Phase transition from Tomonaga-Luttinger liquid states to superconductive phase in carbon nanotubes

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Abstract: We have reported superconductivity (SC) in arrays of multi-walled carbon nanotubes (MWNTs) from viewpoints of both abrupt resistance drop with T_c = 12K [1] and Meissner effect with T_c = ~20K [2]. Based on these reports, some theories for the SC have been proposed and are attracting considerable attention [3-5]. One of the very interesting points of the SC is electron correlation in one-dimensional space; i.e., interplay between SC phase (phonon-mediated attractive Coulomb interaction) and Tominaga-Luttinger liquids (TLL; repulsive Coulomb interaction).

Here, we report the detailed observation of this interplay in relationships of normalized conductance vs. *ev/kT* of partially end-bonded MWNTs [6]. We find that the observed results are qualitatively consistent with previous reports of TLL states in CNTs, while a deviation due to emergence of the SC appears at temperatures < T_c and small *eV/kT* values. We interpret this based on carrier-doping and low-energy theory [7]. Half carrier filling and a large electron-phonon coupling parameter may lead to electron coupling with low-energy acoustic phonons and, then, cause transitions from spin-density wave regime to SC phase via TLL states.

References

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