Nanoscale physics

High-frequency dynamics of Abrikosov vortices in nanostructured superconductors

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

[1] *Radiophysics Faculty, Kiev T.Shevchenko National University, 4-g Glushkov Ave., 03187 Kiev, Ukraine.*
E-mail: pavelborisenko@gmail.com

[2] *Institute of Metal Physics, National Academy of Sciences of Ukraine, 36 Vernadsky St., 03142, Kiev, Ukraine.*

Implantation of dielectric phase nanoparticles in the interior of high-temperature superconductors is a modern trend in fabrication of superconducting materials with a high current carrying capability [1]. The role of nanoparticls consists in pinning of Abrikosov vortices and preventing their dissipative motion under the Lorentz force action caused by transport current flow through superconductor. The pinning effect provided by implanted nanoparticles can be enhanced due to self-organization of dielectric nanoparticles at definite technological conditions in so called 'nanorods', which are linear one-dimensional defects inside superconducting matrix, providing strong pinning of Abrikosov vortices when magnetic field is oriented along the linear defect axis.

In the present work we develop a theoretical model for high frequency response of Abrikosov vortices in the mixed state of 3D anisotropic superconductor which contains: a) separate nanoparticles, which act like strong point-like pinning sites , and b) nanorods, which are linear defects for vortex pinning. We consider vortices as elastic strings and calculate for both cases the surface resistance $R_s(n_i, B, H_{rf}, \omega, T)$. Obtained results indicate that implantation of dielectric nanoparticles can significantly improve superconductor characteristics at microwave frequencies. This effect was observed in some recent experimental works [2].

1. *Xu A., Jaroszynski J., Kametani F., Larbalestier D.* Broad temperature range study of J_c and H_{irr} anisotropy in $YBa_2Cu_3O_x$ thin films containing either Y_2O_3 nanoparticles or stacking faults //Appl Phys Lett.- 2015.- **106**, N 5.- P. 052603(1-5).
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).