High responsivity of graphene photodetector integrated into a sub-THz Fabry-Pérot cavity

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Terahertz (THz) detectors with large sensitivity and fast response are desired for a wide range of fields such as astronomy, non-destructive testing or high-speed wireless communications. However, conventional devices currently suffer from a relatively low responsivity or a slow response. In the last decade, graphene-based photodetectors have emerged as a platform of choice to implement compact THz detectors with low energy consumption and boosted performances, but are currently limited by a low absorption in the THz range [1,2]. To face this drawback, we propose in our recent work [3] a graphene THz detector integrated inside a sub-THz Fabry-Pérot cavity, designed to strongly enhance the absorption of incoming sub-THz light, and thereby the detector responsivity due to the resonant cavity conditions formed by a dipolar antenna and a metallic back mirror. To investigate the high responsivity, we perform time and frequency domain measurements as well as theoretical simulations, where we report an enlarged external responsivity close to 0.3 A/W at the cavity resonant frequency, mainly driven by a strong THz absorption in the photo-active area on the graphene channel, opening new directions for highly sensitive THz detection integrated in a compact and passive device.

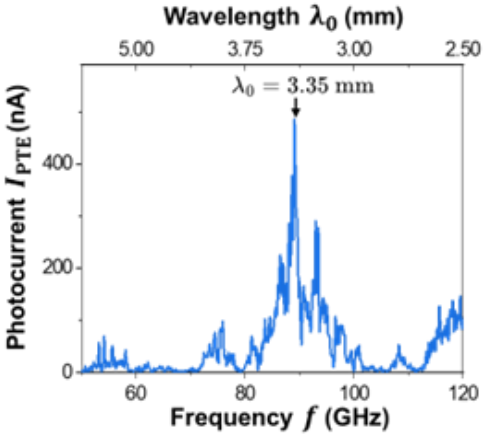

Fig. 1 – Measured photocurrent vs frequency, reporting an enhanced THz detection via a sub-THz Fabry-Perot cavity.

References

[1] S. Castilla *et al.*, "Fast and Sensitive Terahertz Detection Using an Antenna-Integrated Graphene pn Junction", Nano Letters, vol. 19, pp. 2765–2773 (2019).
[2] K. P. Soundarapandian *et al.*, "High-Speed Graphene-based Sub-Terahertz Receivers enabling Wireless Communications for 6G and Beyond", arXiv:2411.02269 (2024).
[3] R. de La Bastida *et al.*, "Graphene-based Fabry-Perot integrated THz detector and interferometer enabling sensitive thickness measurements", to be submitted (2025).