Structural and physical properties of wood-derived biocarbons

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In the present paper we represent the results on a correlation between microstructure and physical properties of biocarbons derived from beech wood by carbonization at different temperatures T_{carb} in the range 600-2400°C. The temperature dependences of the electric resistivity ρ, thermal conductivity æ and thermoelectric power S have been studied in the temperature range 4-300 K. The structural investigation was performed by XRD at 300 K.

According to XRD data the biocarbons have bi-modal microstructure which consists of amorphous phase and nanocrystallites (of three-dimensional graphite and two-dimensional graphene). With increasing T_{carb} from 800 to 2400°C, the size of nanocrystallites increases from 10.2 to 29 Å for graphite and from 24 to 60 Å for graphene components. The amount of nanocrystallites also grows with increase in T_{carb}. It was shown that T_{carb}~900 K is critical point for the change of electrical conductivity mechanism as well as of the character of S(T) and æ(T) dependences. The dependences ρ(T) for the biocarbons with T_{carb}<900°C are adequately described by the Mott law for the variable-range hopping conduction. The crossover to the conductivity characteristic of disordered metal systems is observed at T_{carb}≥1000°C. Analysis of experimental data ρ(T), S(T) and æ(T) showed that in the samples with T_{carb}<900°C the amorphous phase determines the behavior of these parameters, whereas in the samples with T_{carb} ≥1000°C the main role belongs to nanocrystallites.

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