Thermovoltage of a Suspended Carbon Nanotube Heated by Terahertz Radiation

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Due to their one-dimensional nature electronic transport through carbon nanotubes at low temperature is described by collective behavior of the charge carriers, instead of single electron excitations. Resonances due to standing charge-density waves in the carbon nanotube are expected in the 100 GHz to 1 THz range.

We study the conductance of single, suspended carbon nanotubes under 100 GHz radiation. Due to the absence of direct contact to a gate dielectric, these antenna-coupled nanotubes are expected to show less scattering of collective excitations. Furthermore, the thermal contact to the environment is reduced significantly. Hence, cooling of electrons is dominated by out-diffusion to the leads.

The conductance of the carbon nanotubes shows power law scaling in temperature and bias voltage ascribed to Luttinger liquid behavior. The response to 100 GHz radiation is characterized by an increase of the effective temperature in the nanotube, leading to a similar change in conductance as seen for conventional heating of the complete substrate-lead-nanotube system. Modeling of the electron temperature in the suspended nanotube under absorption of microwave power shows that the temperature profile sharply drops to the bath temperature at the nanotube-lead interface. This local temperature profile induces a thermovoltage at zero current, not seen in conventional heating of the entire system.