Electrically tuneable terahertz metasurface enabled by a graphene/gold bilayer structure

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The ever-increasing demand for higher data-rate wireless communications (e.g., 6G telecommunications) is pushing carrier frequencies of wireless systems into the millimeter wave (mmW) and terahertz (THz) bands [1]. In the THz band, wireless technologies are hampered by a lack of materials that can perform at these frequencies, with required functionalities (e.g., reconfigurability and tuneability). Therefore, new materials with ultrafast carrier dynamics and reconfigurable/tuneable properties are required to develop electronic and photonic devices operating at THz frequencies. Graphene-like materials are a strong candidate for THz devices, with an ultrafast carrier mobility and field-tuneable electrical conductivity [2]. Here, we develop a graphene/gold bilayer metamaterial structure which is developed into A 0.2 THz frequency-selective absorber. As shown in Fig. 1(a), 16 dB of amplitude tuning at a 0.2 THz resonance is demonstrated with this approach. Further, as depicted in Fig. 1(b), over 95% broadband modulation is observed in non-resonant regions, with all tuning effects obtained within a low 6V bias voltage. The design and fabrication methods presented are readily adaptable to other tuneable THz devices required for high-speed, reconfigurable THz wireless communication and sensing technologies

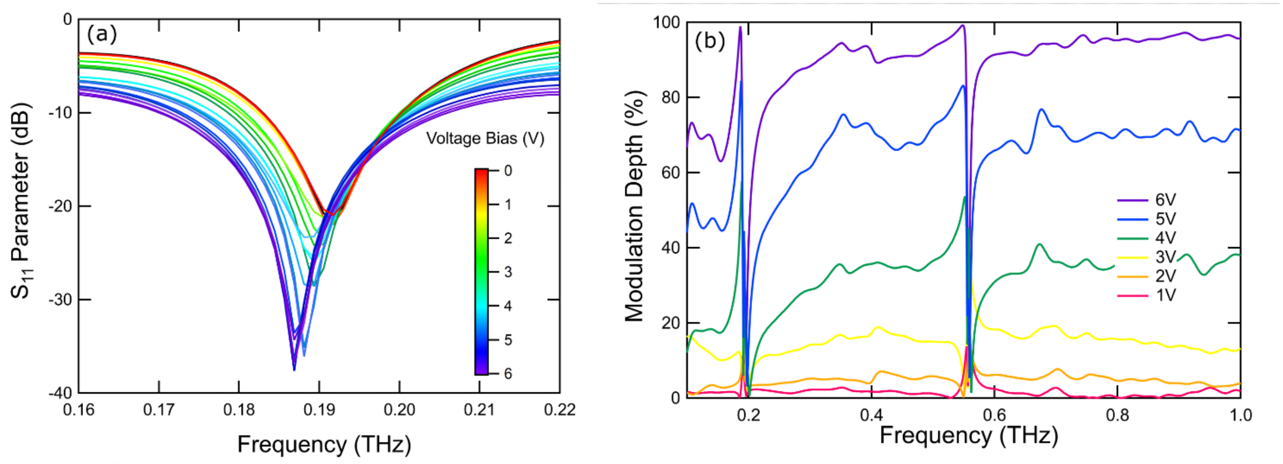

Fig. 1. (a) S11 parameter (power ratio) of the 0.2 THz resonance under varying bias voltage, showing clear frequency and amplitude tuning **(b)** Broadband modulation depth of the graphene/gold bilayer absorber. Discontinuities are seen due to the relative frequency shift of resonant modes within the device.

[1] T. Nagatsuma, G. Ducournau and C. C. Renaud, Advances in terahertz communications accelerated by photonics, *Nature Photonics* **10**, 371-379 (2016).

[2] X. He, Tunable terahertz graphene metamaterials, *Carbon* **82**, 229-237 (2015).