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(O-10)

Can HTS Josephson junction be used for digital application?

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Recent theoretical and experimental achievements in fabrication and investigation of the RSFQ digital circuits have confirmed their advantages in comparison with the silicon technique. The several digital RSFQ cells have been successfully fabricated and tested. Unfortunately at the present moment only Nb-AlO_x-Nb Low-T_c technology process was used for fabrication RSFQ circuits. Such junctions were chosen due to their good reproducibility and suitability for integrated processes. For the realization of the RSFQ logic circuits the junctions with nonhysteretic i-v curves are needed. To have it the external shunts have to be used. This leads to the suppression of the characteristic voltage of junctions (I_cR_n) and limits the clock frequency. Moreover they require the extra place on the microscheme decreasing the degree of integration.

The HTSC Josephson junctions seem to be the suitable candidates for the replacement the all Nb junction in RSFQ schemes since they have

- nonhysteretic I-V characteristic,
- high I_cR_n product (practically five times larger than in Nb-AlO_x-Nb at T = 4.2 K).

The goal of the report is to analyze the possibility of using HTS Josephson junctions in RSFQ digital application. The main principals of the RSFQ circuitry are discussed and the basic limitations are formulated. According with them the main demands for the technology of the HTS Josephson junction fabrication are discussed as well as the possibility of using available types of the HTS junctions.

(O-11)

Effect of Vortex Fluctuations on *Tl* Spin-Lattice Relaxation in the Mixed State of $Tl_2Ba_2CuO_6$

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The behavior of the nuclear spin-lattice relaxation below T_c can give a useful information concerning the pairing state of a superconductor. In particular, in the case of s-wave pairing the relaxation rate has a gap-like temperature dependence, whereas d-wave pairing would result in a power-like temperature law. The latter was reported to be observed for the planar *Cu* and *O* relaxation rate in YBCO[1] so that a non-trivial mechanism of pair formation can be assumed. The above assertions are true only if the nuclear spin relaxation is determined by conduction electrons. However, in the interpretation of the NMR data at temperatures below T_c one has to account for the presence of vortices which always exist in the sample, as far as the measurements are performed in a magnetic field, and thus can complicate the picture[2]. We present the NMR data on the temperature and field dependences of ^{205}Tl spin-lattice relaxation rate, W, in $Tl_2Na_2CuO_6$ and show that vortex fluctuations constitute a dominant mechanism of the low temperature relaxation in this highly anisotropic superconductor. We observed that at temperatures far below T_c, W varies linearly with temperature and decreases with increasing field. Such a behavior can be associated with fluctuations of the pancake vortices. We have separated vortex and quasiparticle contributions to the relaxation rate in the superconducting state and found out that the quasiparticle W exhibits the gap-like behavior down to 20K implying the s-wave pairing. On the other hand, the gap-like dependence begins with temperatures fairly close to T_c whereas in conventional BCS superconductors it should be visible only below $\sim 0.5T_c$. We show that W measurements provide information about the dynamics of the vortex lattice excitations analogous to phonons in the crystal lattice, on their density of states, and on the vortex viscosity.

1. J.A.Martindale, S.E.Barrett, C.A.Klug, K.E.O'Hara, S.M. De Soto, C.P.Slichter, T.A.Friedmann, D.M.Ginsberg, Phys. Rev. Lett. 68, 702 (1992).

2. D.E.MacLaughlin, in Solid State Physics, ed. by H.Ehrenreich, F.Seitz, D.Turnbull (Academic, New York, 1976).

(P1-18)

BICRYSTAL JOSEPHSON JUNCTIONS: FABRICATION AND CHARACTERIZATION

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The Josephson junctions have been fabricated by laser depositing of YBaCuO thin films on bicrystal $SrTiO_3$ substrates and following photolithografic and laser scribing processes.

Application of complex diagnostics, including optical and X-ray diffraction investigations, allowed us at the earlier fabrication stages to define very effectively the degree of potential suitability of the substrates and high-T_c thin films for following utilization.

The temperature dependencies of the important characteristics of the Josephson junctions: critical current I_c, normal resistance R_n and characteristic voltage $V_c=I_cR_n$; diffraction-like critical current dependence from external magnetic field have been measured and discussed. Theoretical model of SNS sandwiches was suggested to explain the experimental dependencies.

