Enhanced Graphene Absorption and Its Implications for Mid-infrared Components

Zhijun Liu*(1), Xiangxiao Ying(1), Yang Pu(1), Chen Yang(1), Kai Li(1), Jimmy Xu(2), and Yadong Jiang(1)
(1) School of Optoelectronic Information, University of Electronic Science and Technology of China, Chengdu, Sichuan 610054, China
(2) School of Engineering, Brown University, Providence, Rhode Island 02912, USA

Extended Abstract

Graphene is an emerging material with potential for advancing infrared devices. As originated from its massless Dirac electrons, graphene exhibits a wide electrostatic tunability and a strong plasmonic response with relatively small loss, which makes it attractive for developing new device functionalities especially in the mid-infrared regime, where many key components are currently in a status of immaturity.

In this talk, we will present our recent efforts on developing graphene-based mid-infrared devices. Firstly, in order to overcome the limitation of graphene's weak absorbance, we fabricate a Salisbury screen structure with a monolayer graphene placed a quarter wavelength above a metallic plane [1]. A greatly enhanced universal absorption of graphene up to 40% is measured, which is identified as the interband transition and explained with a surface impedance model [2]. Secondly, we propose a novel polarization device using rectangle-shape perforated graphene [3]. By mediating the reflection phase using superimposed multiple plasmonic modes of the metasurface, a wide-band tunable cross polarization converter is numerically illustrated with a bandwidth of ~5% of the central frequency (46.8THz) and a peak conversion ratio exceeding 90%. Finally, we will also discuss on the prospects and limitations of graphene's interband and intraband transitions on possible future mid-infrared components.

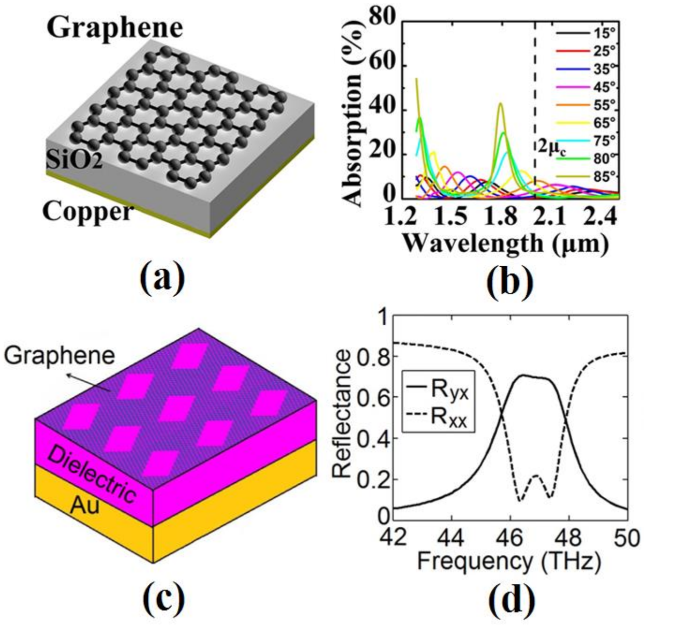

Figure 1. A graphene Salisbury screen (a) and its absorption (b), and a graphene cross polarization converter (c) and its reflection coefficients (d).

References

1. X. Ying, Y. Pu, Y. Luo, H. Peng, Z. Li, Y. Jiang, J. Xu, and Z. Liu, "Enhanced Universal Absorption of Graphene in a Salisbury Screen," *Journal of Applied Physics*, **121**, 2, January 2017, pp. 023110-1- 023110-6, doi: 10.1063/1.4973898.

2. X. Ying, Y. Pu, Z. Li, Z. Liu, and Y. Jiang, "Absorption Enhancement of Graphene Salisbury Screen in the Mid-infrared Regime," *Journal of Optics*, **44**, 1, January 2015, pp. 59-67, doi:10.1007/s12596-014-0230-9.

3. C. Yang, Y. Luo, J. Guo, Y. Pu, D. He, Y. Jiang, J. Xu, and Z. Liu, "Wideband Tunable Mid-infrared Cross Polarization Converter Using Rectangle-shape Perforated Graphene," *Optics Express*, **24**, 15, July 2016, pp. 16913-16922, doi: 10.1364/OE.24.016910.