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Advances in thermomagnetic phenomena based on spin Seebeck effects in hybrid nanostructures

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Thermoelectric conversion efficiency is intrinsically limited due to interdependence of the thermal and electrical conductivity of the materials employed. Recently, a spin-based approach has been discovered and in analogy named the spin Seebeck effect (SSE) [1]. The SSE refers to the generation of spin currents in a magnetic material upon application of a temperature gradient; the spin current is injected and electrically detected in a normal metal in contact with magnetic material, where spin-orbit interaction in normal metal transforms the spin current into an electric field, by means of the inverse spin Hall effect. The observation of the spin Seebeck effect (SSE) in magnetic insulators has opened the possibility to generate pure spin currents with less dissipation losses due absence of mobile charge carriers, and further expand the range of possible materials to study spin mediated thermoelectric conversion. Moreover, the experimental geometry of the SSE with the thermal and electric current paths perpendicular to each other is advantageous for the implementation of thin film and flexible thermoelectric devices [2]. Furthermore, since the heat and electric currents have independent paths, the properties of different materials comprising the SSE hybrid device can be optimized independently. However, there is one main disadvantage for the potential application of the SSE, the low magnitude of the thermoelectric output. Different possibilities are currently being explored, such as increasing the spin current detection efficiency by taking advantage of the spin Hall angle characteristics of different materials [3]. Other approaches can be directed towards increasing the thermal spin current generations, as recently shown in spin induced thermoelectric measurements in $[Pt/Fe_3O_4]\times n$ films multilayers, topic that will be described in this work [4]. A short review of advances on spin Seebeck as well as spin Peltier effect (SPE) [5] will be presented.

References

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