Nanoscale physics

Analysis of optimal barrier configurations for self-shunted Josephson junctions

P. Febvre[1], M. Belogolovskii[2,3], E. Zhitlukhina[2], O. Prokopenko[4]

[1] *IMEP-LAHC – CNRS UMR5130, Université Savoie Mont Blanc, 73376 Le Bourget du Lac, France*
E-mail: Pascal.Febvre@univ-smb.fr

[2] *Faculty of Physics and Technology, Donetsk National University, 600-richchia Str., 21, 21021 Vinnytsia-21021, Ukraine.*

[3] *Superconducting Electronics Department, Institute for Metal Physics, Natl. Acad. of Sci. of Ukraine. Academician Vernadsky Boulevard, 36, Kyiv-03680, Ukraine.*

[4] *Faculty of Radio Physics, Electronics and Computer Systems, Taras Shevchenko National University of Kyiv, Kyiv-01601, Ukraine*

The main device of superconducting micro- and nano-electronics is the Josephson junction formed by two superconducting (S) electrodes with an interface which is weak enough to allow only a slight overlap of electron-pair wave functions from the two electrodes. Conventional SIS devices with a nm-thick insulating (I) interlayer are inherently underdamped and exhibit hysteretic response due to capacitive effect, whereas in superconducting digital applications overdamped Josephson junctions with non-hysteretic current-versus-voltage (*I-V*) characteristics are needed.

In this contribution, we discuss two novel technologies for fabricating self-shunted Josephson junctions of SIS type (I stands for an ultra-thin semiconducting interlayer with embedded metallic nanoscale drops) and SNIS type (N is the normal film of about 100 nm of thickness in contact with a strongly disordered I layer where stochastic distribution of transparencies takes place on a local rather than on a global scale) , both resulting in a single-valued *I-V* curve.

It is shown that the ratio of the critical supercurrent I_c to the excess current can serve as an indicator of the internal structure of a weak link in Josephson junctions. We have calculated temperature dependence $I_c(T)$ for SNIS junctions with an N=Al film in an intermediate state between dirty and clean limits and compared our numerical simulations with experimental data.

The publication is based on the research provided by the grant support of the State Fund For Fundamental Research of Ukraine (project F64/008, Section 1). The authors are thankful to the French-Ukrainian Partenariat Hubert Curien (PHC) DNIPRO N° 34849XH project for financial support.