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Development of high strength high conductivity metal matrix Cu-Nb composites with nanoscaled microstructure

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The progress in a variety of challenging projects in science depends on the availability of the materials with extremely high performance parameters. As an example, the development of the non-destructive pulse magnetic systems with extremely high induction up to 100 T requires the use of the winding wires with very high strength and high conductivity. Unique combination of the mechanical strength (ultimate tensile strength higher than 1000 MPa) and conductivity at the level of 70% IACS could not be attained in commercially available electro technical alloys. The recent advances in exploration of the mechanism of anomalous increase of strength in metal matrix microcomposite materials with nanoscaled microstructure have provided a basis for the research on new type of technically useful winding wires. The long length wires with large rectangular cross sections up to 4 mm×6 mm having ultimate tensile strength (UTS) higher than 1200 MPa and conductivity up to 70% IACS have been successfully designed and fabricated. The present state of microcomposite Cu-Nb winding wire development will be given focusing on the complex interrelations between microstructure, mechanical and physical properties altogether with fabrication issues. The role of the specific structure of boundary regions in microcomposite materials connected with strong texturing will be analyzed. The properties of the microcomposite Cu-Nb winding wires at cryogenic temperature will be presented. In particular fatigue testing at 77K has shown that the designed wires could withstand extremely high loads up to 1400 MPa during more than 1000 cycles. The questions of stability of the developed nanoscaled Cu-Nb winding wires will be reviewed. It was shown that the wires with different designs did not practically change the performance parameters in ambient temperature of up to 200℃.

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