

Temperature control using spin-current

Keywords: spin current, spintronics, spin Peltier effect, thermoelectric cooling

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Background

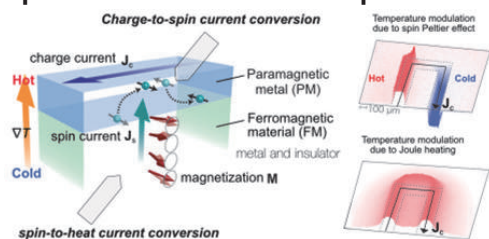
- Dense heating of IT devices due to sophistication and miniaturization
- Necessity of various temperature-controlling technologies
- Emerged spin-based thermoelectric generation (spin caloritronics) due to development of spin-to-charge current conversion

Aim

- Spin caloritronics enables use of magnetic “insulators”
- The mechanisms are need to be clarified for utilization
- Extended and systematic studies are performed using an active thermography method

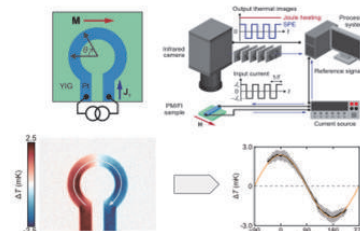
Advanced Research Topics

Temperature modulation due to spin current



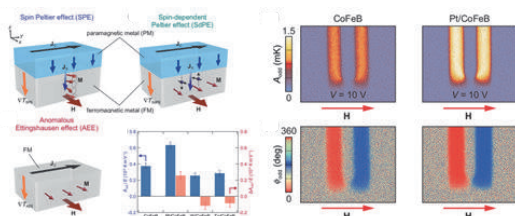
Transverse thermoelectric conversion using insulators, localized temperature control

Extended methods for characterization



Evaluation of symmetry of spin caloritronics phenomena

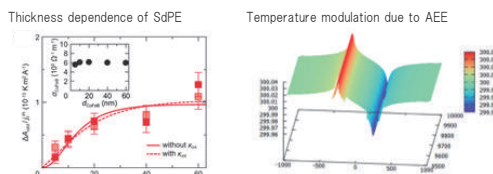
Spin caloritronics effects in metallic systems



Not only spin Peltier effect, but also spin-dependent Peltier and anomalous Ettingshausen effects can be used

Simulations for estimating output properties

Evaluation based on Multi physics simulations using phenomenological modeling finite element method



Quantitative evaluation and estimation of temperature distribution

- Publications**
- R. Iguchi et al., Phys. Rev. B, 98, 014402 (2018)
 - R. Iguchi and K. Uchida, Jpn. J. Appl. Phys. 57, 0902B6 (2018)
 - T. Seki, R. Iguchi, K. Takahashi, and K. Uchida, Appl. Phys. Lett. 112, 152403 (2018)

Summary

- Spin caloritronics research is on-going for novel temperature controllers
- Output properties reflecting spins can be estimated

Research outcome

- On-chip pin-point cooling for high functional devices and for reducing consumption
- Materials research for low-cost and high power density is necessary