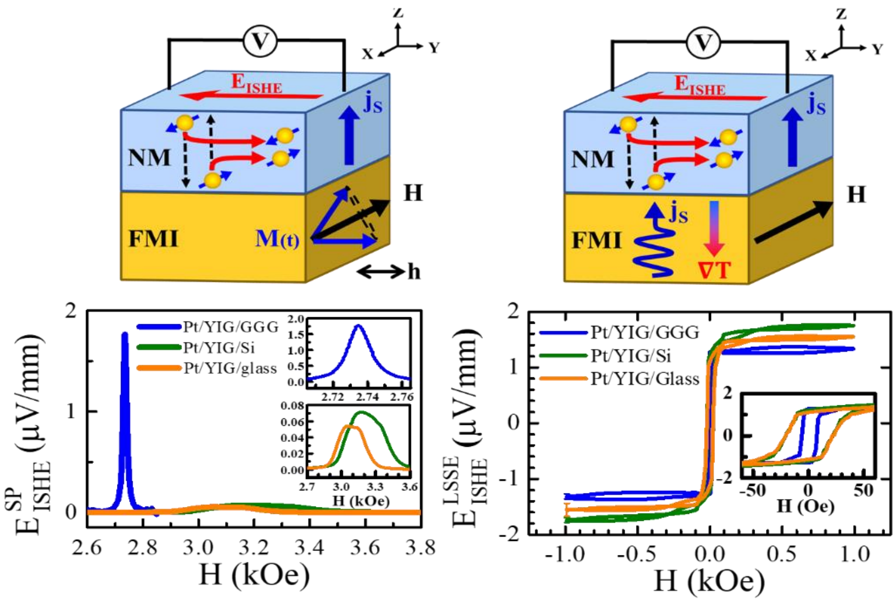
Robust spin current generated by the spin Seebeck effect

Spin pumping (SP) and the spin Seebeck effect (SSE), two of the most common methods for generating a pure spin current from ferromagnetic insulators, are considered to share similar physical mechanisms. However, a systematic study of the fundamental difference of their working principle is missing. In this work, we present experimental evidence of the contrast in a pure spin current generated by SP and SSE, based on results from yttrium iron garnet (YIG) with various crystalline properties. It is shown that while the SP-induced spin current could be two-orders-of-magnitude different between the polycrystalline and epitaxial films, the SSE excited spin current is surprisingly insensitive to the different crystal structures. Our results clearly distinguish the coherent mechanism of SP from the noncoherent mechanism of the SSE. Consequently, the robust SSE voltage against poor crystallinity proves that the SSE is a powerful tool to explore pure spin current physics, and suggests that polycrystalline YIG films are a promising candidate for spin caloritronic applications.



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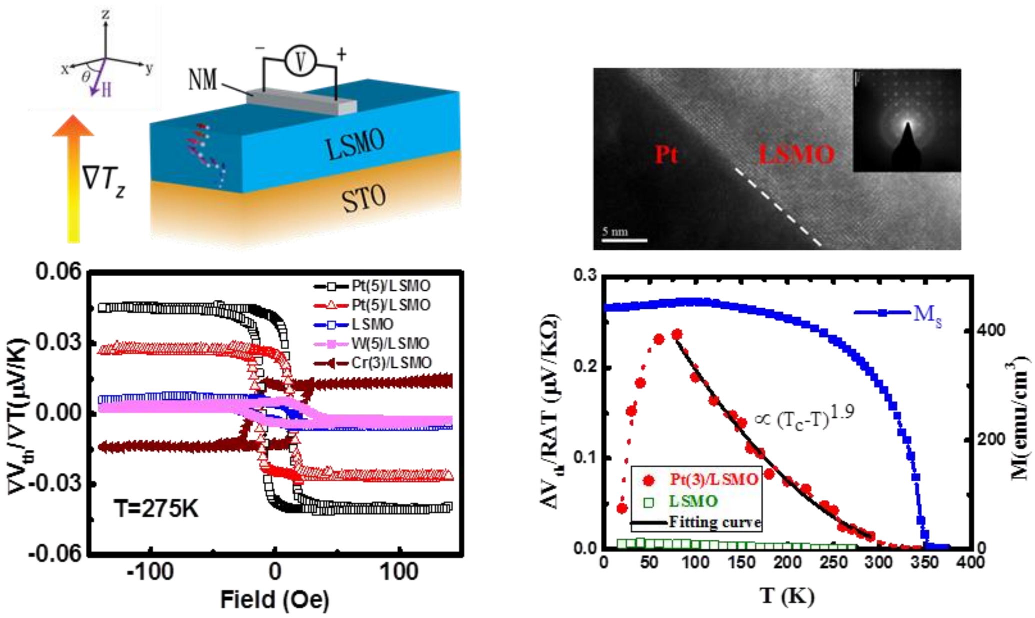
https://journals.aps.org/prmaterials/abstract/10.1103/PhysRevMaterials.1.031401

Longitudinal spin Seebeck effect in a half-metallic $La_{0.7}Sr_{0.3}Mn_{O3}$ film

The longitudinal spin Seebeck effect (LSSE) with a vertical temperature gradient is one of the most important mechanisms to generate pure spin current. Previous studies of the LSSE excited spin current focus mainly on the magnetic insulators, a little on ferromagnetic metals, and rarely on ferromagnetic half metals. In this work, we demonstrate a significant spin current injected from the highly spin polarized ferromagnetic half metal $La_{0.7}Sr_{0.3}MnO_3$ by the LSSE. The sign of the thermal voltage can be reversed by using the spin current detector Cr with a large negative spin Hall angle. The ratio of the inverse spin Hall voltage to the total thermal signal in $La_{0.7}Sr_{0.3}MnO_3$ is much larger than that in ferromagnetic metals, such as permalloy and CoFeB. The nontrivial temperature-dependent voltage suggests that the thermal transport in $La_{0.7}Sr_{0.3}MnO_3$ is carried by magnons. This study provides insight into the mechanism of thermally excited spin current in ferromagnetic half metals and recommends the highly spin polarized $La_{0.7}Sr_{0.3}MnO_3$ as a promising candidate for metal-based spin caloritronics devices.



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