Nanocomposites and nanomaterials

Abnormal solubility of iron-copper nanocomposite components during high-energy mechanical processing

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In this paper we studied specimens of nanocomposite materials (NCM), which were prepared from the following components: PMS1 copper powders, PI1 iron powder, and Multiwall Carbon Nanotubes (MCNT). MCNT were added to the iron-copper mixture in the amount of 0.5 to 2 vol. %. Different proportions of *Fe* and *Cu* concentrations in the respective mixtures were used: 2:1; 4:1, 6:1, 3:7, 2:8 and 1:9. After mixing, the input powders were treated in a planetary-type ball mill (acceleration – 50 *g*, pressure on the substance particle – 5 GPa). Diffraction patterns of the specimens of the materials were obtained on DRON-4.0 automated X-ray machine using filtered cobalt X-rays $K_\alpha = 0.17909$ nm (at a discrete mode).

Our X-ray studies show that interaction of *Fe* and *Cu* powders in the NCM components mixing process leads to formation of metastable solid solution of *Fe* in *Cu* and *Cu* in *Fe*. The parameters of both *Fe* and *Cu* lattices are usually characterized by a nonmonotonic variation with an increase of the powder mixtures treatment time (τ) in the mill. A significant increase of the parameters for the majority of the specimens was observed at $\tau \leq 20$ min, which is characteristic for intense dissolution of *Fe* in *Cu* and *Cu* in *Fe*. It is significant that no X-ray reflections from the bcc lattice of iron were observed when *Fe* and *Cu* powders mixing time was $\tau > 120$ min for the following Fe/Cu proportions: 3:7, 2:8, 1:9. Furthermore, the material obtained from these pressed mixtures is not ferromagnetic, which is an indication of absence of *Fe* phase in the precursors. Presence of the nanotubes, although being an obstacle for formation of the powder particle agglomerates during the initial treatment stages, in the long run does not impede formation of metastable solid solutions of *Fe* and *Cu*.