Nanocomposites and nanomaterials

LOW-TEMPERATURE THERMOMETRY BASED ON HIGH-T_c SUPERCONDUCTOR TUNNEL JUNCTION

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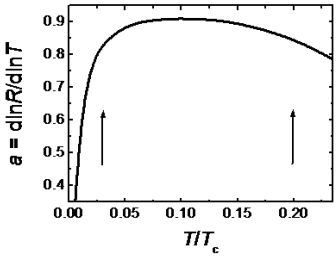
Low-temperature thermometry is a subject of broad scientific interest with a wide variety of sensors. Mainly they are resistors, secondary thermometers which should be calibrated with primary ones, whose thermometric parameter follows a known law. Normal-metal – nano-scaled insulator – superconductor (NIS) tunnel junctions were proposed as perspective primary thermometers for measurements around and below liquid-helium temperatures.

An important characteristic of any resistance thermometer is its sensitivity $a = d\ln R / d\ln T$. Calculations for conventional *s*-wave superconductors have shown that related NIS devices have a nearly temperature independent sensitivity when the junction is biased close to the superconducting gap. In order to increase the temperature range and to permit measurements at zero (but not finite) voltages, we have analyzed temperature dependence of the current in a NIS tunnel junction with the *d*-wave symmetry of the superconducting order parameter.



The maximal conductance was found for the S-film orientation when the normal to junction interfaces forms a 45^0 angle with crystallographic axes *a* and *b* in the copper-oxygen plane. The temperature effect on the parameter *a* is shown in the figure. The arrows indicate the temperature interval where the NIS-device sensitivity is almost constant. Since the critical temperature of high-Tc superconductors can be of the order of 100 K, their usage can substantially expand the range of operating temperatures from 2 to 20 K.

The work was performed within the German-Ukrainian project SE 664/18-1 supported by Deutsche Forschungsgemeinschaft (DFG).