Q 35: Ultrakurze Laserpulse: Anwendungen 2

Time: Wednesday 14:30–16:00 Location: SCH A01

Q 35.1 Wed 14:30 SCH A01

Ultrafast Lattice Heating in Graphite and few-layer Graphene monitored by Ultrafast Electron Diffraction — •Christian Gerbig, Silvio Morgenstern, Cristian Sarpe, Matthias Wollenhaupt, and Thomas Baumert — University of Kassel, Institute of Physics and Center of Interdisciplinary Nanostructure Science and Technology (CINSaT), D-34132 Kassel, Germany

Ultrafast Electron Diffraction (UED) has lately become one of the most promising techniques to directly provide insights into fundamental dynamics at the microscopic level and on the pico- to subpicosecond timescale [1]. The investigation of laser-induced structural dynamics in the recently discovered 2D material graphene via UED should bring new insights in its unique properties [2]. So far time-resolved electron crystallography has been used to study lattice vibrations and coherent motions of graphite sub-surfaces after photoexcitation [3,4].
In this contribution we present first results on the direct observation of transient lattice heating in free-standing graphite and few-layer graphene using UED. In addition, we show a new approach of our setup with the prospect to directly resolve coherent lattice motions.

[1] M. Chergui & A. H. Zewail, Chem. Phys. Chem. **10**, 28 (2009)
[2] A. K. Geim & K. S. Novoselov, Nature Materials **6**, 183 (2007)
[3] A. H. Zewail and coworkers, Phys. Rev. Lett. **100**, 035501 (2008)
[4] R. K. Raman *et al.*, Phys. Rev. Lett. **101**, 077401 (2008)

Q 35.2 Wed 14:45 SCH A01

Ultrafast electron kinetics in metals irradiated with femtosecond XUV laser pulses — •Nikita Medvedev[1,2] and Baerbel Rethfeld[1] — [1]Technical University of Kaiserslautern, Germany — [2]CFEL at DESY, Hamburg, Germany

Metals irradiated with ultrashort laser pulses undergo a photoabsorption by electrons in conduction band and by ionization of deep atomic shells if the photon energy is sufficient. The relaxation of this excited nonequilibrium electron ensemble leads to photoemission, which can be detected experimentally, and to a lattice heating with further observable material modifications. We present a theoretical study of the excited electronic subsystem in solid aluminum irradiated with XUV ($\sim$ 10 - 200 eV) femtosecond laser pulse ($\sim$ 10 fs), as produced by the FLASH (free electron laser in Hamburg). The Monte Carlo method is extended to take into account the electronic band structure and Pauli's principle for excited electrons, secondary ionization, Auger-decays [1,2]. The results show that excited electronic distribution has two branches: a low energy part as a slightly distorted Fermi-distribution and a long high energy tail. We compare the calculated electron distributions with the spectroscopy data obtained in first experiments with FLASH [3].

[1] N.Medvedev, B.Rethfeld, New J. Phys. 12, 073037 (2010)
[2] N.Medvedev, B.Rethfeld, AIP conf. Proc. 1278, 250 (2010)
[3] S. M. Vinko et al., Phys. Rev. Lett. 104, 225001 (2010)

Q 35.3 Wed 15:00 SCH A01

Dynamics of electrons in liquid water excited with ultrashort VUV laser pulse — •Klaus Huthmacher, Nikita Medvedev, and Bärbel Rethfeld — TU Kaiserslautern, Deutschland

In this work we present the theoretical study of the interaction of an ultrashort VUV laser pulse with liquid water. Incident photons ionize water molecules and lead to free electrons, which further create secondary electrons due to ionization and interact via elastic collisions with other water molecules. For the laser pulse we assume a gaussian shape with a FWHM of 10fs and an average photon energy of 50eV.
We use an extended Monte Carlo method [1] to track each free electron and its collisions event by event. In the first step we calculate the realized penetration depth of the photons. Next we evaluate the cross sections for the free electrons refering to ionization and elastic collisions. Furthermore we compute mean free paths and finally we get the energy loss due to elastic collisions or the energy transfer to secondary electrons due to ionization. All the secondary electrons are included in the simulation in the same manner.
As results we present time-, spatially- and energetically resolved electron distributions.

