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Development of Artificial Birefringence for Phase and Polarization Control at 253 GHz

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Terahertz radiation is widely employed in imaging of optically opaque materials, spectroscopy, and communication, and it also holds potential for applications in security and defense. However, most elements used for radiation control typically modulate amplitude or phase. To enable simultaneous polarization control, artificial birefringence can be exploited. This physical phenomenon can be realized in isotropic materials by introducing subwavelength periodic structures that interact with transmitted radiation [1]. The resulting anisotropy expands wavefront control capabilities, allowing simultaneous manipulation of phase and polarization and thereby increasing the available degrees of freedom [2,3].

In this study, we investigate birefringence and the fabrication of functional elements operating at 253 GHz. Specifically, we examine the feasibility of manufacturing half-wave plates and Pancharatnam–Berry (geometric phase) elements using three materials: high-impact polystyrene, fused silica, and high-resistivity silicon (see Fig. 1). Each material entails distinct fabrication techniques and associated constraints. Therefore, a comparative analysis of these processes will be presented. In addition, numerical modeling of birefringent structures will be conducted to identify optimized designs, followed by experimental validation.

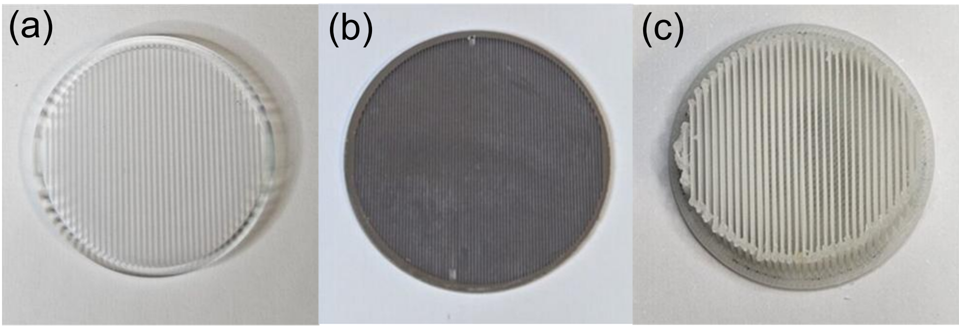

Fig. 1 Pictures of manufactured 1-inch diameter half-wave plates designed at 253 GHz made of (a) fused silica, (b) highly resistive silicon, and (c) high-impact polystyrene.

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