HL 32: C/diamond

Time: Wednesday 16:30–18:00 Location: H14

HL 32.1 Wed 16:30 H14

Diameter and density controlled synthesis of high quality carbon nanotubes via predefined gas phase prepared catalyst particles — •Franziska Schäffel, Christian Kramberger, Mark Rümmeli, Daniel Grimm, Thomas Gemming, Thomas Pichler, Bernd Büchner, Bernd Rellinghaus, and Ludwig Schultz — IFW Dresden, P.O. Box 270116, D-01171 Dresden, Germany

Due to their excellent mechanical and electronic properties carbon nanotubes (CNTs) are promising candidates for the integration into nano-electro-mechanical systems such as nanorelays and actuators or transistors. Effective control of the CNT growth and positioning is however mandatory for the realization of any of these applications. We report on an innovative technique to grow CNT by chemical vapour deposition (CVD) using cyclohexane. Here, the catalyst particles are synthesized separately by inert-gas condensation using DC magnetron sputtering at pressures in the mbar range. This allows for the production of pure catalyst particles with a narrow particle size distribution. The particles act as individual nucleation sites for the growth of CNTs. The size of the particles and their spatial distribution template the diameter and the density of the resulting CNT, respectively. This use of separately generated particles provides significant advantages such as the possibility to engineer the size, morphology, spatial distribution, and mutual separation of the CNTs *prior* to the CVD process. The opportunity to characterize the catalyst particles prior to the CVD reaction together with post-CVD studies of the resulting CNTs provides superior insight into the CNT growth process.

HL 32.2 Wed 16:45 H14

Pressure-induced phenomena in single-walled carbon nanotubes — •K. Thirunavukkuarasu[1], C.A. Kuntscher[1], Á. Pekker[2], K. Kamarás[2], F. Hennrich[3], M. Kappes[3,4], and Y. Iwasa[5] — [1]Experimentalphysik II, Universität Augsburg, D-86159 Augsburg, Germany — [2]Research Institute for Solid State Physics and Optics, Hungarian Academy of Sciences, P.O.Box 49, Budapest, Hungary H 1525 — [3]Institut für Nanotechnologie, Forschungzentrum Karlsruhe, D-76021 Karlsruhe, Germany — [4]Physikalische Chemie, Universität Karlsruhe, D-76128 Karlsruhe, Germany — [5]Institute for Materials Research, Tohoku University, Sendai 980-8577 (Japan)

The study of single-walled carbon nanotubes (SWNTs) under high pressure has attracted much interest recently as the application of pressure induces structural deformations of the SWNTs and also tunes the intertube interactions by changing the distances between the tubes. Both should significantly affect the properties of the SWNTs.

We studied the optical response of thin films of both unoriented and oriented SWNTs over a broad frequency range (IR-VIS) and for pressures up to 8 GPa. The effect of pressure on oriented nanotubes caused major changes in the optical properties only for the polarization along the nanotube axis. We will discuss in detail the effect of pressure on the electronic properties like interband transitions for the different SWNT films.

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HL 32.3 Wed 17:00 H14

Suppressed formation of electron-hole droplets in diamond under strain — •Nobuko Naka, Junko Omachi, and Makoto Kuwata-Gonokami — Department of Applied Physics, The University of Tokyo, Tokyo 113-8656, Japan

Recent advances in growing high-purity single crystal diamonds have led to new opportunities to investigate the optical properties of high-density electron-hole systems created by photo-excitation in diamond. At low temperature, droplets (EHD) of electron-hole pairs in the liquid phase coexist with excitons or plasmas in the gas phase [1,2]. Shimano et al. [2] studied the formation dynamics of the EHD by applying time-resolved luminescence spectroscopy to a type IIa diamond crystal grown by high-temperature, high-pressure synthesis. The luminescence signal originating from EHD has a rise time of 60 ps, while plasma luminescence emerges within the experimental resolution. From temperature dependence measurements, they reported a critical temperature of 165 K for the EHD formation. Although this temperature is much higher than the ones reported for silicon and germanium, EHD in diamond are stabilized due to a delicate balance of the correlation, exchange, kinetic, and excitonic Coulomb energies. We report on suppressed EHD formation in a diamond crystal under strain perturbation.

[1] K. Thonke et al., Diamond Relat. Mater. 9, 428 (2000), N. Teofilov et al., ibid. 12, 636 (2003).

