Hydrogen storage in carbon nanotubes through the formation of C-H bonds

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\textbf{Idea:} storing hydrogen in the chemisorbed form on the surface of the carbon nanotubes

\textbf{Probing tools:} X-ray Photoelectron Spectroscopy (XPS) and X-ray Absorption Spectroscopy (XAS)

\textbf{Hydrogenation:} \textit{in situ} atomic hydrogen treatment

\textbf{Samples:} ultra clean "as grown" SWCN films

\textbf{Growth conditions} SEM pictures Raman spectra

Type 1 C siti:CuaOCu, Gas 500 sccm of He, 100 sccm of H2, Temperature 850°C

Type 2 C siti:CuaOCu, Gas 300 sccm of He, 100 sccm of H2, Temperature 850°C

XPS and XAS spectra of the clean and hydrogenated SWCN

XPS spectra measured for the hydrogenated SWCN, type 1 without intercalated K (on the left) and with intercalated K (on the right). Peak 1 corresponds to the signal from the carbon atoms unaffected by the hydrogenation; whereas peak 2 is due to the hydrogenation degree.

3. The hydrogenated SWNT are stable from ambient temperature to 300°C. It should be pointed out that in the case of intercalated K the C1s shift has different nature — electrons donated by K atoms can move really easy to the excited C atom during photoionization process causing the change of the final state in the photoionization process.

4. Hydrogenation/dehydrogenation process can be cycled.

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Conclusions

1. SWCN with different diameters can reach different hydrogenation degree before "unzipping" and etching.

2. For specific SWCN it is possible to hydrogenate almost 100 at % of the carbon atoms in the walls to form C-H bonds which corresponds to >7 wt % of SWCN hydrogen capacity.

3. The hydrogenated SWNT are stable from ambient temperature to 300°C.

4. Hydrogenation/dehydrogenation process can be cycled.