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Growth Model and Properties of a 3D Carbon Aerogel

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Abstract : Aerographite is a 3D interconnected carbon foam. Its tetrapodal morphology is based on the zinc oxide (ZnO) template structure, which is replicated in the chemical vapour deposition (CVD) into a hollow carbon structure. This replication process is analyzed in ex-situ studies via interrupted synthesis and the observation of the reaction progress by using scanning electron (SEM), transmission electron microscopy (TEM) and Raman spectroscopy techniques. Based on the epitaxial growth process, with a layer-by-layer growth behaviour of the wall thickness or number of layers and the catalytical graphitization of the deposited amorphous carbon into graphitic carbon by zinc, a growth model is created. The properties of aerographite, such as the electrical conductivity is dependent on the graphitization and number of layer (wall thickness). Wall thicknesses between 3 nm and 22 nm are achieved by a controlled stepwise reduction of the synthesis time on the basis of the developed growth model, and by a further thermal treatment at 1800 °C the graphitization of the presented carbon foam is modified. The variation of the wall thickness leads to an optimum defect density (ID/IG ratio) and the graphitization to an improvement in the electrical conductivity. Furthermore, a metallic conducting behaviour of untreated and 1800 °C treated aerographite can be observed. Due to these structural and defective modifications, a fundamental structural-property equation for the description of their influences on the electrical conductivity is developed.

Keywords : electrical conductivity, electron microscopy (SEM/TEM), graphitization, wall thickness
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