Spin-currents, FMR spin-pumping and THz emission from optimized 3d/5d heavy metals interfaces.

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Spin-Hall Effects and spin-charge conversion phenomena at a a short lengthscale either using heavy metals like Pt, W [1], Au:W [2] , Inverse-Edelstein Effect at Rashba [3-5] or topological surfaces or interface [4] are the basis of new spintronics functionalities. Combined with FMR spin- pumping, spin-orbit interactions and in these systems also enable to probe the interfacial properties possibly involving spin-orbit coupling effects like local spin-loss at 3d/5d interfaces [6-7]. It was recently reported that THz emission may be realized in the same kind of heterostructures, either metallic [8] or Rashba system [9], composed of ferromagnetic (FM) and spin-orbital active materials via dynamical spin-to charge conversion in the picosecond scale by using time- dependent spectroscopy (TDS) techniques. Here, experiments consist in exciting magnetization and spin-currents within the FM layer via femtosecond laser excitation and measuring, in the picosecond timescale, the relaxation of the correlated spin and charge currents responsible for THz dipolar emission. The spintronics THz emitters typically reaches the power of ZnTe electro-optic semiconductor technology. In that mind, we will present our last results of THz emission provided by optimized growth bilayers composed of a high-spin orbit material in contact with a ferromagnetic layer like Co/Pt, Co/Au,Pt, NiFe/Au:W, Co/Pt/Au:W) including Au monolayers (MLs) insertion and Au:W spin-sink materials. Those state-of-the art bilayers are analyzed using complementary experiments combining RF-spin-pumping-ISHE measurements and TDS –THZ spectroscopy [4-5, 10-13].

Our results show, that in some conditions, the insertion of Au based materials in Co/Pt structures may enhance either THz or ISHE signals depending on the layer sequence. In particular, the ML Au insertion in Co/AuML/Pt systems evidences a decrease of the spin-orbit strength at the interface, responsible for an increase of the ISHE signal by decrease of SML, conjugated to a decrease of FMR-linewidth and THz emission. We will demonstrate the strict correlation between THz signals and related spin-mixing conductances and will discuss the connection between THz and spin loss phenomena.

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