S8-O1

Dual-Mode Homodyne Imaging with C-Shaped Metalenses

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Terahertz (THz) radiation, characterized by its low-energy frequency range, serves crucial roles in non-destructive imaging applications such as material inspection, security checks, and medical diagnostics [1]. Current THz imaging techniques encounter a trade-off between resolution and dynamic range. Direct detection methods offer high resolution but are limited in dynamic range, whereas heterodyne imaging, utilizing two THz sources, significantly enhances dynamic range albeit at the expense of increased complexity and cost. In contrast, homodyne imaging, based on Mach-Zehnder interferometry principles, simplifies setup while retaining the ability to retrieve phase information and achieve high resolution [2]. This method amplifies sensitivity to subtle changes in optical materials, making it particularly suitable for imaging low-absorption targets. However, prior implementations have lacked polarization-sensitive detection and the capability for simultaneous measurements in both reflection and transmission geometries.

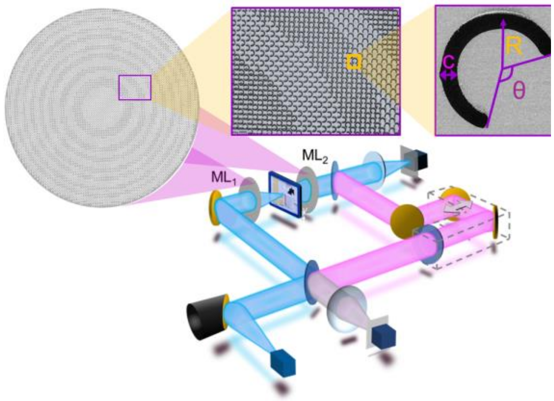

Fig. 1. Stainless steel metalens design with enlarged views, showing the structure quality achieved by laser ablation (a). THz imaging setup in direct, homodyne imaging configurations.

This work aims to advance THz imaging technology by developing a novel system integrating C-shaped metalenses (Fig. 1). These innovations are designed to enhance homodyne detection capabilities, enabling polarization-resolved feature extraction, improved imaging of low-absorption samples, and simultaneous detection in transmission and reflection geometries.

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