New methods for measuring thermal conductivity in thin magnetic films

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Great discoveries on the anomalous Nernst effect in the thin films have been repeatedly reported in thermoelectrics and spin-caloritronics in the past several years and the thin-film thermoelectrics becomes a considerable hot topic[1-2]. Thermal conductivity is one of the most important material parameters in thermoelectrics. It is, however, quite difficult to measure the thermal conductivity in thin metallic films. In this study, we propose a new method for measuring the thermal conductivity in thin magnetic films using the anomalous Nernst effect. We focus on two measurement setups of the anomalous Nernst effect as shown in Figs. 1(a-b) and have estimated the thermal conductivity from the assumption that the transverse Seebeck coefficients are independent of the setups. We have investigated thickness dependence of the thermal conductivity in thin Co films in Fig. 2(a-b). The thermal conductivity in the Co films is almost constant from 100 nm to 20 nm and is similar to that in the bulk Co. When the film thickness is less than 20 nm, however, the thermal conductivity trends to decrease and reaches 30 W/Km at the thickness of 2 nm. According to our knowledge, these reductions of the thermal conductivity in extremely thin metallic films are firstly observed in this study. Our findings may lead to studies and techniques on spin-caloritronics and nanometer-scale thermal management in thin-film devices.

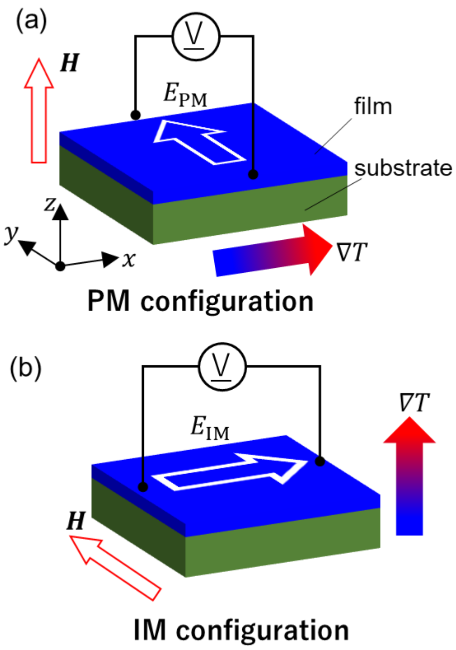

Fig. 1: Schematic diagrams of perpendicular (a) and in-plane (b) magnetization configurations.

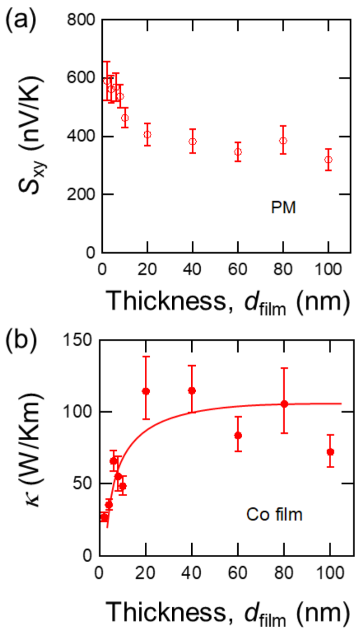

Fig. 2: Anomalous Nernst coefficient (a) and thermal conductivity (b) as a function of the Co thickness.

References

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