Generation of tunable terahertz Bessel beam with a Tsurupica Axicon lens

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1. Introduction

Bessel beams possess unique properties, such as non-diffraction, super-resolution focused spot, and self-healing effects [1]. Thus, they have been currently applied in a variety of fields, including optical trapping/manipulation, and high resolution 3-dimensional imaging [2]. Terahertz (THz) Bessel beams will open the door towards THz coherent tomography (THz OCT) and long-distance THz communications [3].

Axicon lenses are most commonly used to generate Bessel beams, however, there are few axicon lenses used in an entire THz frequency region [4], owing to inherent absorption and large frequency dispersion of optical materials. Thus, it is still difficult to develop the tunable THz Bessel beam light source.

In this presentation, we propose a Tsurupica THz Axicon lens with high transmission and low frequency dispersion, and we also demonstrate a tunable THz Bessel beam generation from a picosecond difference frequency generation in combination with the Tsurupica Axicon lens.

2. Experiments and results

Figure 1 shows an experimental setup for a tunable THz Bessel beam light source, formed of a picosecond laser pumped 4'-dimethylamino- N-methyl- 4-stilbazolium tosylate difference frequency generator (picosecond THz DAST-DFG) and a Tsurupica Axicon lens. The Axicon lens with a wide transmission window in the entire THz frequency region (Fig. 2) was fabricated by a mechanical polishing technique, and its Axicon angle was measured to be 15°.

The generated 4 and 7 THz Bessel beams exhibited typically non-diffractive beam properties, such as multiple ringed spatial profiles and excellent depth of field (Fig. 3). In fact, the depth of focus (confocal length) of the generated Bessel beam was measured to be 10 times longer than that of the Gaussian beams.

3. Conclusion

We have successfully demonstrated the generation of a tunable THz Bessel beam by employing a Tsurupica axicon lens in combination with a picosecond THz DAST-DFG. This system will potentially enable the generation of THz Bessel beam within the entire THz frequency range of 2-7 THz. Also, the system will allow the production of high-order THz Bessel beams with an orbital angular momentum by combining the Tsurupica spiral phase plate [5] or the tunable THz vortex source [6].

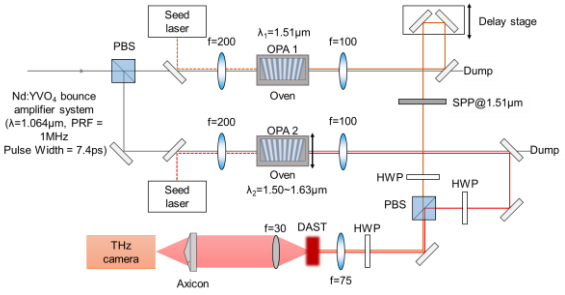

Fig.1 Experimental setup of the widely tunable THz Bessel beam generation.

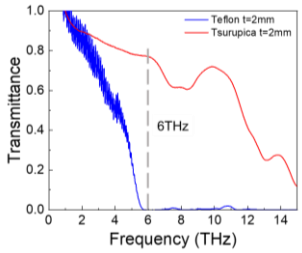

Fig.2 Transmittance of Tsurupica and Teflon.

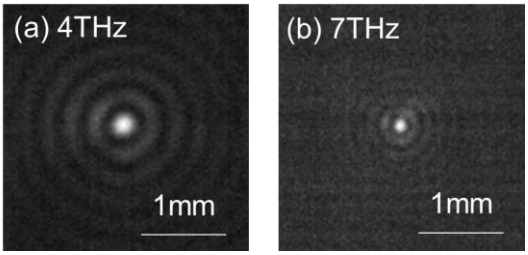

Fig.3 Intensity profiles of THz Bessel beams at 4 and 7 THz.

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