Nanoscale physics

Microwave properties of high-T_c superconductor films with implanted dielectric nanoparticles

A.L. Kasatkin[1], P.A. Borisenko[2]

[1] *G.V.Kurdyumov Institute of Metal Physics, Nat. Acad. Sci. of Ukraine, 36 Vernadsky st., Kiev, 03142, Ukraine*
E-mail: al_kas@i.ua

[2] *Radiophysics Faculty, Kiev T.Shevchenko National University, 4-g Glushkov Ave., Kiev, 03022, Ukraine*

High-temperature superconductor (HTS) thin films are of great interest for application in microwave technique (e.g., filters, resonators, transmission lines, antennas, etc.) because of small values of their microwave surface resistance [1]. The modern trend in manufacturing of practically used HTS thin films and coatings is implantation of dielectric nanoparticles in the interior of HTS materials [2]. The latter leads to significant increase of the critical current density j_c and also the activation energy U_c for the onset of vortex thermally activated motion.

In the present work we argue that implantation of dielectric nanoparticles in the interior of HTS film may be also favorable for microwave applications. In particular, this admixture (few molar percents) of dielectric nano-sized particles can noticeably improve the microwave characteristics of HTS films, namely: a) the surface resistance R_S decreases due to increase of the scattering rate for thermally excited quasiparticles; b) the additional strong pinning centers for Abrikosov vortices, which emerge in the films interior due to implanted nanoparticles, increase the rigidity (Labusch parameter) of an effective pinning potential well for vortex oscillations in the microwave field, thus leading to decrease of vortex contribution to the surface resistance $R_S(H_0)$ in applied dc magnetic field H_0;

c) implanted nanoparticles also cause an increase of the edge barrier for vortex entry in the film interior, thus enhancing the nonlinearity threshold and lowering the response nonlinearity at high microwave power levels. All these results agree well with some experimental observations, obtained on HTS thin films.

1. *Klein N.* High-frequency applications of high-temperature superconductor thin films // Rep. Prog. Phys. – 2002. – **65**, №10. – P. 1387-1425.
2. *Wee S.H., Zuev Yu.L., Cantoni C., Goyal A.* Engineering nanocolumnar defect configurations for optimized vortex pinning in high temperature nanocomposite wirws // Scientific Reports. – 2013. – **3**, Article no.: 2310.