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S E M I N A R
aus
Halbleiterphysik und Nanotechnologie

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Hyperbolic mid-infrared photodetector based on heterostructures of graphene and boron nitride

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In this talk I will present results on a new type of mid infrared photodetector made of graphene/boron nitride van der Waals heterostructure [1]. This detector is operating from the photothermoelectric effect to generate a photovoltage at a graphene pn junction as already demonstrated in the past [2]. We found that the device responsivity is drastically increased when graphene is encapsulated into hexagonal boron nitride (h-BN). In fact, the role of h-BN is twofold. On the one hand h-BN is an excellent substrate for graphene leading to high carrier mobility and also high Seebeck coefficient [3]. On the other hand, owing to its natural hyperbolic dielectric function, h-BN can support hyperbolic phonons polaritons [4]. The hyperbolic phonons-polaritons propagate as confined rays in the heterostructure's slab and are focused at the pn junction, heating up the graphene thus leading to a strong photocurrent. This concept is exploited to boost the external responsivity of mid-infrared photodetectors, overcoming the limitation of graphene pn-junction detectors due to their small active area and weak absorption.

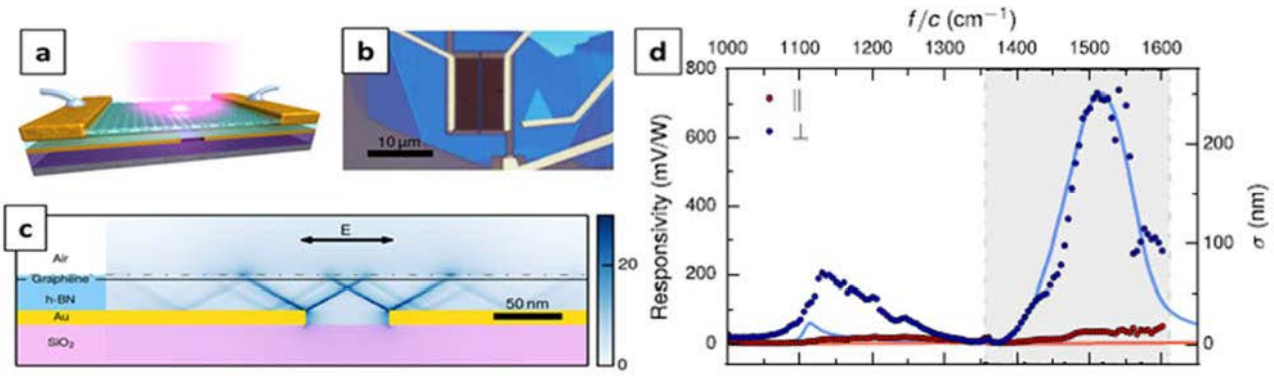

Figure: a. Sketch of the device. b. Optical image of the device. c. FDTD simulation of the propagating phonon-polaritons launched at the gold edges of the split gates. d. Responsivity spectrum of the device and simulated absorption.

[1] Woessner, Parret, et al., Electrical detection of hyperbolic phonon-polaritons in heterostructures of graphene and boron nitride. NPJ: 2D Mater. Appl. 1 (2017)

[2] Gabor, et al. Hot Carrier–Assisted Intrinsic Photoresponse in Graphene. Science 334 (2011)

[3] Dean, C. R. et al. Boron nitride substrates for high-quality graphene electronics. Nature Nanotech. 5, (2010).

[4] Dai et al. Subdiffractional focusing and guiding of polaritonic rays in a natural hyperbolic material. Nature Comm. 6 (2014)