Session 22aD

Transport in Nanotubes and Nanostructures — 22aD1

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The purpose of this talk is to give a brief review on recent theoretical investigations on transport properties of carbon nanotubes. The topics include an effective-mass description of electronic states, absence of backward scattering except for scatterers with a potential range smaller than the lattice constant and some examples of related experiments, a conductance quantization in the presence of short-range and strong scatterers such as lattice vacancies, phonons and electron-phonon scattering, contacts with a metallic electrode, and junctions and topological defects.

Transport in disordered multiwalled carbon nanotubes — 22aD2

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We have studied electric transport in CVD synthesized multiwalled carbon nanotubes (MWNT), with contact resistances around 5 kΩ. Contrary to arc-discharge grown MWNTs that are close to ballistic, these tubes are rather resistive, 30-100 kΩ/μm. At low temperatures ($T < 30$ K), a zero-bias anomaly of tunneling into diffusive 1D wire appears, which behaves differently from that reported for MWNTs grown in arc-discharge: our data does not collapse into a universal curve in a $G(V)/T^\alpha$ vs. $\ln(V/T)$ plot. A tunnel junction with RC transmission line environment looks like the most suitable model. Indeed, at large bias the first order correction to conductance is proportional to $1/\sqrt{V}$. Recent theoretical treatment gives similar results (Rollbühler et al., Phys. Rev. Lett. **87**, 2001), $G(V) \propto \exp(-\sqrt{V/V_0})$, even though our experiment does not conform to the weak tunneling assumption of the calculation.

22aD3 Tunneling into 1D and Quasi-1D Conductors: Luttinger–Liquid Behavior and Effects of Environment

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The paper addresses the problem whether and how is it possible to detect the Luttinger-liquid behavior from the IV curves for tunneling to 1D or quasi-1D conductors. The power-law non-ohmic IV curve, which is usually considered as a manifestation of the Luttinger-liquid behavior in nanotubes, can be also deduced from the theory of the Coulomb blockaded junction between 3D conductors affected by the environment effect. In both approaches the power-law exponents are determined by the ratio of the impedance of an effective electric circuit to the quantum resistance. Though two approaches predict different power-law exponents (because of a different choice of effective circuits), the difference becomes negligible for a large number of conductance channels.

22aD4 Anomalous Negative Magnetoresistance of Multi-Walled Carbon Nanotube with $Ni_{78}Fe_{22}$ Electrodes

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We have investigated the electrical transport properties of a multi-walled carbon nanotube with ferromagnetic $Ni_{78}Fe_{22}$ electrodes at low temperatures. Magnetoresistance curve was non-hysteretic and exhibited a pronounced dip structure at the external field of 160 Oe. Magnetoresistance ratio depended on bias current and became as high as 35% at low bias current. Two- and four-probe measurements gave similar results. Such anomalous features in the magnetoresistance curve persisted up to 10 K.

22aD5 Driving current through single organic molecules

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We have performed conductance measurements with a gold-molecule-gold junction employing the mechanically controlled break junction technique. The organic sample molecules form a stable chemical bridge between the electrodes. Two molecules, which differ essentially by their spatial symmetry, showed discrete stable conductance patterns (IVs), which reflect the symmetry/asymmetry of the sample molecules. This allows to identify the IVs as transport through our sample molecules. The observed sample-to-sample fluctuations demonstrate the strong influence of microscopic details. The body of our data strongly suggests that each stable IV is related to current through only one single molecule.