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Dispersion Compensation in Terahertz Communication Links Using Metallized 3D Printed Hollow Core Waveguide Bragg Gratings

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A novel hollow core waveguide Bragg gratings featuring periodically placed triangular axisymmetric slopes on its inner surface is proposed for the dispersion compensation in the terahertz frequency range. The proposed waveguide Bragg grating is operated in the bandgap of higher order modes and uses the fundamental HE11-like mode for the dispersion compensation. Theoretical results show that the optimized waveguide Bragg grating supports a single mode operation over the 137-141GHz spectral range. Within the single mode guiding range, the dispersion of the fundamental HE11-like mode has large negative values. Specifically, the dispersion of the fundamental HE11-like mode is ~ -130ps/(THz·cm) at 140GHz, while varying in the -500 ~-100 ps/(THz·cm) range over 137-141 GHz. In the vicinity of 160GHz, we also obtain a single mode range over the spectral range of 156-162GHz, where the dispersion of the fundamental HE11-mode varies from -1500ps/(THz·cm) to -60ps/(THz·cm).

Using numerically optimized waveguide structure, we fabricated the prototype of the waveguide Bragg grating using a 3D stereolithography system, and subsequently metallized it with a silver layer using wet chemistry. The optical properties of the fabricated waveguide Bragg grating were then measured experimentally using a terahertz continuous wave spectroscopy. We also mapped the output electric field of the fabricated waveguide Bragg grating. Experimental findings reproduced well the theoretically predicted modal properties, including spectral positions of high transmission regions and modal dispersion within these regions. From this, we conclude that presented device shows single mode operation, relatively high coupling efficiency, and strong negative dispersion, which is at least one order of magnitude higher than these of typical THz waveguides. This makes the proposed device suitable for dispersion compensation in free-space and fiber links for terahertz communications.

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