Simultaneous Dual Scanning Terahertz System

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***Abstract*—Terahertz time domain spectroscopy (THz-TDS) currently requires expensive components, in particular an ultra-fast Ti:Sapphire laser, and signal acquisition is not a real time process. In order to speed up the process for acquiring sample and reference data, we propose to approach dual scanning THz-TDS by using a single fast high precision translation stage and a single lock-in amplifier.**

I. Introduction

THE process of obtaining high quality sample and reference spectra from terahertz time domain spectroscopy (THz-TDS) systems, the can be time consuming[1,2]. To speed up this process, we present a novel simultaneous dual system configuration that has the advantage of concurrently acquiring sample and reference data.

To obtain high quality spectra, it is preferable to gather many averages of both the sample and reference to minimize the noise from the laser and errors from imprecisions of the translation stage. As data can be gathered simultaneously, laser fluctuations and drift noise is mitigated. Positioning error is greatly reduced by using a highly precise translation stage and it is also important to note that any positioning errors will be apparent and identical in both sets of data.

II. Experimental Setup

The two systems are set up as shown in Figure 1, where systems ① and ② are both pumped by a single Ti:Sapphire laser, and use a single optical delay stage. The systems are carefully laid out, ensuring that the optical paths in each system are matched for each individual detector. Three beam splitters are used in order to split the laser equally to the emitters and detectors; these can be seen in Figure 1, with two following the output of the laser, and one following the retro-reflector on an optical delay stage. To ensure that the pulses from both systems are matched temporally, a separate fixed optical path was used in both systems.

Both systems use low temperature grown gallium arsenide (LT-GaAs) photoconductive dipole antenna structures as emitters. Both emitters use a square wave driven power supply to apply a bias voltage across the antenna structure, with the reference square wave signal feed to a single lock-in amplifier. The detector used in system ① is again a LT-GaAs dipole antenna structure, which is connected to the current input of the lock-in amplifier on one channel, while an electro-optical (EO) detector is used in system ②, and connected to the voltage input of the lock-in amplifier on a second channel.

A computer is then used to control and obtain data from both systems, and control code is written such that the computer is able to interface simultaneously with two channels of the lock-in amplifier. The software used in this case is written in LabView.

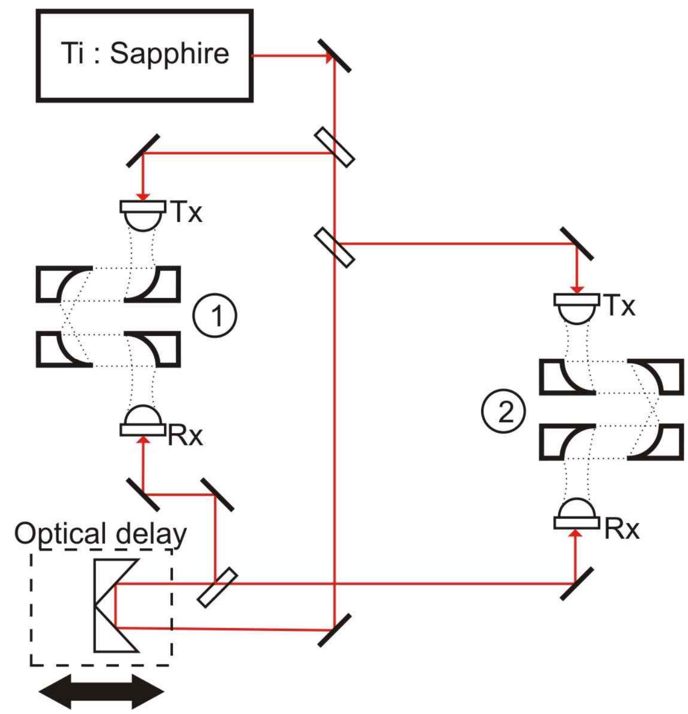

Figure 1: Layout of the simultaneous dual scanning terahertz system. This figure shows the use of a single optical delay stage in two separate systems, ① & ②. The systems are pumped by a single Ti:Sapphire laser.

III. Discussion

The setup of these two systems enables them to be employed independently, such that two separate samples and references can be obtained from both systems, or the systems can be used in parallel, in order to speed up the acquisition time required to obtain both sample and reference data. This also enables the systems to achieve real-time absorption data, as the sample and reference data are gathered simultaneously[1–3].

To further optimize the systems, identical emitters and detectors should be used in order to ensure that the pulse shapes for each system are also identical. Further to this, if the detectors chosen are compatible with a two channel input lock-in amplifier, it is possible to minimize the cost of a second unit. As the lock-in amplifier has two voltage channel inputs, if balanced photo-detectors are connected, a single lock-in amplifier can be used.

Here, we have demonstrated a method which optimizes the

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efficiency and minimizes the cost of two THz-TDS systems, by using a single laser and optical delay stage. However, there are other systems that allow for faster scanning[4] and real-time imaging[5], but at the expense of cost.

Results from the experiments will be shown at the conference venue and in subsequent publications.

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