POLITECNICO DI TORINO
Repository ISTITUZIONALE

Experimental activities on graphene in the sub-THz range

Original
Experimental activities on graphene in the sub-THz range / Virone, G., Paonessa, F., Riaz, M.U., Bianco, G.V., Bruno, G., D'Orazio, A., Matekovits, L.. - (2024), pp. 36-36. (Ninth International Workshop Nanocarbon Photonics and Optoelectronics Kuopio (Fin) 4 - 9 August, 2024).

Availability:
This version is available at: 11583/3000647 since: 2025-06-04T09:35:01Z

Publisher:
University of Eastern Finland

Published
DOI:

Terms of use:

This article is made available under terms and conditions as specified in the corresponding bibliographic description in the repository

Publisher copyright

(Article begins on next page)

26 November 2026

Experimental activities on graphene in the sub-THz range

G. Virone[a], F. Paonessa[a], M. U. Riaz[ad], G. V. Bianco[b], G. Bruno[b], A. D'Orazio[c], L. Matekovits[ad]

[a]*Consiglio Nazionale delle Ricerche, IEIIT, C.so Duca degli Abruzzi 24, 10129, Turin, Italy*

[b]*Consiglio Nazionale delle Ricerche, NANOTEC, via Orabona, 4, 70125 Bari, Italy*

[c]*Politecnico di Bari, Dipartimento di Ingegneria Elettrica e dell'Informazione, Via Orabona 4, 70125 Bari, Italy*

[d]*Politecnico di Torino, DET, C.so Duca degli Abruzzi, 24 - 10129 Turin, Italy*

giuseppe.virone@cnr.it

1. Introduction

The main challenges for future wireless communications are terabit-per-second data rate and coverage everywhere. Such performance could be achieved by exploiting the sub-THz frequency regime (100 GHz – 1 THz) [1], in both Terrestrial and Non-Terrestrial Networks. One of the key-enabling subsystems to operate in the sub-THz frequency range is the antenna. In modern communication environments, the antenna system generally consists of antenna arrays and reflective/refracting surfaces. The present research activities on these topics require advanced materials with good electrical properties (to achieve efficient devices) and a high degree of reconfigurability [2]. These challenges motivate the research line on graphene at sub-THz.

2. The experimental activity

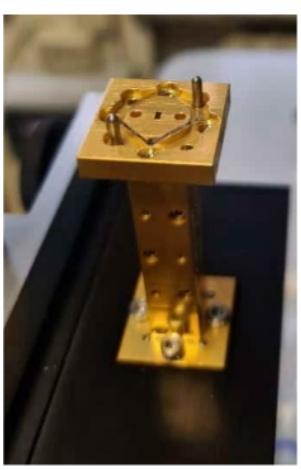


Fig. 1. Example of waveguide-based experimental setup in the 110-170 GHz frequency band

Previous studies demonstrated that reconfigurable absorbers [2], and screens [3], can be obtained in X-band (7-13 GHz) with properly designed graphene layers. Ongoing projects aim at extending these results in the millimeter-wave range (above 30 GHz) [4], and beyond (sub-THz). Such activities require a complete characterization of the properties of the adopted advanced material(s). To this end, we are developing a set of experimental setups to characterize multilayer Chemical Vapor Deposition, CVD, graphene samples in the 65-750 GHz frequency range. An example is shown in Fig. 1. The gold-plated metal waveguide is connected to a millimeter-wave extender (black surface) which is then connected to a Vector Network Analyzer (not visible). The square-shaped glass sample (of edge length of 8.5 mm) is placed on top of the waveguide interface/flange. The graphene layers are transferred on one side of the glass sample. The electromagnetic field is excited/probed through the rectangular aperture (open-ended waveguide 1.6 mm x 0.8 mm) at the center of the top metal flange. This measurement configuration is simpler than the one reported in [5], where lens-based horns were adopted. Consequently, it will allow for an accurate modeling of the electromagnetic environment, leading to a more precise estimation of the material parameters. Moreover, the present measurement setup can be easily calibrated by connecting known devices to the upper waveguide flange.

The results of a measurement campaign carried out on multilayer graphene samples will be presented at the workshop along with possible device configuration that could be developed accordingly.

3. Acknowledgement.

This work was supported by the European Union under the Italian National Recovery and Resilience Plan (NRRP) of NextGenerationEU, partnership on "Telecommunications of the Future" (PE00000001 - RESTART).

The measurement setup is part of the PNRR Infrastructure named Earth-Moon-Mars (EMM), IR0000038 – CUP: C53C22000870006.

4. References

[1] Wei Jiang , Qiuheng Zhang , Jiguang He , et al., Terahertz Communications and Sensing for 6G and Beyond: A Comprehensive View. TechRxiv. June 22, 2023.

[2] Grande, M., Bianco, G.V., Perna, F.M. et al., Reconfigurable and optically transparent microwave absorbers based on deep eutectic solvent-gated graphene. Sci Rep 9, 5463 (2019). https://doi.org/10.1038/s41598-019-41806-w

[3] M. Grande, G. V. Bianco, M. A. Vincenti, D. de Ceglia, P. Capezzuto, V. Petruzzelli, M. Scalora, G. Bruno, and A. D'Orazio, Optically transparent microwave screens based on engineered graphene layers, Opt. Express 24, 22788-22795 (2016)

[4] Magno, G., Caramia, L., Bianco, G.V. et al., Design of optically transparent metasurfaces based on CVD graphene for mmWave applications. Sci Rep 13, 4920 (2023). https://doi.org/10.1038/s41598-023-31298-0

[5] Ehsan Dadrasnia, Sujitha Puthukodan, Vinod V. K. Thalakkatukalathil, Horacio Lamela, Guillaume Ducournau, Jean-Francois Lampin, Frédéric Garet, Jean-Louis Coutaz, Sub-THz Characterisation of Monolayer Graphene, Journal of Spectroscopy, vol. 2014, Article ID 601059, 6 pages, 2014. https://doi.org/10.1155/2014/601059