Enhancement of critical current density by large antidots in inhomogeneous arrays in YBa2Cu3O7 thin films

Antony, Jones[1,3], Jonathan, George[1], Mustafa, Al-Qurainy[1], Sergey, Fedoseev[1,2], Simon, Lam[3], Jia, Du[3] Anatoly, Rosenfeld[2], Alexey, Pan[1]

Alexey, V, Pan, pan@uow.edu.au, Institute for Superconducting and Electronic Materials, University of Wollongong, Australia

The current-carrying ability of type II superconductors can be effectively enhanced by introducing certain intelligent defects within the material. Antidots are a type of intelligent defect where the superconductor is removed in a controlled manner. Engineering antidots in arrays throughout the superconductor leads to interesting and scientifically appealing effects such as an increase to the current carrying ability, rectification of the current, flux filtering and inhomogeneous magnetic field response. We investigated various arrays with different shapes of antidots possessing dimensions larger than magnetic penetration depth in $YBa_2Cu_3O_7$ (YBCO) superconducting thin films. YBCO thin films of high quality were produced by pulsed laser deposition with Tc = 90.0 ± 0.5 K, and $J_C \approx 3.5 \times 10^{10}$ Am^{-2} at T = 77 K. Through photolithography and ion beam etching uniform, graded and spaced arrays were then created in the thin film. Comparing the difference in J_C between the patterned and as deposited films between temperatures of 4.2K-85K and fields of 0-±5T provides an understanding of the effectiveness of the antidot configuration. Non uniform pinning arrays of micron sized triangular antidots enhanced J_C over a broad temperature and field range, whereas the uniform array counterpart systematically degraded J_C [1]. Furthermore, the asymmetric pinning potential of the triangular antidot causes an anisotropic flux trapping, the basis of the ratchet effect.

[1] George, J., Jones, A., Al-Qurainy, M., Fedoseev, S.A., Rosenfeld, A. and Pan, A.V., 2017. Tunable pinning effects produced by non-uniform antidot arrays in YBCO thin films. *Annalen der Physik*. 1600283 (2017), DOI 10.1002/andp.201600283.

[1]Institute for Superconducting and Electronic Materials, University of Wollongong, Northfields Avenue, Wollongong, NSW 2522, Australia

[2]Centre for Medical Radiation Physics, University of Wollongong, Northfields Avenue, Wollongong, NSW 2522, Australia

[3]**CSIRO** Materials Science and Engineering, Bradfield Rd, Lindfield, Australia