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Ultra-wideband graphene-based THz absorbers

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Historically, terahertz science and technology has been restricted to specialized applications such as radio astronomy due to various technological challenges. Hollow rectangular waveguides are the primary transmission line medium in many terahertz systems due to their mechanical stability, low electromagnetic losses, enclosed nature, and compatibility with active circuit elements. Electromagnetic wave devices such as circulators, couplers and power dividers require that one or more of their ports be terminated to eliminate unwanted signals and ensure correct operation. Waveguide terminations are often realized by short-circuited waveguide sections that present low reflection and absorb the incident energy due to the presence of an absorbing material inside the waveguide. We proposed a new kind of ultra-wideband THz absorber which can be directly integrated into a standard metallic waveguide, allowing it to be used in conventional THz systems. In_order to analyze the electromagnetic properties of the absorbing materials in the frequency range from 67 GHz to 500 GHz, the absorbing material has to be embedded inside a waveguide. At the sub-millimeter frequencies, these dimensions get too small to insert any absorbing material; therefore, we use vacuum filtration to directly deposit the absorber material inside a specialized waveguide cassette. This cassette can then be integrated with a waveguide system for material characterization. The integration method developed here is easily scalable to different frequency ranges and waveguide geometries and requires only standard laboratory equipment and techniques, making it viable for high-volume production. In addition, by utilizing the same method with precision silicon micromachined components, our approach could be used to develop compact, low-cost THz waveguide absorbers of complex geometry. In this study, graphene augmented inorganic nanofibers (GAIN) were used as waveguide embedded absorbers. The measured insertion loss between 67 GHz to 110 GHz is greater than 20 dB and exceeds 40 dB at frequencies above 400 GHz. The reflection coefficient of the samples measured below 200 GHz is in excess of −10 dB, indicating that much of the incident energy is reflected by the step change in impedance at the material's interface at these frequencies. The short electrical length of the samples at these frequencies leads to a relatively low insertion loss, despite the material's high reflectivity. Above 200 GHz, the GAIN samples exhibit a reflection coefficient below −10 dB.

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