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Identifying different contributions to the ultrafast spin-to-charge conversion from the experiment

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Spintronics is the thriving field of research with the aim to control the electron spin degree of freedom for potential applications in computing, storage and memory, and fundamental science. Spintronic devices are promising in terms of lower power consumption, higher information density, and non-volatility compared to conventional electronics. However, in order to utilize the electron spin to its fullest potential, the question about efficient generation, detection, transport, and inter-conversion of the electron's intrinsic angular momentum should be answered.
Over the last three decades, the scientific community has mastered spin control in the static regime(DC)[1]. The breakthrough in transient and ultrafast spintronics can be attributed to the detection of the terahertz (THz) radiation, emitted as a consequence of an ultrafast demagnetization [2], and ultrashort spin-current burst injection from a ferromagnet into a metallic layer[3]. In such Ferromagnet/Metal heterostructure, the THz emission is mediated via the Inverse Spin-Hall effect (ISHE). Recently, it has been demonstrated that the time-varying charge current can be generated via spin injection at the Rashba-split inteface[4], [5], or via hot-carrier gradient established in the magnetic heterostructure[6].
In this work, we use 165 femtosecond, 805 nm laser pulses to generate the ultrafast spin-current burst in 5 and 20 nm thick ferromagnet CoFeB. This net spin current then can be converted into the transient charge current within ferromagnet itself (AHE), at the Rashba states established at the CoFeB/MgO interface (IREE) or inside the 3 nm thick Pt layer (ISHE) deposited onto the CoFeB. With comparative analysis of experiments conducted for different geometrical sample orientations and at the different pump wavelengths, we try to estimate ISHE, IREE, and AHE contributions to the overall THz radiation, emitted as a result of ultrafast spin-to-charge conversion.

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Topics

Session A. Physics of condensed matter and spectroscopy

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