June 11th, 2012 - 14:30 pm

Seminar Room 108, DESY Bldg. 49

CFEL SCIENCE

Max Planck Research Department for **Structural Dynamics**

SEMINAR

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Picosecond photocurrents and terahertz generation in nanoscale circuits

The time-resolved dynamics of photogenerated charge carriers in nanoscale systems are typically detected by optical methods such as the transient absorption technique and the time-resolved photoluminescence spectroscopy. Many questions remain concerning the separation and transport of photogenerated charge carriers to source and drain leads, when the nanosystems shall be functional modules in (opto-)electronic circuits. Typical propagation times of ballistic photogenerated charge carriers in nanoscale circuits are in the ps-regime. Conventional electronic measurements cannot resolve such ultrafast dynamics because available electronic equipment cannot produce trigger signals and detect transients faster than tens of picoseconds. Furthermore, nanosystems typically exhibit a high impedance of several kilo-ohms, and ultrafast charge-carrier dynamics are therefore obscured by the response time of the high-frequency circuits.

We recently introduced an experimental on-chip pump/probe scheme to measure the photocurrent dynamics of electrically contacted nanosystems with a picosecond time-resolution [1]. In the talk, I highlight the picosecond photocurrent dynamics in semiconducting nanowires and graphene [2,3]. In particular, our ultrafast experiments clarify the optoelectronic mechanisms contributing to the photocurrent generation at graphene-metal interfaces. We verify that both built-in electric fields, similar to those in semiconductor-metal interfaces, and a photo-thermoelectric effect give rise to the photocurrent at graphene-metal interfaces at different time scales. Our results open the possibility to design and fabricate graphene-based and nanowire-based ultrafast photodetectors, photoswitches, photovoltaic cells, and THz-sources.

[1] L. Prechtel, L. Song, S. Manus, D. Schuh, W. Wegscheider, A.W. Holleitner, Nano Lett. 11, 269 (2011). **[2]** L. Prechtel, M. Padilla, N. Erhard, H. Karl, G. Abstreiter, A. Fontcuberta i Moral, A.W. Holleitner, Nano Lett. accepted 10.1021/nl300262j (2012). **[3]** L. Prechtel, L. Song, P. Ajayan, D. Schuh, W. Wegscheider, A.W. Holleitner, Nature Comm. 3, 646 (2012).

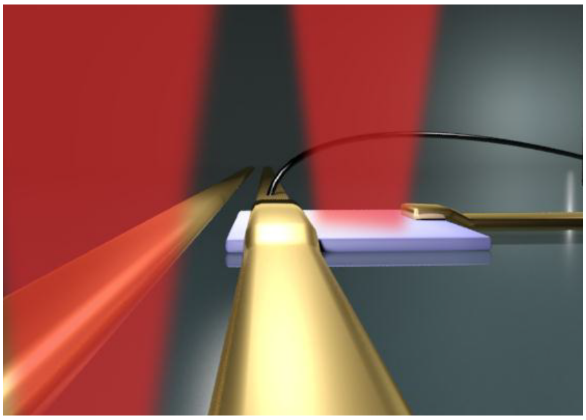

Fig.: Graphene is incorporated into a coplanar stripline circuit. A pump laser pulse focused onto the graphene-sheet generates a photocurrent jphoto. The time-resolved photocurrent is measured with a probe pulse focused onto an ultrafast Auston-switch as a function of the time delay.

Host: Stefan Kaiser, MPSD-CMD, CFEL