MM 54: Nanostructured Materials V

Time: Thursday 15:15–17:00 Location: H16

MM 54.1 Thu 15:15 H16

Understanding the growth mechanism of carbon nanotubes via the "cluster volume to surface area" model — •Sreekanth Mandati[1,2], Jens Kunstmann[1], Felix Börrnert[3], Ronny Schönfelder[3], Mark Rümmeli[3], Kamal K. Karb[2], and Gianaurelio Cuniberti[1] — [1]Institute for Materials Science and Max Bergmann Center of Biomaterials, Dresden University of Technology, Germany — [2]Indian Institute of Technology, Kanpur, India — [3]Institute for Solid State Research, IFW Dresden, Germany

The influence of mixed catalysts for the high yield production of carbon nanotubes (CNTs) has been studied systematically. Based on extensive experimental data a "Catalyst Volume to Surface Area" (CVSA) model was developed to understand the influence of the process parameters on the yield and CNT diameter distribution [1]. In our study, we present a refined version of the CVSA model developed by combining experiments and simulations. We discuss our current understanding of the growth mechanism and how the model might be used to increase CNT yields by using mixed catalysts. [1] S. Tetali et al., ACS Nano (2009), DOI: 10.1021/nn9012548.

MM 54.2 Thu 15:30 H16

Controlling the kink angle of intramolecular carbon nanotube junctions: A combined experimental and theoretical study — Jan Blüher[1], •Jens Kunstmann[1], Imad Ibrahim[1], Alicja Bachmatiuk[2], Felix Börrnert[2], Mark Rümmeli[2], and Gianaurelio Cuniberti[1] — [1]Institute for Materials Science and Max Bergmann Center of Biomaterials, Dresden University of Technology, Germany — [2]Institute for Solid State Research, IFW Dresden, Germany

Intramolecular carbon nanotube (CNT) junctions are nanotubes with kinks generated by heptagon-pentagon defect pairs. They are very attractive functional building blocks for future electronics, as they can be used as diodes and transistors. Usually CNT junctions are synthesized incidentally [1]. Using chemical vapor deposition techniques we are trying to grow CNT junctions in a more controlled way. In particular, we want to control the kink angle in order to produce junctions with well defined electronic properties. Our approach raises the question: Are there special kink angles that induce a certain change in electronic properties? In order to answer this question we developed a scheme that allows generating the atomic structure of CNT junctions with an arbitrary number of heptagon-pentagon defects. To break down the large number of different geometrical possibilities to achieve a CNT junction with a specific angle we study the energetics of different defect combinations and discuss the implication of these results for the experimental realization of well defined CNT junctions. [1]Wei et al., Adv. Mater. 20, 2815 (2008).

MM 54.3 Thu 15:45 H16

Direct imaging and analysis of the internal interfaces between carbon nanotubes and their catalyst particles — •Darius Pohl[1], Franziska Schäffel[1], Christine Täschner[2], Mark Hermann Rümmeli[2], Christian Kisielowski[3], Ludwig Schultz[1], and Bernd Rellinghaus[1] — [1]IFW Dresden, IMW, Dresden, D-01171, Germany — [2]IFW Dresden, IFF, Dresden, D-01171, Germany — [3]NCEM, LBNL, Berkeley, CA 94720, USA

The functionalization of the ends of the CNT has become an important research field due to the potential to hereby modify their physical properties. Functionalized CNT can thus be used to build up new micro-scaled structures with high performance. Owing to its large magneto-crystalline anisotropy energy, L10 ordered FePt is among the most intensively discussed materials when it comes to pushing the superparamagnetic limit towards minimum particle sizes. As a consequence, this material is of particular interest for the realisation of a hard-magnetic termination of the CNT. CNTs as obtained grown via PE-CVD from Fe-Pt multi-layer thin films are characterized by means of aberration-corrected HRTEM. In order to gain a deeper insight into the growth mechanism structural investigations are focused on the atomically resolved characterisation of the FePt-CNT interface. First results on the atomic structure of this metal-carbon interface will be presented. Near-interface lattice expansion is observed which is attributed to Pt segregation towards the surface of the catalyst particle. The results of the structural characterization will be compared with the thermodynamically favoured nucleation sites of the graphitic layers.

