Magnetic studies of nanodiamond – copper composites synthesized at high pressure and high temperature

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Some widely used electrical and heat conductors such as copper and silver are the materials with low wear resistance and the enforcement of their abrasion resistance is the task which may be successfully solved by using the detonation nanodiamonds (DND). A series of copper composites with the inclusions of 0 wt.% DND was prepared at HPHT conditions (P~7 GPa, T=1100-1900°C, t=60 s).

The composites were studied by means of magnetic susceptibility (MS) method in the temperature range 2-300 K. The MS of all the samples follows well to the Curie-Weiss low in the temperature range below 100 K. The Curie-Weiss term in the MS is related with the presence of paramagnetic spins (S=1/2) or unpaired free radicals locating in the DND particles and not in the host copper matrix. Recently we found that these paramagnetic spins (S=1/2) are originated from the own point-like defects of diamond lattice which are located within thin (~1.5 nm) undersurface layer of DND particles with mean size ~5 nm [1]. The concentration of localized spins in a diamond phase of synthesized composites is about 5.4-6.0×10^{19} g^{-1}, which is a little bit lower than that one in pristine DND in the powder form (~6.3×10^{19} g^{-1}). The increasing the temperature of HPHT synthesis from 1100°C to 1700°C does not practically affect on the concentration of unpaired radicals in DND phase although the subtle reducing of this value with raising the synthesis temperature is clearly seen. These results mean that during rapid HPHT synthesis of Cu/DND composites DND particles inside the matrix do not subjected to the intensive graphitization process and their crystalline cores are well conserved and unconventionally stable in a melted copper. Such stability can be easy understood taking in mind the facts that copper does not create compounds with external carbon atoms of DND and own defects of DND are not so movable at short time of HPHT synthesis. From the other hand the obtained results mean that own paramagnetic radicals of DND particles can serve as an unconventionally stable spin markers for some special tasks related with identification of objects with inclusions of detonation nanodiamonds.

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[1] A.I. Shames, V.Yu. Osipov, A.E. Aleksenskiy, E. Ōsawa, A.Ya. Vul'. *Diamond Relat. Mater.* **20** (2011) 318.