

Name

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TUE 1**Fermi Energy Shift in Substrate-Deposited Metallic Nanotubes: A Raman Scattering Study**

Benjamin Hatting¹, Sebastian Heeg¹, Kenichi Ataka¹, Joachim Heberle¹, Frank Hennrich², Manfred M. Kappes², Ralph Krupke², Stephanie Reich¹

¹Institut für Experimentalphysik, Freie Universität Berlin, Berlin, Germany

²Institut für Nanotechnologie, Karlsruhe Institute of Technology, Karlsruhe, Germany

We report on Fermi energy shifts in metallic single-walled carbon nanotubes occurring when the tubes are deposited from a solution onto a silicon substrate. The Fermi energy shifts are monitored experimentally in the high-energy mode Raman lineshape. The metallic LO mode is affected by a Kohn anomaly and related broadening and asymmetry mechanisms, all of which are in effect at intrinsic Fermi energies and are lifted when the Fermi energy is shifted. We do not observe any changes in the high-energy mode Raman lineshape of semiconducting tubes, in agreement with the absence of the linear electronic bands leading to the Kohn anomaly and the broadening and asymmetry. Our conclusions are verified by combined electrochemical and Raman measurements, which allow us to reproduce the lineshape in solution and on silicon by deliberately shifting the Fermi energy and to quantify the corresponding Fermi energy shifts. These findings affect the commonly used method of discerning metallic from semiconducting nanotubes by their high-energy mode Raman lineshape.

TUE 2**Comparative study of tungsten-trioxide/MWCNT composite materials fabricated by various methods**

Adam Vas¹, Peter Berki¹, Zoltan Nemeth¹, Balazs Reti¹, Klara Hernadi¹

¹Department of Applied and Environmental Chemistry, University of Szeged, 6720 Szeged, Rerrich B. ter 1., Hungary

Due to growing demand for special materials this work aimed at preparing nanocomposites and mechanical mixtures with combination of multiwalled carbon nanotubes (MWCNTs) and tungsten-trioxide (WO₃). For this purpose different methods were used: impregnation and hydrothermal synthesis for preparing composite materials, and furthermore milling and ultrasonication for preparing mechanical mixtures. In these synthesis processes different precursors were used: WO₃ and WCl₆. Functionalized and not functionalized MWCNTs were equally used in the procedures. The applied mass ratios of MWCNTs to WO₃ were 1:15 and 1:25, respectively. The produced materials were characterized with X-ray diffraction (XRD), Raman microscopy, transmission- (TEM) and scanning electron microscopy (SEM), and energy-dispersive X-ray spectroscopy techniques. The multiwalled carbon nanotube based composite materials are promising candidates for testing as gas sensors or

catalysts, and in addition, the mechanical mixtures are also promising candidates for testing as photocatalysts.

TUE 3

Triplet Exciton Dynamics in Single-Wall Carbon Nanotubes

Tobias Hertel¹, Florian Späth¹, Hannes Kraus², Andreas Sperlich², Dominik Stich¹, Vladimir Dyakonov^{2,3}

¹Institute of Physical and Theoretical Chemistry, Faculty of Chemistry and Pharmacy, Julius-Maximilian University Würzburg, Am Hubland, 97074 Würzburg, Germany

²Institute of Physics, Faculty of Physics and Astronomy, Julius-Maximilian University Würzburg, Am Hubland, 97074 Würzburg, Germany

³Bavarian Center for Applied Energy Research e.V. (ZAE Bayern), Am Hubland, 97074 Würzburg, Germany

Triplet excitons in SWNTs may contribute significantly to the dynamics of energy transport, redistribution and charge separation in SWNT based photonic devices. Here we report on femtosecond time-resolved pump-probe spectroscopy, picosecond time-resolved photoluminescence spectroscopy and spin sensitive photoluminescence investigations of triplet excitons in semiconducting SWNTs. We focus on monodisperse (6,5)-SWNTs with a first subband exciton transition at 982 nm. Triplet exciton dynamics are studied using triplet-triplet annihilation and delayed fluorescence (DF) as a probe. Spin sensitive optically detected magnetic resonance (ODMR) provides clear support for the role of triplet excitons for DF. Ground state recovery is found to follow a $t^{-1/2}$ power law characteristic of diffusion limited annihilation reactions in 1D systems. This allows to estimate the triplet exciton diffusion coefficient to be on the order of $10 \text{ cm}^2 \text{ s}^{-1}$. The power dependence of ODMR data on the other hand suggests that triplet lifetimes are $60 \pm 30 \text{ } \mu\text{s}$.

TUE 4

Probing the layer number and stacking order in few-layer graphene by out-of-plane phonons

Felix Herziger¹, Patrick May¹, Janina Maultzsch¹

¹Institut für Festkörperphysik, Technische Universität Berlin, Germany

Since the electronic properties of graphene strongly differ with the number of layers and their stacking order, the knowledge about both properties is of crucial importance for the fabrication of microelectronic devices. We present a double-resonant Raman mode in few-layer graphene, which is able to probe the number of graphene layers [1]. This so-called N mode on the low-frequency side of the G mode results from a double-resonant Stokes/anti-Stokes process combining a longitudinal optical (LO) and an out-of-plane (ZO') phonon. Simulations of the double-resonant Raman spectra in bilayer graphene show very good agreement with the experiments. We