Thickness dependent Nernst effect for superconducting NbN thin films

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Observation of an anomalous Nernst signal in the high temperature phase of underdoped cuprates has motivated several experimental and theoretical researches on the Nernst effect in the high temperature superconductors [1-4]. For the last two decades, Nernst effect has been considered as an important tool to investigate the superconducting fluctuations due to vortex-like excitations in high T_c superconductors [1-4]. Most importantly, the sign and magnitude of Nernst signal depend on the phase-slip electric field induced by a vortex current driven by the applied thermal gradient [4]. On the other hand, the physical properties of NbN thin films are very sensitive to the charge-carrier density, which can be tuned by controlling growth conditions and film thickness [5]. Here, we present observation of puzzling Nernst signal generated by fluctuating Cooper-pairs in the vortex state of NbN thin films with different thicknesses.

Thin films of NbN with various thicknesses were deposited using reactive dc magnetron sputtering by sputtering an Nb-target in Ar-N_2 gas (10:1) mixture on MgO (100) substrates. For measurements of transport and thermal properties, these thin films were converted into patterned Hall bar structures (see in Fig. 1(a) and SEM image in Fig. 1(b)) by using the optical lithography and ion-milling process. The transport and thermal properties were investigated by using PPMS. The Nernst signals as a function of temperature for 10 nm and 20 nm thin films clearly show the variation with magnetic field as shown in Fig. 1(c) and (d). The superconducting fluctuations observed in Nernst effect in NbN thin films with different film thicknesses will be discussed with their transport properties in details.

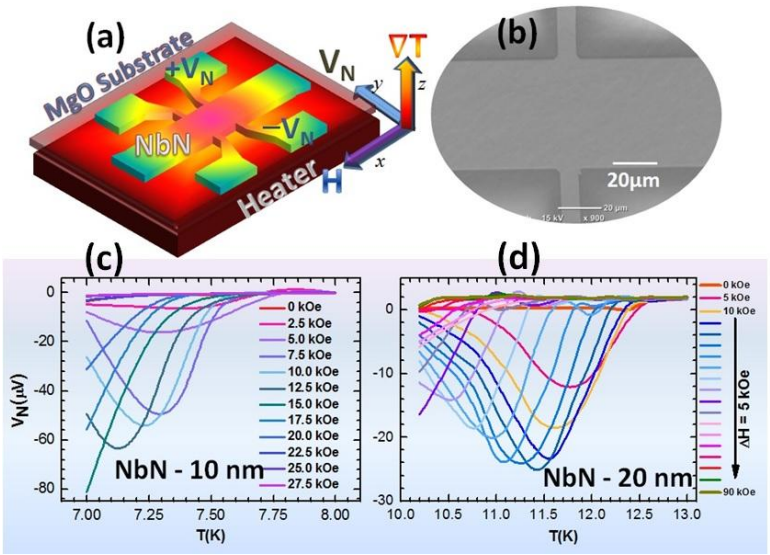

Fig. 1. (a) Schematic of Nernst effect setup with Hall bar and (b) SEM image of Hall bar structure, (c) Nernst signal as a function of temperature for 10 nm and (d) for 20 nm thin films with different applied magnetic fields.

References

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