of silica in ethanol. SiO₂ nanoparticles were then mixed with resorcinol-formaldehyde (RF) carbon precursor solution with several concentrations ranging between 0.20 and 0.99. The samples were dried by increasing temperature from ambient to 150 °C by step of 10 °C/day and then pyrolysed under controlled argon atmosphere at different temperatures between 600 and 1500 °C. The TEM image of nanocomposite with 50% of RF concentration and pyrolyzed at 675 °C (RF-SiO₂-0.5-675) shows that the sample was mainly composed of homogenous spherical nanoparticles with 14 to 20 nm in diameter. The nanoparticles were found to have various shapes and were more agglomerated. The XRD investigations carried out on samples pyrolyzed at 675 °C outline that the materials have an amorphous structure for all RF concentrations. The V-I characteristics for RF-SiO₂-0.5-675 sample exhibit a non linear behavior for all measurement temperatures ranging between 80 and 300 K. Furthermore, the ac-conductivity measurements show that samples have a semiconductor behavior.