Tunable metallicity dependent p-type doping in single-walled carbon nanotubes

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Recent studies on the intercalation of single-walled carbon nanotubes (SWCNTs) with molecules like K or FeCl\textsubscript{3} mostly neglect the influence of the nanotube metallicity on the resulting characteristics. Therefore we investigated the electronic structure of SWCNTs intercalated with FeCl\textsubscript{3} using highly pure metallic and semiconducting nanotubes as a starting material produced by state of the art metallicity separation techniques. Making use of X-ray photoemission and X-ray absorption measurement, the intercalated nanotubes were probed to discern their electronic properties. Strong p-type doping concomitant to a strong shift of the Fermi level is evidenced. Analysis of the valence band illustrates that semiconducting SWCNTs exhibit significantly higher doping after similar intercalation doses. For metallic SWCNTs the 1D Tomonaga-Luttinger-liquid is preserved over the whole intercalation range whereas semiconducting SWCNTs show a transition into a 3D Fermi liquid state already at very low doping. Together with results from Raman measurements this study poses another important step towards precisely tunable graphitic materials yielding a wide range of different properties when metallicity effects are taken into account.

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