[2] R. Shimano et al., Phys. Rev. Lett. 88, 057404 (2002).

HL 32.4 Wed 17:15 H14

Metal-insulator transition and superconductivity in heavily boron-doped single crystal diamond — •Philipp Achatz[1,2,3], Etienne Bustarret[1], and Thierry Klein[1] — [1]CNRS Grenoble/LEPES, 25 Avenue des Martyrs, 38042 Grenoble, France — [2]CEA Grenoble/DRFMC/SPSMS, 17 Avenue des Martyrs, 38054 Grenoble, France — [3]Walter Schottky Institut, TU München, Am Coulombwall 3, 85748 Garching, Germany

The superconducting properties of diamond epilayers grown along {001} and doped with boron ($0.3 < n_B < 3$ at. %) have been investigated at low temperatures down to about 50 mK by a.c. and d.c. resistivity, as well as by a.c. magnetic susceptibility, and the phase diagram of this type II superconductor was established. Further, the results show that the critical boron concentration n_c is the same for the normal to superconducting and for the non-metal to metal transitions, on the order of 0.3 at. %, in agreement with estimates derived from various theoretical approaches. A variable range hopping behaviour was clearly observed on the insulating side of the transition, and, as expected, the characteristic temperature T_0 tended toward zero at the transition. On the metallic side, the zero temperature conductivity σ_0 scaled with $(n_B/n_c - 1)^\nu$ with $\nu \approx 1$. The critical temperature T_c remained high in the vicinity of the metal-non metal transition, and it was rather found to scale with $(n_B/n_c - 1)^{1/2}$. These results led us to propose that the electron-phonon coupling parameter λ remains large down to $n_B/n_c \approx 1.1$, and to examine the metal-insulator transition and the parameter set (λ, μ) in terms of scaling laws.

HL 32.5 Wed 17:30 H14

Electronic and optical properties of diamond/organic semiconductor heterostructures — •Wojciech Gajewski[1], Jose Garrido[1], Martin Niedermeier[1], Oliver Williams[2], Ken Haenen[2], and Martin Stutzmann[1] — [1]Walter Schottky Institute, TU München, Am Coulombwall 3, 85748 Garching, Germany — [2]Institute for Materials Research, University of Hasselt, Wetenschapspark 1, BE-3590 Diepenbeek, Belgium

Different diamond substrates (single crystalline: SCD, poly-crystalline: PCD and nano-crystalline: NCD) were used to investigate the electronic and optical properties of the diamond/organic semiconductor heterostructures. Layers of a poly[ethynyl-(2-decyloxy-5-methoxy)benzene] - PEB, pentacene and 4-nitro-biphenyl-4-diazonium cations - Ph-Ph-NO2 were prepared by spin coating, thermal evaporation and grafting, respectively. The measurements of the electronic transport along the organic layer were performed using a Hg probe as well as Hall effect measurements in the temperature range 70 - 400K. The I-V characteristics of the B-doped diamond/organic semiconductor heterostructures were measured at room temperature by means of the Hg probe. Undoped IIa and undoped PCD films were used for a study of the optical and optoelectronic properties of prepared heterostructures. The influence of the organic layer homogenity and layer thickness on the optical properties will be discussed. Furthermore, preliminary data on perpendicular and parallel transport in the heterostructures layer will be reported.

HL 32.6 Wed 17:45 H14

The interface between diamond and aqueous electrolyte — •Markus Dankerl, Andreas Reitinger, Andreas Härtl, Jose Antonio Garrido, and Martin Stutzmann — Walter Schottky Institut, Technische Universität München, Am Coulombwall 3, 85748 Garching.

C-H as well as C-O surface termination of diamond are both stable in electrolyte, but have different electrochemical characteristics. C-H terminated diamond shows the particularly interesting property of being surface conductive with holes as charge carriers. As the surface conductivity of undoped single crystalline diamond is influenced by pH, ionic strength and applied potential through the electrolyte, the design of ISFETs becomes possible. We report new results concerning

the characterization of the diamond surface in contact with an aqueous electrolyte using electrochemical and electronic methods. In particular, ISFETs based on single crystalline diamond are investigated with respect to the influence of pH on the surface conductivity and the carrier concentration in the two dimensional hole gas. To this end Hall effect measurements are conducted on the conductive diamond surface in electrolyte. The screening effect of monovalent and divalent salts on the surface potential is likewise investigated. The results are discussed in the context of the influence of the parameters on the charge carriers.