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Spintronic Terahertz Emission Regulated by Au Nanoparticles

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Abstract

Spintronic terahertz emitters driven by femtosecond laser pulses based on ferromagnetic and heavy metal heterostructures have become one of the best candidates for the next-generation terahertz sources. Moreover, since the materials in spintronic terahertz emitters are both magnetic and heavy metal nanofilm, it is very suitable to be used for biosensing and near-field imaging applications. Inspired by laser-terahertz emission microscopy, we hope to realize the detection of biochemical reaction on the spintronic terahertz emitter. Owing to the good photoelectric performance and biocompatibility of gold nanoparticles, it has received extensive attention and applications in the field of bioanalysis. Besides, with the rapid development in recent years, plasmonics has innovative progress in many research areas. Therefore, combining the biosensing and spintronic terahertz emitters to take advantage of both may have some valuable applications.

Spintronic terahertz emission microscopy（STEM）

Inspired by the idea of laser terahertz emission microscopy (LTEM) proposed by Prof. Masayoushi Tonouchi [20–22], we propose spintronic terahertz emission microscopy. When we sealed water onto W/CoFeB/Pt, we can clearly observe the modulation effect of terahertz signal.

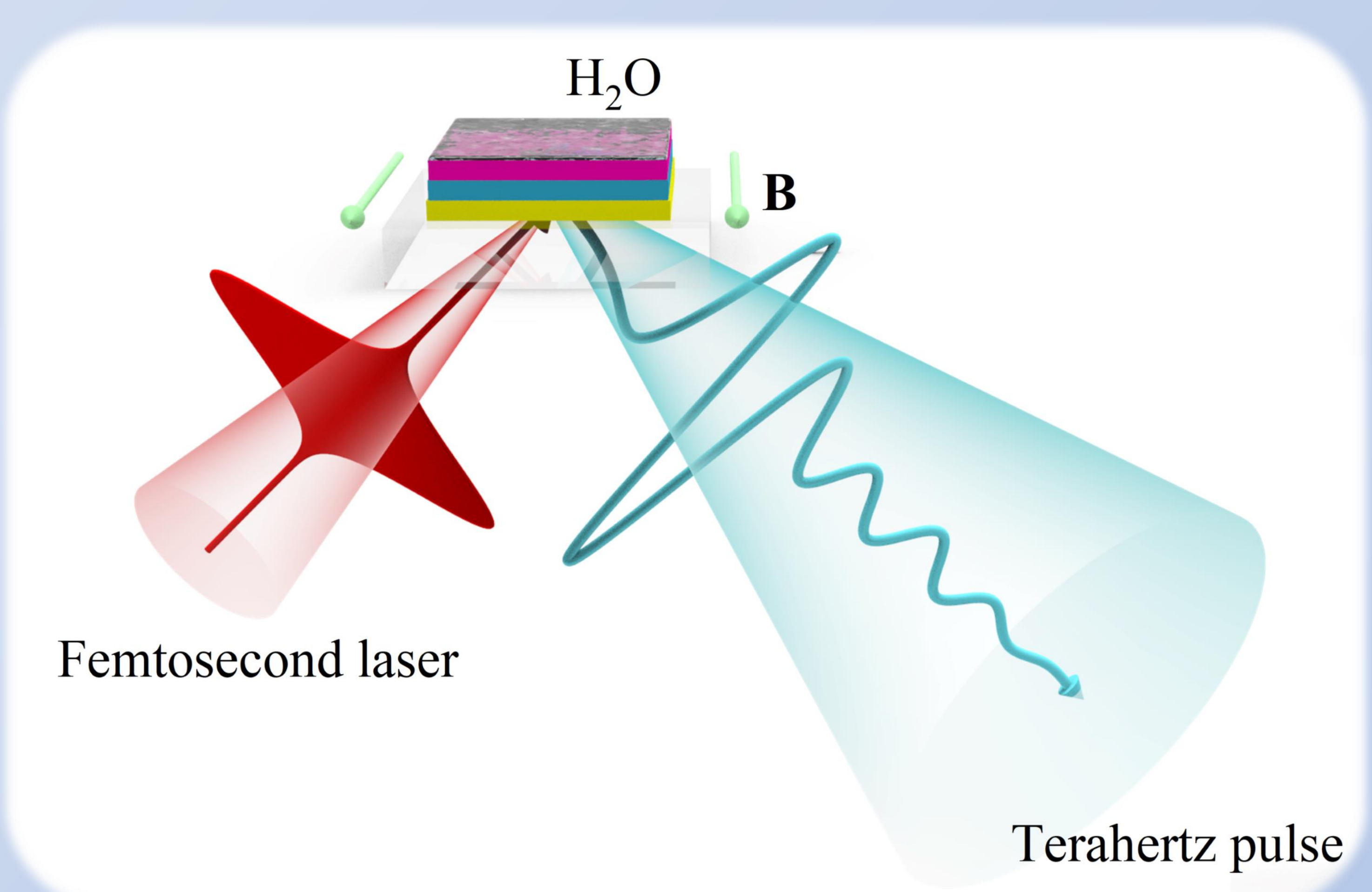

Fig. 1. Schematic diagram of STEM.

