Spintronic Thermal Switching

Ken-ichi Uchida*

National Institute for Materials Science, Japan

Thermal switching provides an effective way for active heat flow control, which has recently attracted increasing attention in terms of nanoscale thermal management technologies. In magnetic and spintronic materials, the thermal conductivity depends on the magnetization configuration: this is known as the magnetothermal resistance effect [1]. Here, we show that ferromagnetic metal/nonmagnetic metal multilayer films exhibit giant modulation of the cross-plane thermal conductivity depending on the magnetization configuration. For example, the magnetothermal resistance ratio for the epitaxial $Cu/Co_{50}Fe_{50}$ multilayer reaches 150% at room temperature, which is much larger than the previous record high [2]. Surprisingly, the magnetization-dependent thermal conductivity change for the $Cu/Co_{50}Fe_{50}$ multilayer was observed to be much greater than that of the cross-plane electrical conductivity, suggesting unconventional spin-dependent thermal switching mechanisms. We also found that the thermal conductivity of ferromagnetic metal films can be tuned by engineering spin boundary conditions [3]. These results clarify the potential of spintronic multilayers as thermal switching devices.

[1] K. Uchida and R. Iguchi, J. Phys. Soc. Jpn. 90, 122001 (2021).
[2] H. Nakayama et al., Appl. Phys. Lett. 118, 042409 (2021).
[3] T. Hirai et al. (unpublished).

*Corresponding author Ken-ichi Uchida
Affiliation National Institute for Materials Science
E-mail address UCHIDA.Kenichi@nims.go.jp