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# 3D printed hollow core terahertz Bragg waveguides with defect layers for surface sensing applications

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We study a 3D-printed hollow core terahertz (THz) Bragg waveguide for resonant surface sensing applications. We demonstrate theoretically and confirm experimentally that by introducing a defect in the first layer of the Bragg reflector, thereby causing anticrossing between the dispersion relations of the core-guided mode and the defect mode, we can create a sharp transmission dip inside of the waveguide transmission bandgap. By tracking the changes in the spectral position of the narrow transmission dip, one can build a sensor, which is highly sensitive to the optical properties of the defect layer. In order to calibrate our sensor, we use PMMA layers with different thicknesses attached on the waveguide inner surface. Strong frequency shift is observed, and the demonstrated sensitivity is found to be 0.1GHz/μm to changes in the defect layer thickness. Then, an example of THz resonant surface sensing using α-lactose monohydrate powder as the analyte is demonstrated experimentally. The anticrossing phenomenon between the core-guided mode and the defect mode is confirmed by imaging the modes propagated in the Bragg waveguide using a fiber coupled THz microscopy setup. Moreover, both THz time-domain spectroscopy (TDS) and continuous wave (CW) systems are used for comparative study of designing optimal detection systems. Unlike many other photonic bandgap waveguide sensors operating on a more common bulk sensing modality, the one proposed here enables a resonant surface sensing modality.

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