Efficient Terahertz Generation Using Fe/Pt Spintronic Emitter Excited at 800 nm and 1550 nm

FIR Center of Univ. of Fukui [1], Photonic Center Kaiserslautern [2], OPTIMAS of Univ. of Kaiserslautern [3], Physics Dept. of Univ. of Kaiserslautern[4], °Valynn Katrine Mag-usara[1], Garik Torosyan[2,3], Jessica Afalla[1], Joselito Muldera[1], Dmitry Bulgarevich[1], Hideaki Kitahara[1], Sascha Keller[3,4], Laura Scheuer[3,4], Johannes L'huillier[2,3], Rene Beigang[3,4], Evangelos Th. Papaioannou[3,4], and Masahiko Tani[1]

E-mail: valynn@fir.u-fukui.ac.jp

Recent studies involving spintronics have highlighted ultrathin metallic multilayers as a novel and very promising class of broadband terahertz radiation sources that are deemed to be efficient, easy-to-use, and robust [1-3]. Such spintronic multilayers essentially consist of ferromagnetic (FM) and non-magnetic (NM) thin films. When triggered by ultrafast laser pulses, they generate pulsed THz radiation due to the inverse spin-Hall effect [4] – a mechanism that converts optically driven spin currents from the magnetized FM layer into transient transverse charge currents in the NM layer, resulting to THz emission. As THz emitters, FM/NM multilayers had been intensively investigated so far only at 800-nm excitation wavelength using femtosecond Ti:sapphire lasers [1-3]. In this work, we demonstrate that an optimized spintronic bilayer structure of 2-nm Fe and 3-nm Pt grown on 500-μm MgO substrate is just as effective as a THz radiation source when excited either at λ = 800 nm or at λ = 1550 nm by ultrafast laser pulses from a relatively low cost and compact fs fiber laser (pulse width ~100 fs, repetition rate ~100 MHz). Fig. 1 shows the waveforms and spectra of the THz radiation when the optimized Fe/Pt bilayer structure was used as emitter in a standard THz time-domain emission spectroscopy setup. Even with low incident power levels, the Fe/Pt spintronic emitter exhibits efficient generation of THz radiation at different excitation wavelengths.

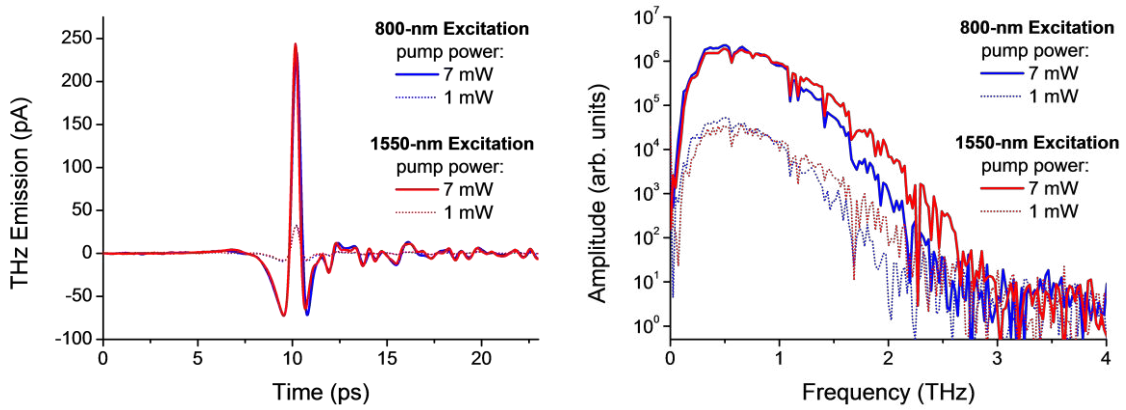

Fig. 1. Time-domain waveforms and corresponding spectra of THz emission from an optimized Fe/Pt spintronic emitter in a 15-mT magnetic field directed along the plane of the Fe layer.

1. T. Seifert, *et al.*, Nature Photonics, **10**, 483-488 (2016).
2. D. Yang, *et al.*, Advanced Optical Materials, **4**, 1944-1949 (2016).
3. G. Torosyan, *et al.*, arXiv:1707.08894v2 [physics.app-ph], 1-10 (2017).
4. E. Saitoh, *et al.*, Applied Physics Letters, **88**(18), 18509 1-3, (2006).