Controlling Terahertz Waves using Graphene Supercapacitors

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Abstract
In this work, we demonstrate a terahertz intensity modulator using a graphene supercapacitor which consists of two large area graphene electrodes and electrolyte medium. The mutual electrolyte gating between the graphene electrodes provides a very efficient electrostatic doping with Fermi energies of 1 eV and charge density of 8x1013 cm-2. We show that, the graphene supercapacitor yields more than 50% modulation between 0.1 to 1.4 THz with operation voltages less than 3 V. The low insertion losses, the simplicity of the device structure and polarization independent device performance are the key attributes of graphene supercapacitors for THz applications.

References

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Figures

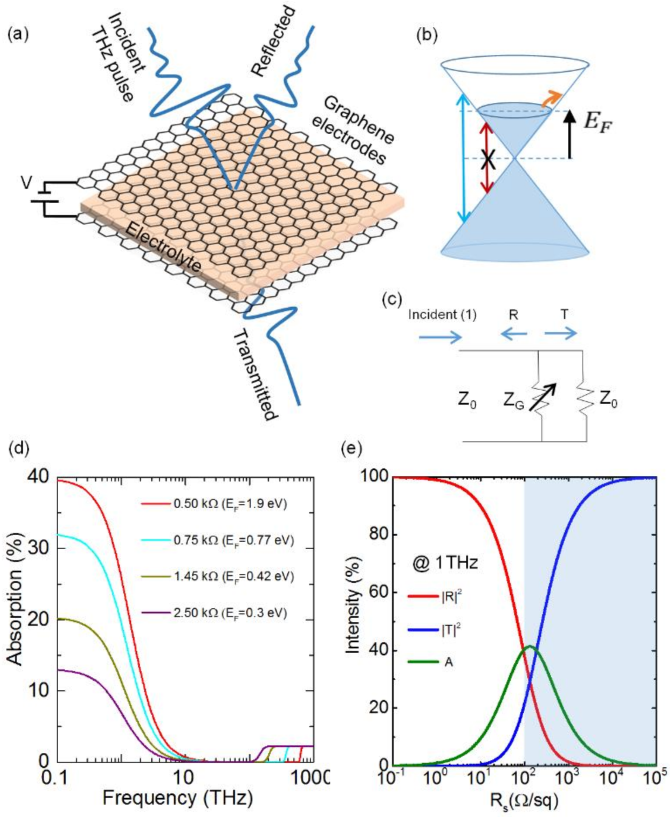

Figure (a) Schematic representation of the graphene supercapacitor used as a broad-band terahertz modulator. The supercapacitor consists of ionic liquid electrolyte sandwiched between two large area graphene electrodes. The charge density on graphene electrodes is modulated efficiently by an external voltage applied between the graphene electrodes. (b) Schematic band structure of electrostatically doped graphene electrodes. The arrows represent the interband and intraband electronic transitions. (c) The equivalent transmission line model of the graphene layer. (d) Calculated optical absorption of single layer graphene plotted against the frequency for different doping levels. (e) The change of reflection, transmission and absorption of graphene as a function of sheet resistance. The shaded area indicates experimentally accessible sheet resistance for CVD graphene.