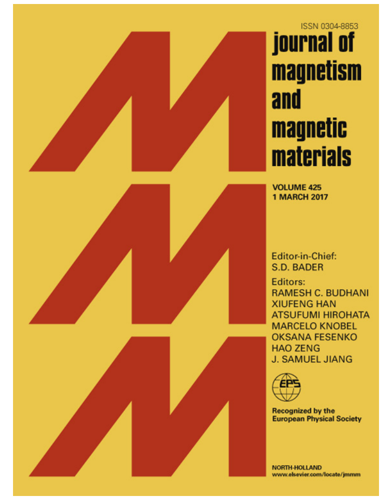
Accepted Manuscript



Research articles

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PII: S0304-8853(16)33129-8
DOI: http://dx.doi.org/10.1016/j.jmmm.2017.06.044
Reference: MAGMA 62840

To appear in: *Journal of Magnetism and Magnetic Materials*

Received Date: 20 November 2016
Accepted Date: 7 June 2017

Surface current at non-magnetic metal/ferromagnetic insulator interface due to Rashba spin-orbit interaction

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Abstract

We theoretically investigate a new mechanism of interfacial current in a two-layer system consisting of a magnetic insulator and an adjacent non-magnetic metal. The mechanism is based on Rashba spin-orbit interaction in the metal layer near the interface where the magnetic insulator induces non-zero magnetization. The rotation of the magnetization of the magnetic insulator induces the alternating interfacial current in the non-magnetic metal. Coordinate and time dependencies of the current and induced magnetization in the non-magnetic layer are calculated using quasi-energy approach assuming ballistic conductivity in non-magnetic metal. It is found that the current displays sizable magnitude within the metal layer over a distance which significantly exceeds a region with non-zero spin-orbit interaction. Both the current and the spin density induced in the metal layer demonstrate oscillatory dependence as a function of the distance from the interface due to the interference of the incoming and reflected waves.

Keywords: Surface current, Inverse Spin Hall Effect, Rashba Spin-Orbit Interaction
PACS: 75.76+j, 72.25.Mk, 85.75.Nn

1. Introduction

The current which flows along the surface of solid sample may be of different origins. The theory of orbital magnetization in solids developed in the last two decades [1, 2] led, in particular, to the thorough analysis of the surface current carried by the surface Wannier functions. It was demonstrated that this surface current makes significant contribution into the magnetization of ferromagnetic insulator [3]. This phenomenon can be said to originate from the surface Wannier functions motion around the surface [1] and this happens with samples of arbitrary sizes.

The other kind of interfacial currents is related to anomalous charge and spin Hall effects. These effects[4–7], have attracted great attention during the last decade because of their potential applications in spintronics. Theoretical and experimental exploration of these effects and related phenomena in multilayers revealed, in particular, the possibility of spin-charge conversion which is the inverse spin Hall effect (ISHE))[8–10], predicted more than forty years ago [11]. All these phenomena rely on the spin-orbit interaction (SOI). The layered structures show great diversity of the SOI effects due to the geometry of the system. A particular type of SOI, known as the Rashba effect[12], occurs in layered systems because of breaking space inversion symmetry in the direction perpendicular to the plane and is confined to a few angstroms near the interface. The Rashba SOI is responsible for the band splitting on the metal surfaces[13, 14] as well as for the various anisotropic magnetoresistive phenomena[15–17] in the multilayered structures. Calculation of the Rashba SOI magnitude at the interface has been the subject of a number of theoretical works[18–20]. It was found

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