# Spintronic Terahertz Generation Using an Optimized Metallic Bilayer of Epitaxial Grown Fe/Pt on Silicon Substrate

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Metallic spintronic heterostructures consisting of ultrathin ferromagnetic (FM) and non-ferromagnetic (NM) layers emit THz radiation through a distinct and efficient THz generation mechanism, which arises from the conversion of spin current generated in the FM layers into transverse charge current in the NM layers [1, 2]. We have previously demonstrated that an optimized bilayer of 2-nm Fe and 3-nm Pt epitaxial grown on 500-µm MgO substrate is a remarkably versatile spintronic THz emitter, as it exhibited fairly the same THz emission efficiency at 780-nm and 1550-nm pulsed excitation wavelengths [2]. In this work, we investigated spintronic THz generation when the Fe/Pt bilayer is epitaxial grown on 500-µm Si substrate. As with the Fe/Pt on MgO, the THz emission properties of the Fe/Pt on Si were probed by standard THz time-domain emission spectroscopy using a mode-locked femtosecond (fs) fiber laser source (pulse duration: ~100-fs; repetition rate: ~100 MHz; central wavelengths: ~780 nm, ~1550 nm).

Fig. 1 shows that, unlike the versatile MgO-based Fe/Pt spintronic THz emitter, the Si-based Fe/Pt bilayer is less efficient to use with 780-nm optical pump, which has sufficient photon energy to generate free charge carriers in the Si substrate. Such carriers absorb THz radiation, thereby resulting in THz losses and significantly reduced measured THz emission. When the optical excitation is at 1550-nm, which is the typical output wavelength of the more common fs fiber laser sources, the Fe/Pt on Si exhibits comparable THz emission performance with the Fe/Pt on MgO. In addition, it can also be a convenient alternative to a 5-µm dipole type LT-GaAs photoconductive antenna (PCA) emitter under sub-bandgap excitation.

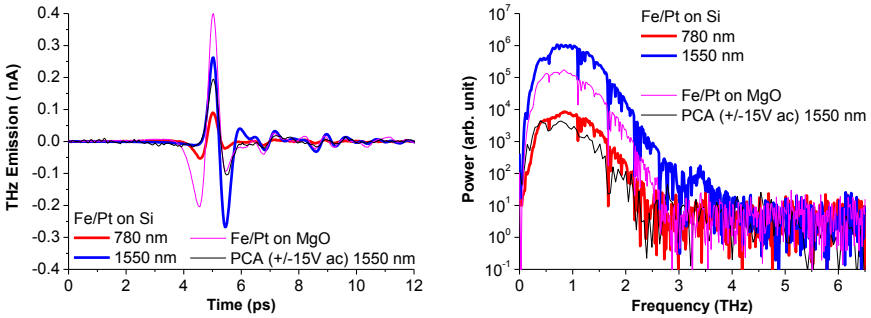


Fig. 1. Time-domain waveforms and power spectra of the Fe/Pt on Si spintronic THz emitter at 7-mW average pump power. For comparison, data for Fe/Pt on MgO and sub-bandgap excitation of a 5-µm dipole type LT-GaAs PCA emitter at the same pump power are also included.

References:
[1]. T. Seifert *et al.*, Nature Photonics **10**, 483-490 (2016).
[2]. E. Th. Papaioannou *et al.*, IEEE Transactions on Magnetics **54**, 9100205 (2018).