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INTERNAL FRICTION OF THE Cu–NbTi SUPERCONDUCTING COMPOSITE AFTER COMBINED PLASTIC DEFORMATION

By internal friction (IF), relaxation processes in the Cu–NbTi composite obtained by combined plastic deformation with equal channel multi angle pressing (ECMAP), hydrostatic extrusion (HE) and drawing in a temperature range of 100–900 K were studied. At low temperatures (< 300 K), peaks of the temperature dependence of IF of the composite prepared using ECMAP at 150 and 270 K were detected. From the comparison with the temperature dependence of IF of copper and the NbTi alloy, it can be concluded that they are determined by deformation of the composite at the interface under the influence of thermal stress. The disappearance of the peaks during the second cooling after heating points at their deformation nature. The lack of low-temperature peaks in the composite obtained without of ECMAP, and their presence at applied sign-alternating strain may be related to several reasons: different levels of microstrain in the samples, maintaining of good adhesion between the copper and the alloy with axially symmetric deformation of HE and drawing as opposed to alternating strain of ECMAP, the difference in the coefficients of linear thermal expansion of the composite components. As the temperature increases from 100 to 900 K, the value of IF increases by order. At the same time preliminary deformation by ECMAP increases IF to 30% in comparison with the composite obtained by HE and drawing. At $T > 300$ K, IF peaks of the tested materials are detected at temperatures of 525–550 and 660–670 K. Comparison of the activation energy calculated by the Wert–Marx formula, with the published data allowed suggestion that the first peak is due to the redistribution of impurity atoms of oxygen, which are located at octahedral voids of the titanium lattice under external alternating voltage of small value. The second peak of IF corresponds to superimposed recrystallization and grain boundary peaks of IF of the copper matrix. The quantitative evaluation of the activation parameters of relaxation processes was obtained.

Keywords: internal friction, equal channel multi angle pressing, composite

Fig. 1. Low-temperature (I) and high-temperature (II) IF of the Cu–NbTi composite and its components: *а* – ECMAP (□ – $e_{ECMAP} = 9.84$, ● – $e_{ECMAP} = 13.12$) + HE + drawing; *б* – HE + drawing (■ – Cu, △ – NbTi, ○ – Cu–NbTi)