Tailoring the electronic properties of low-dimensional carbon solids

T. Pichler
Faculty of Physics, University of Vienna

The presentation will give an overview on our current research focus on the electronic properties of carbon based low dimensional quantum solids. These properties are strongly influenced by basic correlation effects. Archetypical examples of these systems are graphene, graphite and single wall carbon nanotubes (SWCNT) which are determined by the local arrangement of their sp^2 hybridised carbon atoms, such that their character is either a zero gap semiconductor, semi-metallic, insulating, semiconducting or metallic. Examples of our recent work on how one can unravel the underlying electronic structure using high energy spectroscopy (electron energy-loss, (resonant) photoemission and x-ray absorption spectroscopy) as a probe will be presented. Special emphasis will be given to the influence of basic correlation effects and local field corrections on the electronic properties of graphite, graphite intercalation compounds and SWCNT. The latter exhibit for metallic tubes a Luttinger liquid behavior.
Furthermore, an overview on how to functionalize them 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 and metallocenes) as well as examples for the growth of defined inner tubes from the different precursors via a nanochemical reaction. 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. The detailed understanding of these fundamental electronic properties of functionalised graphite, SWCNT and graphene is the key to their future success.