Dynamics of Vortices in Nano-Structured Superconductors with Periodic Arrays of Various Antidots

D.E. Fujibayashi[a, b] and Masaru Kato[a, b]

[a]Department of Mathematical Sciences, Osaka Prefecture University, Sakai, Osaka, Japan
[b]CREST, JST, 5 Sanban-cho, Chiyoda-ku, Tokyo, Japan

There are many studies about pinning of vortices by various shaped antidots in superconductors using molecular dynamics method.[1]We have introduced general form of pinning potential for various shaped antidots and using this potential, we have been doing the molecular dynamics simulation of vortices. For example, we take the pinning potential for a triangular antidot as $V = -\frac{1}{2}\frac{fp}{rp}\left(\sum_{i=1}^{3}\{(\mathbf{r}_j - \mathbf{r}_p)\cdot\mathbf{n}_i\}^{vq}\Theta\left((\mathbf{r}_j - \mathbf{r}_p)\cdot\mathbf{n}_i\right)\right)^{\frac{fl}{vq}}$ where $\mathbf{r}_j$ is the coordinate of the vortex, $\mathbf{r}_p$ is the coordinate of the antidot, f_p is the strength of the pinning, r_p is the radius of the antidot, vq and f_l defines the roundness and the flatness of the pinning potential of the antidot, respectively. $\Theta\left((\mathbf{r}_j - \mathbf{r}_p)\cdot\mathbf{n}_i\right)$ is a step function and $\mathbf{n}_i = \left(\cos\frac{2\pi}{n}i, \sin\frac{2\pi}{n}i\right)$ is the normal vector of edges. We investigated the effect of the various shapes of antidots varying n, vq and f_l and found that the maximum number of vortices pinned changes when the shape of the antidots are changed. For example, the longer the edge of the polygon perpendicular to the flow of vortices was, the more vortices the antidot could hold. Also, we investigate the dynamics of vortex flow in superconductors with various shaped antidots.

[1]C.J. Olson Reichhardt, C. Reichhardt, Physica C **432** (2005) 125-132