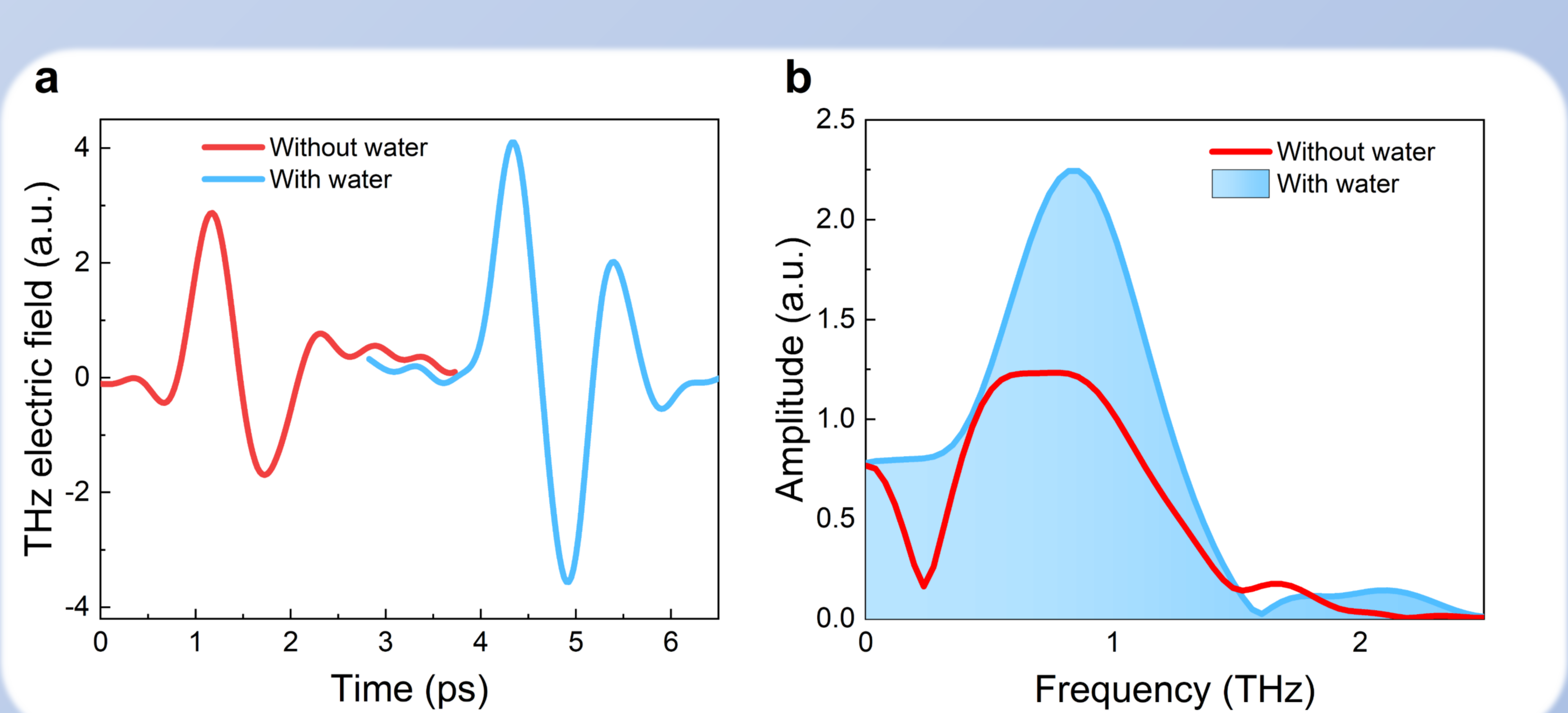

Fig. 2. (a) Terahertz temporal waveforms with and without water. (b) Their corresponding Fourier transformed spectra, respectively.