[1] N. Medvedev and B. Rethfeld *New Journal of Physics* **12** (2010) 073037

Q 35.4 Wed 15:15 SCH A01

Visualisierung des Elektronen-Beschleunigungsprozesses bei der Laser-Wakefield-Beschleunigung — •Maria Nicolai[1], Hans-Peter Schlenvoigt[1], Stuart P. D. Mangles[2], Alexander G. R. Thomas[2], Aboobaker E. Dangor[2], Heinrich Schwoerer[1], Warren B. Mori[3], Zulfikar Najmudin[2], Karl M. Krushelnick[2], Alexander Sävert[1] und Malte C. Kaluza[1] — [1]Institut für Optik und Quantenelektronik, 07743 Jena — [2]Imperial College London — [3]UCLA Los Angeles

Bei der Wakefield-Beschleunigung werden durch einen intensiven Laser hohe elektrische Felder in einer Plasmawelle erzeugt. Dadurch können auf sehr kurzen Distanzen Elektronen auf relativistische Energien beschleunigt werden. Dieser Prozess konnte bisher nur über numerische Simulationen untersucht oder indirekt beobachtet werden.

In dem hier vorgestellten Experiment wurde eine Kombination aus Schattenbildern, Interferometrie und Polarimetrie verwendet, um die magnetischen Felder sichtbar zu machen, die die Elektronen und die Plasmawelle umgeben. Wenn ein linear polarisierter Probepuls einen Bereich im Plasma mit starken Magnetfeldern durchläuft, dann wird seine Polarisation durch den Faraday-Effekt gedreht. Diese Polarisationsdrehung wurde experimentell gemessen und daraus das magnetische Feld ermittelt, welches durch den Elektronenstrom erzeugt wurde. Durch die Veränderung der zeitlichen Verzögerung zwischen Haupt- und Probepuls konnte erstmals die zeitliche Entwicklung des Beschleunigungsprozesses mit hoher räumlicher und zeitlicher Auflösung untersucht werden.

Q 35.5 Wed 15:30 SCH A01

Photonic structure-based acceleration of non-relativistic electrons — •John Breuer and Peter Hommelhoff — Max-Planck-Institut für Quantenoptik, Garching, Deutschland

Laser-based electron acceleration is an intriguing tool for small-size particle accelerators, but also for precise temporal control of non-relativistic electrons. Our concept is based on periodic electric field reversal, thus the electrons are accelerated directly by the laser electric field (proposed in [1]). We illuminate a fused-silica transmission grating with Titanium:sapphire femtosecond pulses in order to excite evanescent spatial modes which propagate synchronously with 30 keV electrons. Numerical simulations show expected accelerating gradients of up to 60 MeV/m and an energy gain of around 300 eV at a distance of 100 nm away from the grating surface. We will describe our experimental setup, present first results and discuss possible applications.

[1] T. Plettner, R. L. Byer et al., PRSTAB, 9, 111301 (2006)

Q 35.6 Wed 15:45 SCH A01

Time-resolved amplified spontaneous emission in quantum dots — Jordi Gomis-Bresco[1], Sabine Dommers-Völkel[1], Oliver Schöps[1], •Yücel Kaptan[1], Olga Dyatlova[1], Dieter Bimberg[2], and Ulrike Woggon[1] — [1]Institut für Optik und Atomare Physik, Technische Universität Berlin, Straße des 17. Juni 135, 10623 Berlin, Germany — [2]Institut für Festkörperphysik, Technische Universität Berlin, Hardenbergstraße 36, 10623 Berlin, Germany

Complementary to prior pump-probe experiments the time-resolved amplified spontaneous emission (TRASE) of the excited state (ES) in InGaAs quantum dots-in-a-well (DWELL) based semiconductor optical amplifiers (SOAs) is studied by utilizing a Streak Camera System. The natural advantage of this approach is that we are able to directly resolve the population dynamics of the ES after the amplification of an ultrashort 150fs pulse resonant to the ground state (GS). Conducting the TRASE measurement when saturating the SOA we observe a 10ps delay between the nonlinear GS pulse amplification and the subsequent ES population drop-off [1]. It is well-known from pump-probe experiments that the GS population recovers in the time range of a few picoseconds. Assuming a cascade-like relaxation path (2D barrier-ES-GS) a corresponding fast decrease in the intensity of the ES ASE should be visible in the measurements. Since our observed 10ps delay contradicts this expectation, we conclude the dominance of a direct capture relaxation path (2D barrier-GS) in electrically pumped DWELL structures. [1] J. Gomis-Bresco et al., Appl. Phys. Lett. (accepted)