Characteristics and Application of Terahertz Imaging Non-destructive Detection

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***Abstract*- There has been a significant interest in employing terahertz (THz) technology, spectroscopy and imaging for non-destructive evaluation. The implementations of some different THz imaging measurements for non-destructive examination of diverse materials in practical applications are briefly introduced. Examples of the measurement of maize seeds and fuel tank insulation foam panel and razor blade using THz pulsed spectroscopic imaging or continuous-wave (CW) THz imaging are presented and analyzed, exploring the characteristics of these modalities. Furthermore, the spatial patterns of the maize seeds were extracted, along with a view of a progress in real-time imaging and potential prospects of THz imaging technology.**

I. INTRODUCTION

As for diverse materials for non-destructive evaluation, different THz imaging measurements have their respective characteristics and relative applications. In this paper, we will give a outline of three imaging systems and explore the characteristics of pulsed and CW imaging via the example measurement of maize seeds and fuel tank insulation foam panel and razor blade, so that they may be applied optimally and show potential to make new assemblies.

II. IMAGING NON-DESTRUCTIVE EVALUATION

THz imaging modalities in our labs have used different sources and detection techniques, the same samples detected by them have different results, showing their respective characteristics and applications.

The pulsed imaging system in transmission geometry have utilized a mode-locked Ti: sapphire femtosecond laser, an InAs wafer used as an emitter and a ZnTe crystal employed as a sensor. This method records the waveform of the transmitted THz pulses, preserving phase and amplitude information. Based on the spectral and imaging datum, we have identified maize seeds, which have different characteristic absorption spectra, by THz imaging technology using the method of component pattern analysis [1]. And that, based on depth information directly conveyed by image, the thickness of the ladder of fuel tank foam can be obtained. The uniformity and consistency of tablet coating can be non-destructively detected because of the principle [2]. A razor blade shielded by an opaque material (foam) is detected, which shows the capacity of detecting hidden objects, and the spatial resolution can approximately reach to 1.1mm [3].

The CW imaging system is in reflection geometry, a frequency-doubled Gunn diode oscillator emitting a 0.2THz is utilized as a source, while an unbiased Schottky diode is used as the detector. Since it does not require a time delay scan, CW imaging affords a compact, fast and relatively low-cost system. In example of fuel tank insulation foam panel, non-destructive detection of four man made built-in defects is realized in several minutes, but it can not be used to identify the maize seeds as loss of depth and spectral information. However, in pulsed transmission system, the defects can not be evaluated because THz pulse could not penetrate the metal panel. As for the image of the razor blade, the resolution is 2.7mm, smaller than pulsed system.

Real-time imaging system established under way employs a Ti: sapphire oscillator and a regenerative amplifier used as laser, and a digital CCD to record optical image via a two-dimensional electro-optic sampling [4], realizing real-time THz imaging without loss of spatially distributed phase and amplitude information and image movies.

The modalities presented above can make new assemblies, for example, CW imaging system can yield both amplitude and phase information by the use of additional optical delay [5] and feasibility of real-time THz imaging with a coherent CW illumination source has also been demonstrated [6].

III. CONCLUSION

These modalities here have their own characteristics and relative applications, which must be considered if they are to be optimally applied. And make new assemblies will have wider applications in quality monitoring and material non-destruction inspection.

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