Graphene-based heterostructures for Terahetz detection technology

José M. Caridad[a,b], O. Castelló[a], S.M. López-Baptista[a], T. Taniguchi[c], K. Watanabe[c], H.G. Roskos[d], Juan A. Delgado-Notario[a]

[a] *Departamento de Física Aplicada, Universidad de Salamanca, Salamanca 37008, Spain*
[b] *Unidad de Excelencia en Luz y Materia Estructuradas (LUMES), Universidad de Salamanca, Salamanca, 37008, Spain*
[c] *Research Center for Materials Nanoarchitectonics, National Institute for Materials Science, Tsukuba305-0044, Japan*
[d] *Physikalisches Institut, Johann Wolfgang Goethe-Universität, Frankfurt am Main D-60438, Germany*

Corresponding author email: jose.caridad@usal.es

The outstanding properties of two-dimensional (2D) crystals and van der Waals heterostructures have sparked a *renewed interest in* the study and development of terahertz (THz) photodetectors made of these alluring materials [1,2]. Among others, 2D crystals have the potential to enable ultrasensitive and fast photodetection of THz radiation even at room temperature.

In the present work, we explore the use of distinct graphene and hexagonal boron nitride (hBN) heterostructures to design novel and high-performance THz detectors.

In particular, by exploiting the high mobility of charge carriers in hBN-encapsulated graphene, we first demonstrate the realization of a unique, frequency-selective and frequency-tunable detector of THz radiation working at room temperature. [3]

Moreover, we show an enhanced THz photoresponse occuring in graphene/hBN heterostuctures with aligned graphene and hBN crystal lattices, which can be directly ascribed to the presence of superlattice effects in these systems. [4]

Ultimately, we briefly discuss how the introduced THz detectors can be used in a large number of existing and new functionalities including sensitive and selective sensing, frequency mixing, signal multiplication and modulation as well as radiation confinement.

[1] D.A. Bandurin, et al. *Nat. Comm*. 9, 5392 (**2018**)

[2] M. Mittendorff, et al. *Nano Lett.* 17, 5811 (**2017**)

[3] J.M. Caridad, et al. *Nano Lett.* 24, 935 (**2024**)

[4] J.A. Delgado-Notario et al. *Submitted*