Influence of nanostructural carbon forms on deformation behaviour of copper at mechanical activation

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Nanocarbon modification of metals and alloys appears to have considerable promise in developing materials of the new generation. Several approaches such as production of ultra strong film coatings at metal and carbon co precipitation, the use of super high deformations in Bridgmen anvils are considered for the metals to be obtained. Mechanical grinding by high voltage mills to obtain a super saturated solid solution of carbon in metals, the metals being inactive to carbon under normal conditions, is one of the promising technologies as well. Copper is one of the metals mentioned above.

Nanocomposites, Cu-C (5 и 25 at.%C), have been produced by mechanical activation. Powders of mixed fullerites, $C_{60/70}$ (~18%C_{70}), graphite, Cg, and multilayer carbon nanotubes have been chosen as carbon materials. The samples have been tested in AGO-2S ball mill under inert gas conditions (P=0.1 MPa), a power being equal to 28.1 Vt. To study the structural changes of samples after activation the x-ray structural analysis, optic metallography, scanning electron microscopy, as well as the method of micro hardness measurements have been employed.

It has been shown that in the process of copper synthesis with various carbon forms in the initial mixture a different mechanism of Cu particles deformation is observed. It has manifested about significant differences in the texture of the samples and kinetics of crystalline particles grinding (the form and dispersion). Thus the samples with a lesser carbon content 5 at.% differ greatly from the others. Being mechanically treated for less than 2 hours Cu particles take the form of equal-axis powders, balls and scales for $C_{60/70}$, Cg и C_{nt} accordingly. So all compared Cu-C are of different micro hardness. The Cu-Cg composite has shown the greatest micro hardness, 159 kGs/mm^2, and for Cu-$C_{60/70}$ and Cu-C_{nt} it amounts 125 kGs/mm^2 and 143 kGs/mm^2. The essential particle micro hardness increase in Cu suggests that carbon has a pronounced effect on strengthening the metals. At 25 at.%C the particles of the composites obtained differ, mainly, in size.

The x-ray structural investigations have shown that (regardless of the allotropic carbon form) if the time of grinding the particles increases the amount of micro distortions in the copper lattice rises, the areas of coherent scattering decrease and the copper lattice increases in size. The lattice increase may be caused by deformation dissolution of carbon producing the resulting formation of supersaturated solid solution in copper. Kinetics of the solid solution formation depends on the form and amount of carbon and the time of mechanical milling.

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