Critical current of MgB_2 microbriges

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Last decade the multiband superconductor MgB_2 became a wide used novel superconducting material. For technical applications the most important problem is critical current enhancement. In the present work we study the peculiarities of the critical current of MgB_2 extracted from current-voltage (I-V) characteristics. The (I-V) characteristics of two parallel connected MgB_2 microbriges (of 3 μm width and a diameter of the quantization loop about 3 μm) have been measured at different temperatures in the constant current regime. This circuit was made by a laser scribing (nitrogen laser with 337 nm wavelength) from a textured a-axis oriented MgB_2 film grown on MgO (100) substrates with a critical temperature T_c=37,7 K. The critical temperature of the prepared microbriges was lower than T_c of the film because of the sample inhomogeneity, appeared during laser treatment. It was found from X-ray diffraction analysis that the coherent scattering region (the size of crystallites) calculated on the basis of the halfwidth of the diffraction peak (100) MgB_2 is about 45 – 50 nm. All of the I-V characteristics were registered during the current sweeping from $-I_{max}$ to $+ I_{max}$ and back (fig. 1). As we can see from the data of fig. 1, the I-V curves are hysteretic, have voltage steps and an excess current. The voltage steps on the curves can be explained either by formation of phase slip centers [1] or by switching of a network of Josephson junctions to the resistive state [2]. For phase slip phenomenon is typical a presence of an excess current and a constant differential resistance of steps. In our case, however, the main feature of the voltage steps is nonlinearity, i.e. the differential resistance slightly decreases with the current increasing. This nonlinearity can be related to the resistivity due to the flux motion [3]. In fig. 2 the temperature dependence of the critical current of measured MgB_2 microbriges is presented. In order to determine which mechanism of resistivity works it is necessary to study Josephson properties of microbridges [4] and to conduct low temperature laser microscopy scanning [5] for a visualization of the spatial distribution of resistive areas along microbridges.

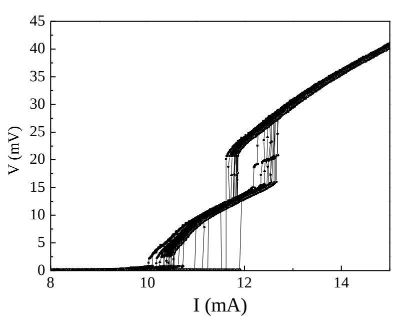

Figure 1. The I-V characteristics of two parallel connected MgB_2 microbriges at different temperatures.

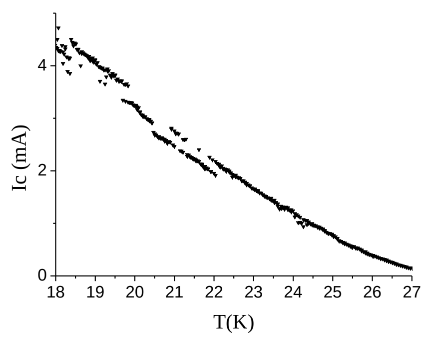

Figure 2. Temperature dependence of the critical current of measured MgB_2 microbriges.

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