Spintronic terahertz emission modulated by Au

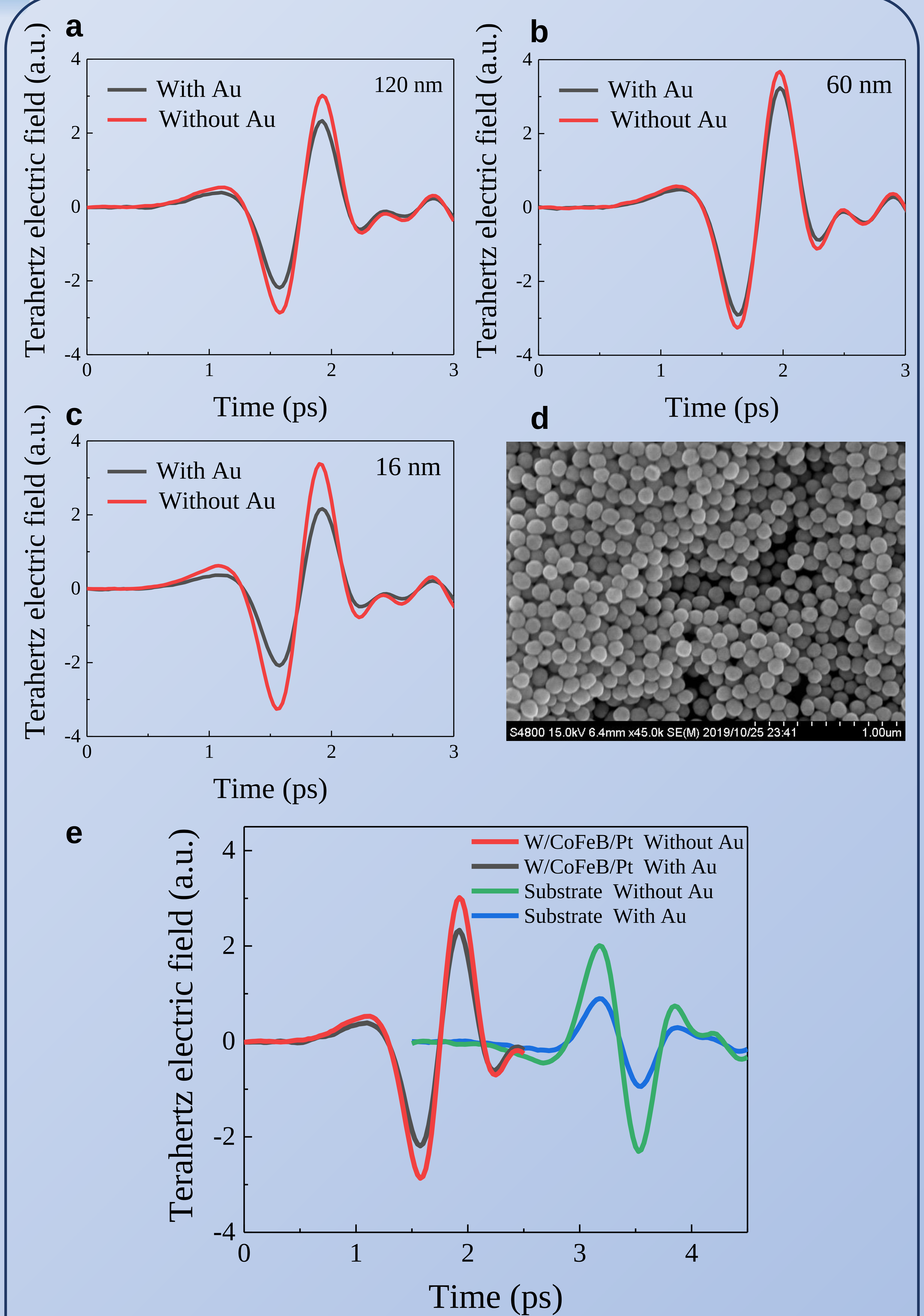

Fig. 3. (a)-(c) Terahertz temporal waveforms from W/CoFeB/Pt with (Black line) and without (Red line) Au nanoparticles for different size: 120nm, 60nm and 16nm. (d) SEM photo of Au nanoparticles used for spintronic terahertz emission with 120nm. (e) Terahertz temporal waveforms from different incident surface with and without Au nanoparticles (120nm), respectively.

This figure exhibits the terahertz temporal waveforms emitted from spintronic emitters with and without nanoparticles. we can see that the terahertz yield from W/CoFeB/Pt with Au nanoparticles for this three sizes is weaker than that without Au, which represents the regulatory effect of Au nanoparticles on the terahertz generation.

Summary

In this work, we proposed spintronic terahertz emission microscopy. we fabricated Au nanoparticles onto W/CoFeB/Pt spintronic terahertz emitter to study the modified terahertz signals. We changed the incident direction and get different modulation effects of Au on terahertz and femtosecond laser. Since Au nanoparticles is biosensing compatible, such spintronic terahertz emission spectroscopy may have some applications.