

A Multi-Vortex State Related Pinning Phenomena in Nb Thin Films with Square Pinning Arrays

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Superconductor thin films with square pinning arrays were fabricated using electron beam lithography and reaction dry etching techniques to explore the vortex pinning behavior. Periodic critical current matching peaks are observed in magnetotransport measurements. At certain temperatures, it is found that the height of the third matching peak is about the same as that of the fourth matching peak for film with pinning size of 200 nm, and it appears that the third matching peak is missing. Similar phenomena are observed for films with larger pinning sizes, but the missing peaks are at the fourth or fifth matching fields. Molecular dynamic simulations were made to obtain the ground state vortex distributions at different parameters such as the pinning strength, pinning size and magnetic field. Phase diagrams are produced from these results. These simulation results reveal a systematic vortex reentrance phenomenon at certain magnetic fields, which could offer good explanations to the features we found in the experiments.