MM 54.4 Thu 16:00 H16

Magnetomechanical Interactions in Freestanding, Ferromagnetically Filled Carbon Nanotubes — •Stefan Philippi, Uhland Weissker, Markus Löffler, Thomas Mühl, Albrecht Leonhardt, and Bernd Büchner — Leibniz Institute for Solid State and Materials Research Dresden, Dresden, Germany

The extraordinary mechanical properties of carbon nanotubes (CNT) yield enormous potential for applications in nano-electromechanical systems (NEMS). Yet almost all of the proposed or already implemented NEMS are actuated via electrical effects. Employing CNT with ferromagnetic filling will offer alternative applications for magnetically driven NEMS, if both their magnetic and mechanical properties are equally well understood. In this talk, several static and dynamic effects of applied magnetic fields on filled CNT are discussed with regard to fundamental analyses of their magnetomechanical properties as well as basic principals for potential applications.

MM 54.5 Thu 16:15 H16

Synthesis and mechanical properties of iron-filled carbon nanotubes — •Uhland Weissker, Markus Löffler, Franziska Wolny, Thomas Mühl, Albrecht Leonhardt, and Bernd Büchner — Leibniz-Institut für Festkörper- und Werkstoffforschung, IFW Dresden, Helmholtzstr. 20, 01069 Dresden, Deutschland

Iron-filled carbon nanotubes (CNTs) are a promising material for magnetic applications. In addition to their interesting magnetic properties their mechanical properties are also very important for applications as probes for magnetic force microscopy (MFM) or actuators.

The mechanical properties of iron-filled multi-walled carbon nanotubes were investigated by static and dynamic bending methods.

It was found that a modified Euler-Bernoulli beam model, accounting for the mounting of the CNT on a substrate and characteristic structural defects, can be used to evaluate and explain the experimental data in order to obtain the mechanical properties. Dominating defects influence the mechanical behavior which is expressed by an eigen mode frequency ratio that differs from that of an ideal beam. Furthermore, the shape of the envelope of the resonant vibration state is evaluated.

It is also shown that the resonance frequency of the CNTs can be tailored by etching the CNTs in a water vapor environment inside a scanning electron microscope (SEM). The mechanical properties of iron-filled CNTs are comparable to that of unfilled multi-walled CNTs, thus they are promising material for MFM probes.

MM 54.6 Thu 16:30 H16

Current-induced shaping of carbon nanotubes and their filling — •Markus Löffler, Stefan Philippi, Uhland Weissker, Thomas Mühl, Thomas Gemming, Rüdiger Klingeler, and Bernd Büchner — IFW Dresden, (P.O. box 270116, 01171 Dresden,) Germany

With the help of an in-situ nanomanipulator, structural changes and mass transport phenomena in filled and empty multi-wall carbon nanotubes (MWCNT) under electrical bias have been studied inside a transmission electron microscope. The inter-shell resistance has been determined by subsequently removing nanotube shells with short time high bias transport. Electromigration and thermal activation have been determined as the main causes of current-driven mass transport, which has been studied in different regimes. Especially, fully reversible mass transport inside a MWCNT as well as current-induced directed growth of carbonaceous nanostructures has been observed. The knowledge of the measured properties of filled carbon nanotubes presents a starting point for the understanding of growth dynamics as well as for future applications in nanoelectromechanical systems (NEMS).

MM 54.7 Thu 16:45 H16

Photoluminescence on single-walled carbon nanotubes: A recipe to relative signal intensities — •Sebastian Heeg[1], Joel Abrahamson[2], Michael Strano[2], and Stephanie Reich[1] — [1]Department of Physics, Free University of Berlin, Berlin, Germany — [2]Department of Chemical Engineering, Massachusetts Institute of Technology, Cambridge, USA

This contribution has been withdrawn.