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3D Printed Hollow-Core Terahertz Optical Waveguides With Hyperuniform Disordered Dielectric Reflectors

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Novel hollow-core THz waveguides featuring hyperuniform disordered reflectors are proposed, fabricated, and characterized. Our main motivation is to explore the possibility of designing hollow core waveguides that feature spectrally broad bandgaps that are potentially superior to those attainable with purely periodic structures. Particularly, we demonstrated theoretically that using resin/air material combination that offers relatively low refractive index contrast of 1.67/1, one can design a hollow core waveguide featuring a 90GHz (˜21%) bandgap centered at 0.43THz. In such a waveguide, a highly porous PBG reflector comprised ˜113μm radius cylinders connected with ˜35μm thick bridges. We then attempted fabrication of such waveguides using 3D stereolithography. The diameter of the resultant waveguides (reflector size) is ˜20mm, while the diameter of the hollow core is ˜5mm. Due to limitations of 3D printer used in our work, the resolution was limited to 100μm which allowed us to print structures with bridges thicker than 200μm. As we demonstrated both theoretically and experimentally, thicker bridges lead to the overall reduction in the bandgap spectral size. Nevertheless, the fabricated waveguides featured relative wide bandgaps (up to ˜15%), and low transmission losses (<0.10cm-1) within their PBGs.

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