Large Spin Current Generation during Magnetic Phase Transition of FeRh

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Spin current generation lies at the heart of modern spintronics. Pure spin current can be generated via spin pumping, wherein the magnetization precession of ferromagnet produces a spin current into a neighboring non-magnetic layer.[1] So far, the spin pumping has mainly been used as a tool for quantifying magnetic parameters, including the spin Hall angle, spin diffusion length, spin mixing conductance, etc.,[2-4] because the efficiency of spin current generation is not large enough for use in spintronic applications, such as current-induced magnetization switching.[5] In this study, we propose a novel method to generate a large spin current via spin pumping. We utilize a FeRh which undergoes a magnetic phase transition from an antiferromagnet (AFM) to ferromagnet (FM) around 370 K.[6] The magnetic phase transition of FeRh from AFM to FM accompanies the change of total angular momentum from zero to finite. The change of angular momentum generates a spin current into a neighboring non-magnetic layer, and is converted to the charge current through the inverse spin Hall effect (ISHE). We find that the ISHE voltage is generated exclusively during the phase transition. Furthermore, the measured signal is found to depend on the sign of spin Hall angle and the direction of magnetization of FeRh, confirming that the observed signal indeed originates from the phase transition-induced spin pumping and ISHE. The generated spin current density is at least 3 orders of magnitude higher than those in previous spin pumping reports,[7,8] and is comparable to that generated by the spin Hall effect.[5] Our work provides a novel way to generate spin current, which could be utilized in potential spintronics applications.

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