Excitation Wavelength and Pump Power Dependence of Terahertz Emission of Fe/Pt Spintronic Bilayer Structure

(D)Miezel Talara[1], (P)Valynn Katrine Mag-usara[1], (B)Yoshinori Oda[1], Hideaki Kitahara[1], (P)Jessica Afalla[1], Garik Torosyan[2,3], 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]

[1] Research Center for Development of Far-Infrared Region, University of Fukui, Japan

[2]Photonic Center Kaiserslautern

[3]Univ. of Kaiserslautern, Research Center OPTIMAS

[4]Univ. of Kaiserslautern, Department of Physics

Email: miezel@fir.u-fukui.ac.jp

Spintronic heterostructures consisting of layers of ferromagnetic (FM) and nonmagnetic (NM) metals, are promising THz sources due to their considerable advantages over other conventional THz sources. THz emission of spintronic heterostructures has tunable amplitude and polarization, a relatively large field amplitude even using a low pump power, and is broadband [2-4]. Moreover, metallic spintronic heterostructures do not require contacts for THz emission and have high optical damage threshold (5mJ/cm^2) [2-4]. THz radiation in spintronic heterostructure is generated when spin current is converted into transverse charge current [1]. The incident femtosecond laser pulse launches spin-polarized electrons in the ferromagnetic (FM) layer and these excited electrons superdiffuse from the ferromagnetic (FM) layer to the nonmagnetic (NM) layer converting spin current into transverse charge current generating THz radiation [1]. Most of the studies on the THz emission of spintronic heterostructures used 800-nm and 1.55-µm as the excitation wavelengths of the laser pulses [2-4]. In a previous study by Papaioannou *et al.* [5], an Fe/Pt spintronic bilayer structure was observed to be an effective THz radiation source when using either 800-nm or 1.55-µm excitation wavelengths. In this paper, excitation wavelengths of 400-nm and 800-nm were used to pump the Fe/Pt spintronic heterostructure using a mode-locked Ti:sapphire Tsunami laser which delivers ~100-fs optical pulses at a repetition rate of 82 MHz. The 400-nm excitation wavelength was generated by passing the 800-nm pump beam from the laser source through a second harmonic generation (SHG) module. The spintronic THz emission at 400-nm and 800-nm excitation wavelengths were detected by a LT-GaAs dipole-type photoconductive antenna. THz-Time Domain Emission Spectroscopy (THz-TDES) measurements of the Fe/Pt spintronic bilayer structure pumped using 400-nm and 800-nm excitation wavelengths showed comparable THz amplitude as shown in Fig 1. Also, THz-TDES measurements of the bilayer structure subjected to variable pump power showed the emitted THz waves to be slowly approaching saturation with increasing injection power as shown in Fig 2.

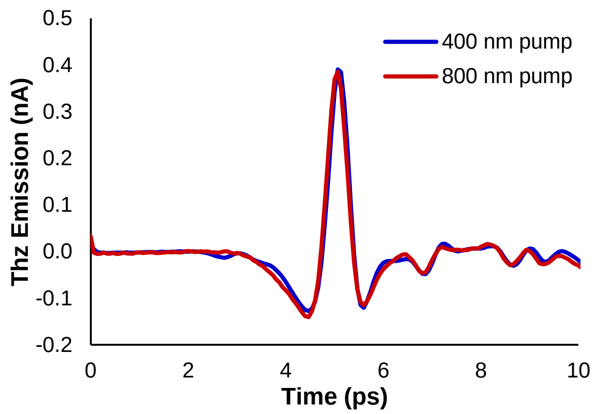

Fig 1. Comparison of the THz spectra of 400nm and 800nm excitation wavelengths

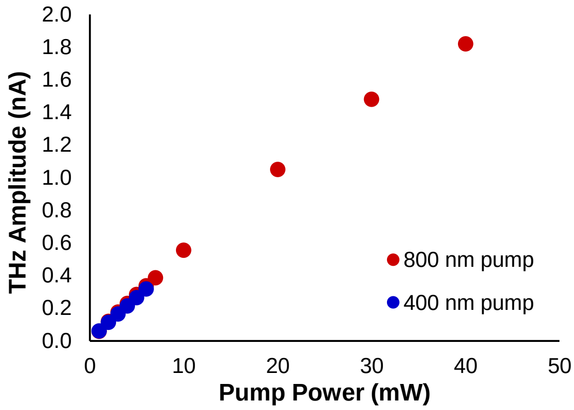

Fig 2. Power dependence graph of the resulting THz amplitude

References:

[1] E. Saitoh *et al.*, Applied Physics Letters, **88**, (2006).
[2] T. Seifert *et al.*, Nature Photonics, **10**, (2015).
[3] D. Yang *et al.*, Advanced Optical Materials, **4**, (2016).
[4] G. Torosyan *et al.*, Scientific Reports, **8**, (2018).
[5] E.Th. Papaioannou *et al.*, IEEE Transactions on Magnetics, **54**, (2018).