



Polymers under Multiple Constraints

Physikalisches Kolloquium

Thursday,

10th April
2014

at: 5.15 pm

Gustav-Mie-
Hörsaal,
Theodor-Lieser-
Str. 9, 06120
Halle

*Coffee will be
served from
4.45 pm!*

Prof. Dr. Mischa Bonn

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Ultrafast Carrier Dynamics in Gra- phene and Graphene Nanostructures

Graphene is an attractive candidate for many optoelectronic applications because of its vanishing bandgap and high carrier mobility. An essential process for such applications is the dissipation of the energy of photoexcited charge carriers in the material. Two competing energy relaxation mechanisms for optically excited carriers exist: They can (i) thermalize with intrinsic carriers near the Fermi level, heating them to higher energy states through the process of 'hot carrier multiplication'; or (ii) the excess energy of the optically excited carrier can be lost via emission of phonons. With optical excitation-THz probe spectroscopy, an optical method for probing photoconductivities on ultrafast timescales [1], we reveal highly efficient energy transfer from an optically excited carrier to multiple heated charge carriers (relaxation path (i)).

While presenting an advantage for some applications, the vanishing bandgap of graphene can also be a disadvantage in applications such as photovoltaics. A chemical synthesis approach was recently shown for making well defined, narrow graphene nanoribbons (GNRs) with widths as small as ~ 1 nm [2]. In these structures, carrier confinement in the lateral dimension induces a bandgap corresponding to absorption of visible wavelength. Similarly, carbon nanotubes (CNTs) are one dimensional graphene nanostructures which can exhibit bandgaps. We present a study of the complex photoconductivity of GNRs and semi-conducting CNTs, and show that while the mechanism of photoconductivity is very similar in the two materials, the charge mobility is very different between the two nanostructures [3].

[1] K. J. Tielrooij, J. C. W. Song, S. A. Jensen, A. Centeno, A. Pesquera, A. Zurutuza Elorza, M. Bonn, L. S. Levitov and F. H. L. Koppens, Photoexcitation cascade and multiple hot-carrier generation in graphene, *Nature Physics* 9, 248 (2013).

[2] A. Narita, X. Feng, Y. Hernandez, S. A. Jensen, M. Bonn, H. Yang, I. A. Verzhbitskiy, C. Casiraghi, M. R. Hansen, A. H. R. Koch, G. Fytas, O. Ivasenko, B. Li, K. S. Mali, T. Balandina, S. Mahesh, S. De Feyter and Klaus Müllen, Synthesis of structurally well-defined and liquid-phase-processable graphene nanoribbons, *Nature Chemistry* 6, 126 (2014).

[3] S. A. Jensen, R. Ulbricht, A. Narita, X. Feng, K. Müllen, T. Hertel, D. Turchinovich, and M. Bonn, Ultrafast photoconductivity of graphene nanoribbons and carbon nanotubes, *Nano Letters* 13, 5925 (2013).

