Terahertz Imaging of Paraffin-embedded Epithelial Cell of Rat using Pulsed and CW THz Systems

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Abstract—**To investigate the response of cell to the terahertz wave, both the pulsed and CW THz wave systems are employed. The THz wave systems include TDS broadband pulsed THz system(0.3-3THz), narrowband CW BWO vacuum THz generator, (0.5THz)and narrowband CW Gunn diode THz generator(0.3THz). THz imaging of a rat's paraffin-embedded epithelial cell with tumor is studied.**

I. Introduction And Background

The pioneering Terahertz(THz) imaging in the frequency range between 0.1 and 2.0 THz by Hu [1] have generated tremendous interest in the fields of THz sensing and imaging. Especially in medical imaging, terahertz imaging is expected to be a powerful technique because of the effective piercing feasibility, which enables to perform safe and high resolutive imaging(e.g., effective wavelength enough to pierce slight samples and to get clear image, extremely low energy compared to X-ray,).

Most of the initiative works on THz imaging utilized time-domain measurements using a femtosecond laser[2-4]. A big advantage of vast information due to broadband operation provides with a good resolution. However, low intensity limits their THz imaging in practice taking too much time to scan the objects. Recently there also exists THz imaging using CW THz radiation sources such as BWO's and quantum cascade lasers.[5,6] CW THz sources like BWO's can provide much higher output power and frequency stability for a better signal-to-noise ratio. Potentially THz camera can be realizable using CW THz sources with a array detector. Good review on comparison between pulsed and CW THz imaging is published.[7] In this report, we present both pulsed and CW THz imaging for a epithelial cell of rat.

II. Results

CW THz imaging system is constructed as shown in Fig 1. (a) using several CW radiation sources such as 0.2THz and 0.3THz Gunn diodes, and 0.5THz BWO and pyro-electric sensor, 30GHz~3THz detectable, and 4 Off-Axis-Parabolic mirrors (OAPs). Sample is located at the most focused position which means in the middle of M2 and M3 to get maximum transmission. Paraffin-embedded epithelial tissues of rat, to which tumors are implanted, are prepared to identify the response to the THz wave. As shown in Fig 2. these bionic samples are hydrated and paraffin-embedded so that even the small vibration or oscillation is out of consideration while experiments. Signal to noise ratio (SNR) for this CW system is about 10,000:1, better or of same level compared to previous researches [5-6][8-9].

Preliminary measurements using 0.3THz CW source is presented in Fig. 3 (b). A Pulsed THz image using the TDS broadband pulsed THz system shown in Fig. 1 (b) the system of which is equivalent with previous studies[2-4] is presented in Figure 3 (a) for comparison. The details of measurements and their comparison using pulsed TDS system, Gunn diode and BWO vacuum THz system will be presented.

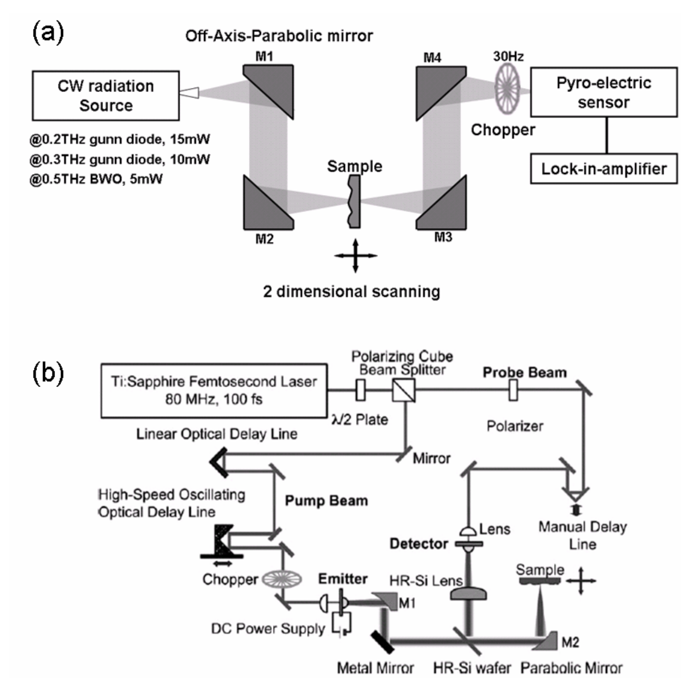

Figure 1: Schematic of Terahertz imaging setup (a) CW system using 0.2THz, 0.3THz gunn diode and 0.5THz BWO (b) TDS system using femto-second laser of 0.3-3THz.[10]

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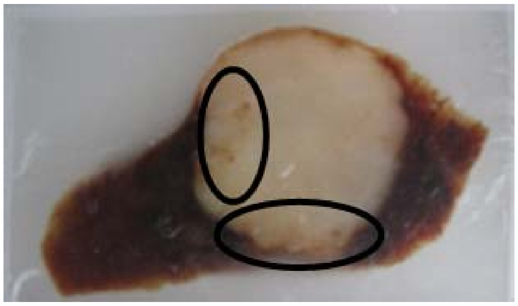

Figure 2: Optical image of paraffin-embedded epithelial cell of tumor planted rat (2*3.5cm^2, 3mm thickness). Circled areas are tumor suspicious.

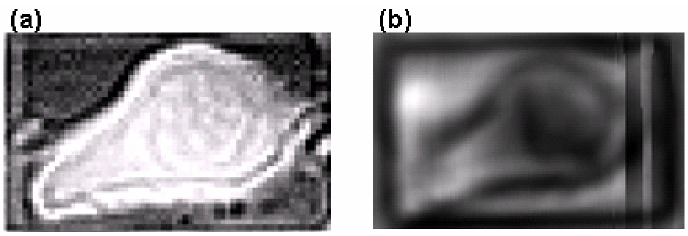

Figure 3: THz image of paraffin-embedded epithelial cell of rat by (a)femtosecond laser, (@0.3-3THz, 70*50 pixels, W8 filtering) (b)0.3THz CW image (@0.3THz, 3*4 cm^2, 160*120 pixels)

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