P23

THz metalens design development and application to beam forming

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Terahertz (THz) radiation falling within 100 GHz to 10 THz range possesses low non-ionizing energy and has capability to penetrate many dielectric materials [1]. This characteristic makes THz radiation useful in various fields such as security, production quality control, imaging, and bio-fabric analysis [2]. Traditionally, these applications relied on bulky and expensive lenses or mirrors to manage beam propagation, making the systems inconvenient for practical use. One solution for reducing the size of these systems is the use of metalenses. They combine lens phase profile with metaatoms, that are geometric shapes smaller than the wavelength, such as split ring resonators, to achieve phase delay and polarization rotation.

This research covers numerical simulations conducted to determine the appropriate complementary split-ring resonators (CSRR) metaatoms for integration into a 250 GHz metalens design. A two and four subzone multilevel zone plate was used as the phase surface for four F=30 mm metalens designs. Both simulations and experimental results demonstrated that all four lenses can focus radiation efficiently, with a full width at half maximum close to the wavelength (Fig. 1).

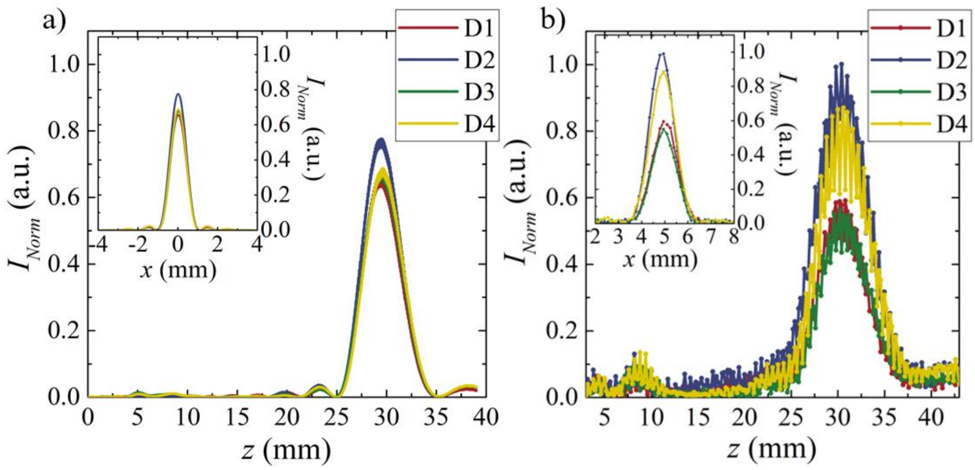

Fig. 1 Simulation results a), experimental results b).

In this work,, the influence of metalens bending on focusing performance was experimentally evaluated. A decreasing bending radius leads to a reduction in intensity at the focal point and an increase in beam FWHM. Finally, a 250 GHz metalens was used in an object imaging setup. Imaging of a metal USAF target defined the achievable resolution, which is 0.63λ. Imaging a target made of several different dielectric materials demonstrated that, by employing the metalens, it is possible to distinguish low-absorbing objects.

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