MAR16-2015-009447

Abstract for an Invited Paper
for the MAR16 Meeting of
the American Physical Society

Mechanism of spin current transfer through antiferromagnetic dielectrics

VASYL TYBERKEVYCH, Oakland University

The mechanisms of spin current (SC) transfer are well-studied in both metallic systems, where SC is carried mostly by spin-polarized electrons, and in ferromagnetic (FM) dielectrics, where propagating spin waves (magnons) are responsible for the spin transfer. The possibility of SC transfer through *antiferromagnetic dielectrics* (AFMD) is much less investigated, although recent experimental studies by H. Wang *et al.* [H. Wang *et al.*, Phys. Rev. Lett. **113**, 097202 (2014)] demonstrated extraordinary high efficiency of SC transfer in tri-layer FM-AFMD-Platinum (YIG-NiO-Pt) systems measured by the inverse spin Hall effect (ISHE). Perhaps the most unexpected result of these studies was that, with the increase of the thickness of the AFMD layer, the ISHE voltage, first, *increased*, and, then, exponentially decayed with the characteristic decay length of $\lambda \sim 10$ nm. Moreover, the excitation frequency, equal to the ferromagnetic resonance (FMR) frequency of the YIG layer, was rather low compared to the frequencies of the antiferromagnetic resonance in the AFMD, which rules out the eigenmodes of the AFMD layer as potential carriers of the spin current. Here we propose a possible mechanism of SC transfer through the AFMD with a biaxial anisotropy, which explains all previous experimental findings and opens a new way of manipulating spin currents using anisotropic AFMD materials. We show, that spin current can be carried by *evanescent* AFMD modes non-resonantly excited at the FM-AFMD interface. The decay length of the evanescent modes is defined by the AFMD anisotropy and determines the SC penetration depth into the AFMD. Furthermore, the anisotropy of the AFMD leads to the coupling between the spin subsystem and the crystal lattice of the AFMD, which makes possible exchange of angular momentum between these subsystems. We demonstrate that, under certain realistic conditions, the angular momentum flows from the lattice to the spin subsystem, in which case the AFMD layer acts as a *spin current amplifier*. The enhancement or the suppression of the spin current by the AFMD lattice depends on the phase shift between the two evanescent AFMD modes and, thus, can be controlled by the method of excitation.