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Atmosphere Dependence of Normal State Resistance of BSCCO Thin Films Obtained with Micromechanical Exfoliation

Atomic layers of superconducting materials have attracted much attention due to possible high critical temperatures of superconductivity, gate control of superconducting properties and applications. For a layered superconductor $NbSe_2$, mechanical exfoliation technique has been commonly used to obtain thin layers which exhibit clear superconductivity down to monolayers.[1,2] On the other hand, for a high temperature layered superconductor, $Bi_2Sr_2CaCu_2O_{8+x}$ (BSCCO), it is not straightforward to observe superconductivity in exfoliated thin films [3], and the recipe for the atomic superconducting layers have not been established yet. It is commonly believed that whether superconducting transition occurs or not strongly depends on the normal state resistance of the film; the quantum phase transition of the superconducting thin films occurs depending on the strength of the dissipation.[4,5] Here, to clarify the origin of the difficulty in observing the superconductivity in exfoliated BSCCO thin films, we investigate the dependence of the normal state resistance of BSCCO thin films on atmosphere.

We obtain BSCCO thin films from a bulk whisker using the Scotch tape method. The superconducting transition temperature of the bulk crystal is about 110 K. A BSCCO thin film is transferred on an SiO_2/Si substrate with electrodes, and the normal state resistivity with four terminal configuration is measured. We find that the normal state resistivity dramatically decreases with evacuation and annealing, indicating that the carrier doping by adsorption of molecules on the film surface increases the normal state resistivity and hamper the superconducting transition.

References

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