Oxide thermal rectifier

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Thermal rectifier is a device in which heat flows in a forward direction while it can hardly flow in the opposite direction. Due to the controllability of the heat current, the device can be promising for future practical application, as diode is essential for the modern electronics. Recently, Peyrard reported a simple theory to realize the thermal rectification [1]. The theory requires juxtaposed two different materials whose temperature dependences of the thermal conductivities are different. Consequently, thermal resistance of the sample changes in the forward and the opposite directions, respectively, leading to the thermal rectification.

According to the principle, we have demonstrated the thermal rectification in an oxide thermal rectifier fabricated by the perovskite cobalt oxide $LaCoO_3$ and $La_{0.7}Sr_{0.3}CoO_3$. Rectifying coefficient defined by the ratio of heat current in the forward direction to that in the reverse direction is 1.43, which is well reproduced by the theory [2]. To further improve the performance of the thermal rectifier, we have investigated shape-dependent thermal rectification [3] and have fabricated an oxide thermal rectifier made of $La_{1.98}Nd_{0.02}CuO_4$ and MnV_2O_4 [4]. By utilizing a jump of a thermal conductivity originated in the structural phase transition in MnV_2O_4, a rectifying coefficient of 1.14 has been achieved in the presence of a small temperature difference of 2 K. We would like to thank Professor I. Terasaki for fruitful discussion, Mr. D. Sawaki, and Mr. Y. Teraoka for technical supports.

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