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Structured light and laser ablated flat optics in nonparaxial terahertz imaging systems

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Terahertz (THz) imaging leverages the ability of THz radiation to propagate with minimal losses through various dielectric materials, making it a powerful tool for non-invasive inspections in materials science, security, and medicine. Effective THz imaging systems in practical applications require compact, efficient components with low power consumption and no need for optical alignment. Diffractive optical elements (DOEs) can replace bulky components, making systems more compact and even suitable for on-chip integration. Recent studies have shown that THz structured light outperforms conventional Gaussian beams in resolution and contrast, enabling better estimates of the optical properties of low-absorbing materials.

This report discusses the design and assembly principles of nonparaxial THz imaging systems using silicon-based DOEs, including Fresnel zone plates, Fibonacci lenses, Bessel axicons, and Airy zone plates [1], all made from high-resistivity 500 μm thick silicon substrates via femtosecond laser ablation. The study evaluates THz light illumination at 600 GHz and scattered light collection from raster-scanned samples using a single-pixel detector. Metrics such as contrast, resolution, depth of field, and focus are analyzed to assess system performance [2]. The optimal modulation transfer condition in nonparaxial THz imaging is found to be separate from the best image irradiance condition. This research highlights the importance of structured illumination and light-collection schemes, as well as the assembly principles of silicon DOEs, in developing compact THz imaging systems.

REFERENCES

[1] R. Ivaškevičiūtė-Povilauskienė, P. Kizevičius, E. Nacius, D. Jokubauskis, K. Ikamas, A. Lisauskas, N. Alexeeva, I. Matulaitienė, V. Jukna, S. Orlov, L. Minkevičius, G. Valušis, *Light: Science & Applications* **11**, 1 326 (2022).

[2] S. Orlov, R. Ivaškevičiūtė-Povilauskienė, K. Mundrys, P. Kizevičius, E. Nacius, D. Jokubauskis, K. Ikamas, A. Lisauskas, L. Minkevičius, and G. Valušis, *Laser Photon. Rev*. **18**, 2301197 (2024).