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FABRICATION OF Cu-Cr NANOCOMPOSITES FOR ELECTROTECHNICAL APPLICATIONS

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Summary: Metals and their alloys with a grain size in the nano- and submicrometer scale are of special interest because of their exceptional mechanical and physical properties.
Last decades Cu-Cr matrix composites have been of current interest due to excellent combination of high density, mechanical strength, electrical and thermal conductivities. They are considered to have great potential for their use as electric contact and brush materials at normal and elevated temperatures [1-4]. One of the essential aspects of high quality Cu-Cr bulk materials require that initial components should be mixed in a submicron- and nanostructural level. Namely, Cu phase must be uniformly distributed in a Cu matrix and the size of Cr particles should be in a nanometer range. However, Cr has very little solubility in Cu under equilibrium condition [5]. Analysis of the available literature shows that nanostructured pseudo-alloys may have advantages for electrotechnical applications as compared to conventional micro-sized composites.
In the present study a set of nanocomposite Cu–Cr powders with the grain size of these immiscible metals below 5 nm were prepared by high-energy ball milling. The powders were then consolidated by short-term (5 min) spark plasma sintering at 700–900 C under pressure (50 MPa) to obtain essentially pore-free pseudo-alloys. The grain sizes in the produced bulk materials remained within the ranges 5–60 nm for Cr-based phase and 200–300 nm for Cu-based matrix. These nanocomposites have a Vickers microhardness up to 3.9 GPa and a specific electrical resistivity in the range 6–9.6 μΩ cm, which make them promising candidates for the application in high-voltage circuit breakers.

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