(P1-19)

Stationary properties of the HTS SNS Josephson junction

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In the framework of the microscopic theory of superconductivity the stationary properties of the HTS Josephson SNS type junctions have been investigated. It was assumed that according to the experimental data the SN boundaries of the structures posses the small transparency and the suppression of the superconductivity in S-electrodes in the near-boundary region is negligibly small.

From the structure of the Usadel equation in the N interlayer and the boundary conditions at the SN interfaces it was shown that the approximation R >> I is valued, where R and I are the real and imagery parts of the Usadel function. This open the possibility to find the analytical solution for the temperature dependence of the critical current under the appropriate values of the N-layer thickness d. The results of the calculations fits well the available experimental data.

HTS YBCO Films on SrTiO3 Substrates: Fabrication and Characterization.

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The detailed characterization of the YBCO films grown by laser ablation on $SrTiO_3$ substrates by using X-ray double crystal diffraction (DCD), X-ray topography, conventional X-ray difractometry and SEM has been carried out.

Two kinds of the substrates has been used. From X-ray topography it follows that the substrates "a" has a block structure with the typical sizes larger than 1 mm^2. The maximum angle of the block's misorientation in the [100] direction do not exceed 20 arcmin. The rocking curve of the (200) peak observed by Cu Ka_α radiation had a full width at half-maximum (FWHM) 4 and 3 arcmin for substrates "a" and "b" correspondingly. The angle α between the [001] direction and the normal to the substrates plane is smaller than 0,5°. For the substrates "b", X-ray topography and DCD results in the monoblock structure. The angle α is closed to 3,5°. The detailes of the film preparation has been published elsewhere [1].

The X-ray analysis of the films confirmed that they epitaxially grown with the c-axis perpendicular to the substrates. The X-ray rocking curve (ω-scan) of the (005) peak have FWHM 12 and 9 arc min for films on substrates "a" and "b" correspondingly. The SEM analysis have shown that the films has a smooth surface with the small amount of a-oriented overgrows in the films fabricated on the substrates "b".

The examination of the films confirms high degree of it's homogeneity with c-axis length 11.67 A.

1. Zach K., Borck J., Linzen S., Krausslich J., Schmidl F., Schneidewind H., and Seidel P. Journal of Alloys and Compounds 195, pp. 199-202 (1993).

NOISE AND STRUCTURAL DIAGNOSTICS OF YBaCuO FILMS ON THE VARIOUS SUBSTRATES

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Noise studies of superconductors allow to move us forward to understanding of the 1/f noise problem as well as the superconductivity origin. Noise of HTSC films has important meaning for bolometers. The present work was aimed to comparative noise studies of oriented YBaCuO films prepared by variuos methods on various substrates. The films were previously selected according to their structure quality using x-ray microanalysis, X-ray structure analysis, electron microscopy and Raman light scattering methods. We studied films on $SrTiO_3$, Al_2O_3 , $NdGaO_3$, $LaAlO_3$, YSZ, MgO/$BaSrTiO_3$ and Si/ZrO_2 substrates manufactured by laser ablation and magnetron sputtering. The film thicknesses are ~1500-2000 Å, $\rho(300)$=70-2000 $\mu\Omega\cdot$cm, Tc =85-91 K, ΔT=1,5-4 K. The test specimens are meander-type and bridge-type. We have been investigating the noise spectra in frequency range 1 - 10^6 Hz at 78 - 300 K and also current, resistance and magnetic field dependences of noise. Two components of 1/f noise were observed in experiment. The first component that was from 300 K to T_c depends on structure defects affecting on electrical conductivity in the normal state. Hooge's coefficient for noise at T=300 K varied in range α=0,5-1,4 for high-quality films. The least α was observed for films on MgO which had c-axis lied in substrate plane. The second component dominated in superconducting transition and had maximum at $R<R_n/2$. That noise increased with magnetic field. We assume two mechanisms of the magnetic-dependent noise: weak Josephson links on grain boundaries and vortice movement in grains. Using obtained results we made calculation of noise equivalent power of HTSC bolometers.