Non-equilibrium optical properties of encapsulated graphene

Eva A. A. Pogna[1]

C. Trovatello[1], K. J. Tielrooij[2], N. C. H. Hesp[2], A. Principi[3], M. Lundeberg[2], L. Banszerus[4], M. Massicotte[2], P. Schmidt[2], D. Davydovskaya[2], C. Stampfer[4], M. Polini[5], F. H. L. Koppens[2] and G. Cerullo[1]

1-Physics Department, Politecnico di Milano, 20133 Milano, IT
2-ICFO, The Barcelona Institute of Science and Technology, 08860 Castelldefels, ES
3-Radboud University, Institute for Molecules and Materials, 6525 Nijmegen, NL
4-JARA-FIT 2nd Institute of Physics, RWTH Aachen University, 52074 Aachen, GE
5-Instituto Italiano di Tecnologia, Graphene labs, Via Morego 30, 16163 Genova, IT

evaarianna.pogna@polimi.it

Light absorption in graphene creates a hot electrons distribution, whose cooling dynamics is ruled by electron-electron, electron-phonon and phonon-phonon interactions. According to supercollision theory [2], in SiO_2-supported graphene defect-assisted scattering with acoustic phonons plays a major role in accelerating the relaxation to equilibrium, reducing the efficiency of graphene photodetectors. To minimize this interaction, van der Waals heterostructures with graphene encapsulated by different layered materials have been proposed. In particular, hexagonal boron nitride (hBN) has demonstrated successful in decreasing the defects density and doping, improving graphene's electrical properties [1-2]. Here we present an experimental study of the optical properties of encapsulated graphene by high sensitivity ultrafast transient absorption experiments (see Figure 1). We investigate the role of the encapsulant material in the hot-electron cooling process by comparing graphene encapsulated into hBN of different thicknesses and into MoS_2 (see Figure 2). We study the relaxation dynamics as function of lattice temperature and hot electron temperature, tuned by changing the excitation power.

References

[1] Dean, C.R. et al., Nature Nanotech, 5 (2010) 722
[2] Mayarov, A.S. et al., Nano Lett., 11 (2011) 2396
[3] Betz, A. C. et al., Nature Phys., 9 (2013) 109-112

Figures

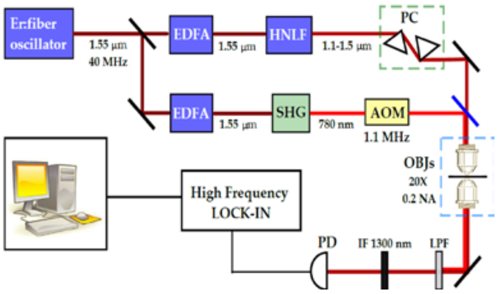

Figure 1: High-sensitivity transient absorption setup based on 40 MHz Er-doped fiber laser.

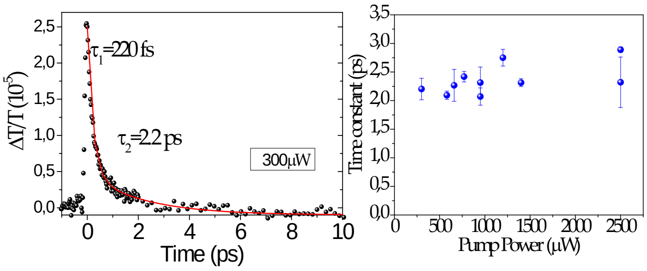

Figure 2: Transient transmittivity of MoS_2/graphene/ MoS_2 and cooling time as function of the excitation power.