Thermal imaging of spin-caloritronic phenomena

Ken-ichi Uchida[1-3]

[1]*National Institute for Materials Science, Tsukuba 305-0047, Japan*
[2]*PRESTO, Japan Science and Technology Agency, Saitama 332-0012, Japan*
[3]*Center for Spintronics Research Network, Tohoku University, Sendai 980-8577, Japan*

The Peltier effect modulates the temperature of a junction comprising two different conductors in response to charge currents, which is used in solid-state heat pumps and temperature controllers in electronics. Recently, in spintronics, a spin counterpart of the Peltier effect was observed [1]. The "spin Peltier effect (SPE)" modulates the temperature of a magnetic junction in response to spin currents.
In the main part of this talk, we report thermal imaging of the SPE; using lock-in thermography (LIT) technique, we visualize the temperature modulation induced by spin currents injected into a magnetic insulator from an adjacent metal [2-4]. The thermal images reveal characteristic distribution of spin-current-induced heat sources, resulting in the temperature change confined only in the vicinity of the metal/insulator interface, which is different from thermal distribution expected from standard heat sources. From systematic experiments and numerical calculations, we found that this seemingly counterintuitive result is attributed to "dipolar heat sources" generated by spin currents. The finding of this anomalous temperature distribution allows us to estimate the actual magnitude of the temperature modulation induced by the SPE, which is more than one order of magnitude greater than previously believed.
Finally, we also show the versatility of the LIT technique; it can be used for investigating not only the SPE but also various spin-caloritronic, thermoelectric, and magnetocaloric phenomena.

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