Terahertz Inverse Spin Hall Effect in Multilayer Spintronic Heterostructures

Roman Sobolewski[1]

[1] Departments of Electrical and Computer Engineering and Physics and Astronomy, Materials Science Program, and the Laboratory for Laser Energetics
University of Rochester, Rochester, NY 14627-0321, USA

Terahertz (THz) radiation is situated between the infrared and microwave regions in the electromagnetic spectrum with a bandwidth ranging from 0.3 to 30 THz and has numerous applications in various fields, ranging from security screening, through radioastronomy, to nonionizing biomedical spectroscopy and imaging. One of the most interesting forms of THz radiation are subpicosecond in duration bursts of electromagnetic waves. These, so-called, THz transients are, typically, characterized by a 0.1 to 6 THz spectral range, and are most often generated by femtosecond optical excitation of ultrafast, semiconducting photo-switches (e.g., low-temperature–grown GaAs), or through optical rectification in nonlinear crystals (e.g., ZnTe). THz transients can also be efficiently generated by spintronic, ferromagnet/heavy metal (FM/HM) nanobilayers. In this case, the core emission mechanism is the THz inverse spin Hall effect. A transient longitudinal spin current induced in FM by a femtosecond laser pulse is converted in HM into a transient transverse charge current that results in a THz transient. In this presentation we focus on the spin transport and THz transient generation in multilayer spintronic heterostructures consisted of either stacked, FM/HM bilayers separated by a variable thickness (1 to 4 nm) Cr exchange interlayer, or FM/MgO/HM heterostructures, where a few-nm-thick MgO, grown *in-situ*, acts as a tunneling barrier. Finally, we also demonstrate that when in a spintronic bilayer, a 2-dimensional graphene is substituted for HM, one, again, observes a large THz transient, this time due to the inverse Rashba-Edelstein effect. The FM-induced Rashba texture in graphene was confirmed by direct observation of the THz circular photogalvanometric effect.

14.04.2025, 11:00

New Seminar Room, Boltzmanngasse 5, 1st floor, 1090 Wien