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Pristine and metallicity selected single wall carbon nanotubes: Electronic and optical properties vs. doping and interaction.

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The presentation will give an overview on our current experimental research focus on the electronic and optical properties of functionalized single wall carbon nanotubes (SWCNT) as archetypes of low dimensional quantum solids. These properties are strongly influenced by basic correlation effects and environmental effects. Other archetypical examples of these low dimensional carbon systems are fullerenes, graphene and graphite. All these systems are determined by the local arrangement of their sp2 hybridized carbon atoms, such that their character is either semi-metallic, insulating, semiconducting or metallic. Examples of our recent work on how one can analyze the electronic and optical properties using high energy spectroscopy (electron energy-loss, photoemission and x-ray absorption spectroscopy), as well as optical and Raman spectroscopy as probes will be presented. Special emphasis will be given to the influence of basic correlation effects and local field corrections, as well as environmental effects on the electronic properties of graphene/graphite [1] and SWCNT [2]. The latter exhibit for metallic tubes a Luttinger liquid behavior [4]. In addition, the influence of the bundling/debundling (van der Waals interaction) and the influence of metallicity selected, i.e. purely metallic vs. purely semiconducting, SWCNT will be elucidated. Furthermore, an overview on how to functionalize the SWCNT in order to tailor their electronic structure will be given. This includes examples for the three alternative doping routes, namely, substitution, intercalation and endohedral doping (e.g. by filling with fullerenes [3], metallofullerenes and metallocenes [4, 5]) as well as examples for the growth of defined inner tubes from the different precursors via a thermal nano-chemical reaction [4, 6, 7]. In comparison to graphite intercalation compounds [8], the electronic structure of doped graphene and SWCNT will be elucidated. For metallic functionalized nanotubes doping induced changes will be discussed in the framework of a dimensionality crossover which causes a change from a one-dimensional metal to a

normal Fermi liquid [9]. The detailed understanding of these fundamental electronic properties is the key to their future success in nano-electronic and nano-optical applications.

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