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Redirecting of THz beams using flat optical elements dependent on polarization

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Terahertz (THz) radiation has attracted significant attention due to its potential applications in communication, imaging, and sensing systems. In this work, flat optical elements with subwavelength details, fabricated using additive manufacturing, were investigated as compact components for THz beam redirecting and focusing. The structures are based on cyclic olefin copolymer (COC), a material characterized by low absorption coefficient and low refractive index in the THz range. Particular attention is devoted to the structures with different infill geometries, enabling the control of the effective refractive index and the realization of constant-thickness optical elements. Measurements were performed for structures introducing phase delay either through the fill factor (FF) of subwavelength geometries or through geometrical thickness variation. An example of a measurement for variable thickness conical [1] lens designed for a 10° beam deflection angle is presented in Fig. 1, demonstrating simultaneous beam redirection and focusing into an elongated half-line formed just after the structure.

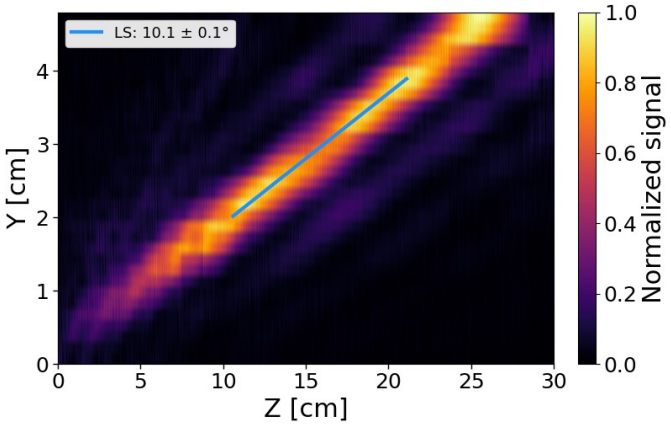

Fig. 1. Normalized signal distributions (Y-Z plane) measured at 96 GHz for the conical 10° element, illustrating beam redirecting and focusing into elongated half-line.

The proposed structures can be applied in compact systems dedicated to the characterization of subwavelength samples in the sub-THz regime. In liquid-crystal-based wedge systems, proper matching of the source polarization is essential for efficient refractive index modulation [2] and controlled beam deflection. Moreover, constant-thickness gradient-index (GRIN) optical elements also exhibit polarization-dependent behavior resulting from their subwavelength internal geometry. Consequently, the efficiency of beam steering depends not only on the operating frequency and infill parameters, but also on the polarization orientation of the THz source.

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