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Transporteigenschaften von SINIS-Kontakten

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The transparency of the tunnel barriers in double-barrier junctions influences the critical current density and the form of the current-voltage characteristics. We have performed a systematic study of the influence of the barrier transparency on critical current and normal resistance by preparing SIS and SINIS junctions based on Nb/Al oxide technology under identical technological conditions and comparing their transport properties. We have fabricated Nb/Al-Oxid/Al/Al-Oxid/Nb devices with different current densities using a conventional fabrication process, varying pressure and oxidation time. Patterning of the multilayers was done using conventional photolithography and the selective niobium etching process. The current density of SIS junctions was changed in the range from 0.5 to 10 kA/cm^2. At the same conditions the current density of SINIS devices revealed 10 to 1000 A/cm^2 with non-hysteretic current-voltage characteristics and characteristic voltages of 300 μV. In SINIS junction fabricated with an extreme short oxidation time and low oxygen pressure we obtained current densities up to 26 kA/cm^2 and characteristic voltages of 450 μV.

The transport properties have been investigated in the temperature range from 8 K to 0.3 K. By comparing the experimental and theoretical temperature dependence of the $I_C R_N$ product we estimated the barrier transparency in terms of the effective suppression parameter γ_{eff}. The comparison shows a good agreement of experimental data with the theoretical model of tunneling through double-barrier structures in the dirty limit and gives $\gamma_{eff} \approx 300$ with an asymmetry parameter $\gamma_- \approx 0.2$ for junctions with a current density 1 kA/cm^2. For junctions with 26 kA/cm^2 we estimated a $\gamma_{eff} \approx 300$ assuming a symmetric barrier. Taking into account the limited characteristic voltage for these high current densities we conclude that in these devices the asymmetry is substantial and will be included in the calculation in the next future.

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