Electric Field Controlled Hall and Thermo-power Effects in $La_{0.7}Ca_{0.3}MnO_3$ Thin Film

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The electric field effect in manganites (i.e., electric field control of magnetization, magnetic anisotropy, domain structure, spin polarization, critical temperatures, etc) recently attracted much attention due to its potential applications in spintronics, multiferroic and magnetoelectronics [1-3]. Also, substantial research efforts have been devoted in spin caloritronics to investigate the interplay of spin and thermoelectric transport phenomena in manganites [4]. What have not yet been investigated are changes in Hall effect [5], possibly the carrier density [5] and the thermal counterpart of the Hall effect (i.e., the Nernst effect [4]) in this material, when the electric field is applied on manganite films.

Here, we present an approach to control the Hall effect and transverse thermopower (i.e., Nernst effect) of manganites. Using a field-effect gated device, we aimed to tune the Hall and Nernst effect of manganite (i.e., $La_{0.7}Ca_{0.3}MnO_3$) channel.

We have deposited thin films of mangnites (i.e., $La_{0.7}Ca_{0.3}MnO_3$) on STO (001) substrates by the pulsed laser deposition (PLD) method. For measuring the Hall and Nernst effects, these thin films were converted into patterned Hall bar structures, as shown in the inset of Fig. 1, by using the optical lithography and ion-milling process. Subsequently, a layer of Al_2O_3 of about 60 nm thickness was deposited on top of this manganite thin film using ion beam sputter (IBS) in order to use it as a gate electrode (see in Fig. 1). For Nernst measurements the Hall bar structure was mounted on a platform to obtain the required temperature gradient as shown in Fig. 1. A cryostat of physical property measurement system (PPMS-Quantum Design Inc.) was used for obtaining temperature and magnetic field variations. The electric field effect of manganite films will be discussed in detail.

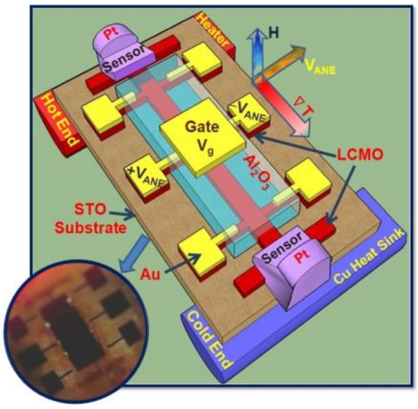

Fig. 1. Schematic of Nernst effect measurement and inset shows the Hall bar structure using optical microscope image.

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