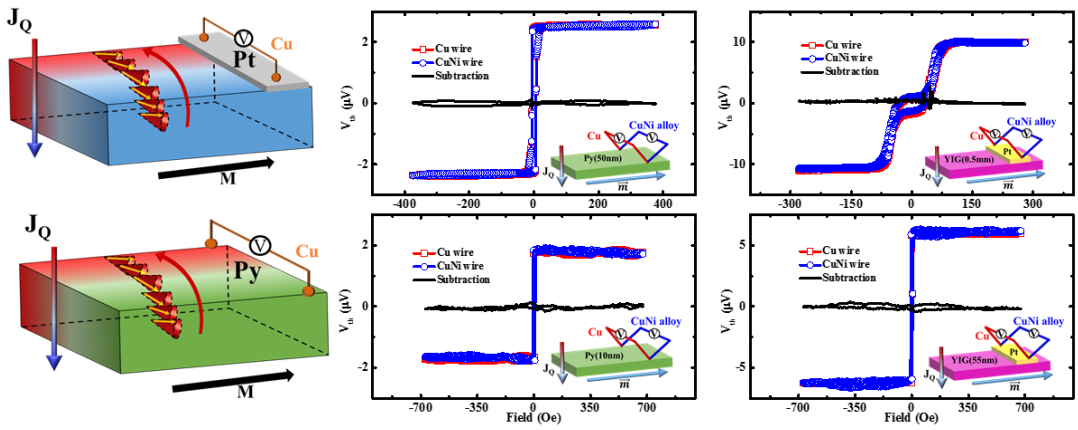
Thermal Hall Effect in the Anomalous Nernst and Spin Seebeck Effects

The anomalous Nernst effect (ANE) and the spin Seebeck effect (SSE) in spin caloritronics are two of the most important mechanisms to manipulate the spin-polarized current and pure spin current by thermal excitation. Nevertheless, a recent research work suggests that the thermal Hall effect (THE) have field dependences indistinguishable from, and may even overwhelm, those of the ANE and SSE. Therefore, it is vital to investigate the contribution of the THE in the ANE and SSE.

In this work, we show that the thermocouple effect is indeed inevitable in the ANE and SSE configuration. By using several special measurement geometries, we are able to compare the magnitude of the THE with that of the ANE in Py and that of the SSE in YIG. Our results show that the contribution of the THE by the thermal couple effect in the Py and YIG is negligibly small. The spin-polarized current in the ANE and the pure spin current in the SSE remain as indispensable elements to explore these two spin caloritronics phenomena. Our work will be very useful to study the THE in materials with inversion symmetry breaking.



-Y. J. Chen and S. Y. Huang, Absence of the Thermal Hall Effect in Anomalous Nernst and Spin Seebeck Effects, Phys Rev. Lett. **117**, 247201 (2016)
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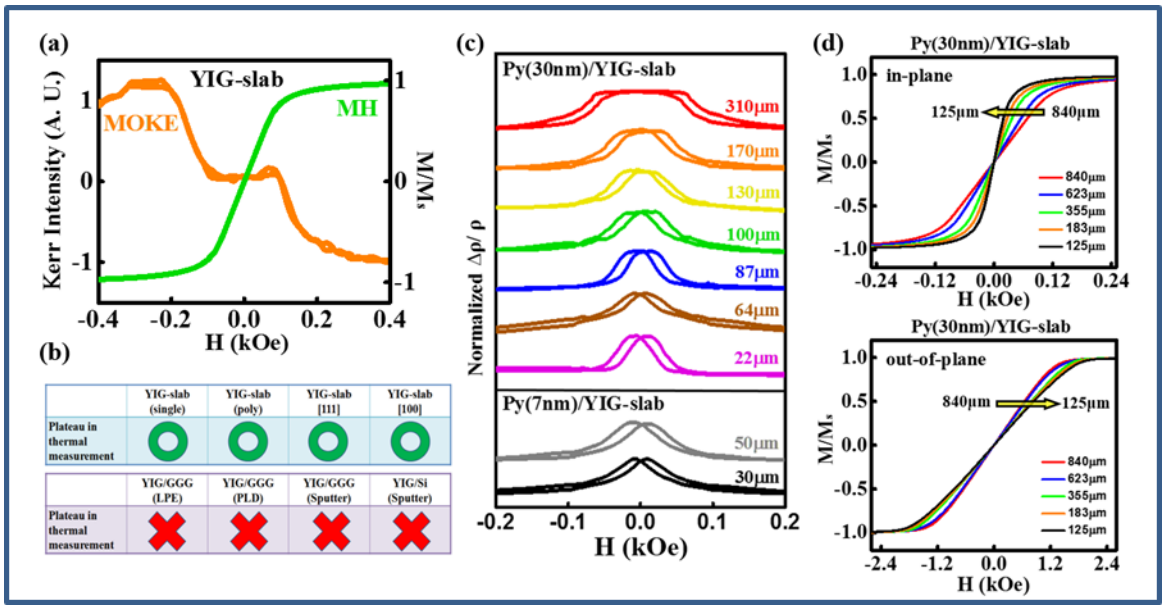
Magnetization reversal behavior detected by thermal spin current:

We show that the thermal measurement with a vertical temperature gradient is an important tool for detecting magnetization structure with high sensitivity. In the case of the longitudinal spin Seebeck effect (LSSE), Pt/YIG is one of the most important bi-layer structures for studying pure spin current phenomena. The spin current can be converted to the charge current by the inverse spin Hall effect (ISHE) with a defined spin direction given by the magnetization orientation of YIG. However, both the ISHE voltage from the LSSE and the magnetoresistance from the electrical transport show a clear plateau behavior in the low field range, which is inconsistent with the magnetization reversal behavior of YIG. By using thermal spin current and the highly sensitive micro-magneto-optic Kerr effect (MOKE) measurement, we provide conclusive evidence that the hitherto unaccounted for peculiar field dependence is due to noncollinear magnetization between surface and bulk YIG. Our results show that LSSE with a vertical temperature gradient can function as sensitive tools to study the surface magnetization configuration of materials.



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