Nanoscale physics

RF-electrodynamics of nanostructured high-T_c superconductors

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At present time dielectric phase nanoparticles implanted in the interior of high-temperature superconductors (HTS) are frequently used for improvement of transport characteristics and enhancement current-carrying capability of these materials due to strong pinning of Abrikosov vortices and impeding their dissipative motion under the Lorentz force action, caused by transport current flow through superconductor [1]. Besides that, dielectric nanoparticles implanted in the matrix of HTS film can noticeably improve its characteristics at microwave frequencies, as it was shown in some resent experiments (see, e.g.,[2]).

Here the theoretical model for microwave response of nanostructured high-T_c superconductor (HTS) film, with artificial dielectric nanoparticles, implanted in the films interior, is developed, and the microwave surface resistance $R_s(T,H,)$ is calculated both for the Meissner and mixed states of superconductor film in applied dc magnetic field. The nonlinear effects in the surface resistance $R_s(H_{ac},)$ caused by an entrance of Abrikosov vortices, induced by microwave field, through films edges are also considered. Obtained results indicate that implantation of dielectric nanoparticles in HTS material can significantly improve its characteristics at microwave frequencies. Namely, these implanted nanoparticles can decrease the surface resistance in the Meissner state, eliminate Abrikosov vortices oscillations and related microwave energy losses, thus decreasing the Abrikosov vortices contribution to the R_s value in the mixed state of HTS film, and noticeably increase the nonlinearity threshold of the microwave response.

1. Maiorov B., Baily S. A., Zhou H., Ugurlu O., Kennison J. A., Dowden P. C., Holesinger T. G., Foltyn S. R., Civale L. Synergetic combination of different types of defect to optimize pinning landscape using $BaZrO_3$-doped $YBa_2Cu_3O_7$ // Nature Mater.- 2009.- **8**.- P. 398– 404.

2. *Sato S., Honma T., Takahashi S., Sato K., Watanabe M., Ichikawa K., Takeda K., Nakagawa K., Saito A., Ohshima S.* Introducing Artificial Pinning Centers Into YBCO Thin Films to Improve Surface Resistance in a DC Magnetic Field // IEEE Trans Appl Supercond.- 2013.- **23**, N 3.- P. 7200404(1-4).