

Study of the Possibility of Nanodiamond Particles Transformation into Carbon Onions in Metal Matrix Composites when Heated in Non-Oxidizing Conditions

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Abstract

It is known that when heated in non-oxidizing conditions at more than 1000°C, nanodiamonds are transformed into onion-like carbon nanoparticles [1]. Various methods have been developed to produce metal matrix composites with both agglomerated and non-agglomerated nanodiamond reinforcing particles [2]. What is of interest here is the possibility of transformation of nanodiamonds contained in a metal matrix in carbon onions, since it enables to produce a new composite material. Copper and nickel were taken as the matrix. Composite granules were produced by mechanical alloying. Annealing was performed in argon or in vacuum: copper specimens were heated up to 1050°C, nickel specimens – up to 1200°C. The produced material was studied by scanning and transmission electron microscopy and differential scanning calorimetry (DSC) methods. Fig.1 shows an onion-like particle in a copper matrix, suggesting the possibility of nanodiamonds transformation into carbon onions, if nanodiamonds are contained in a metal matrix. But there was another effect discovered. The composite granules after they were taken from the planetary mill jars where mechanical alloying had taken place were subject to increased oxidation at room temperature. The oxides produced chemically reacted with nanodiamonds (chemical element – carbon) when heated. The DSC curves clearly show the beginning of these chemical reactions (Fig.2). It results in the decrease of nanoparticle content in a composite. To eliminate this adverse effect, all operations shall be carried out in non-oxidizing conditions.

References

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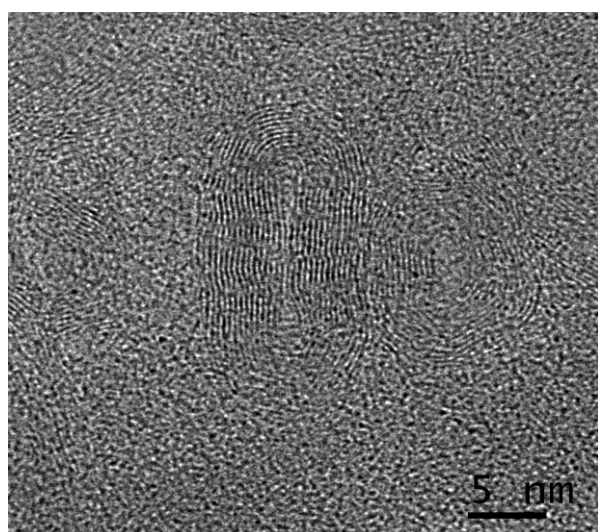


Figure 1. Onion-like carbon nanoparticle inside copper matrix (TEM)

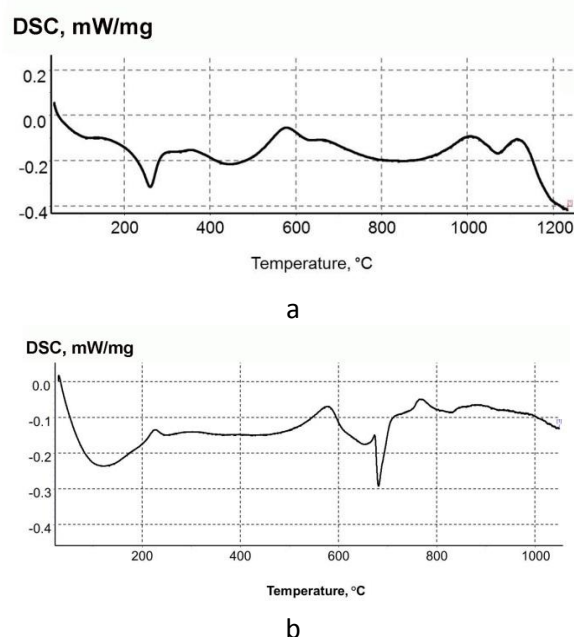


Figure 2. DSC curves for composites: a-Ni+ND; b-Cu+ND. Reaction between ND and oxides starts around 550°C