Recent progress in the synthesis and characterization of nanotubes and fullerene-like nanoparticles from 2-D layered compounds

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In this presentation we shall deliberate on new synthetic strategies for nanotubes and fullerene-like nanoparticles (IF) from layered compounds. A few metal halides, like $CdCl_2$ and $NiCl_2$ have been synthesized in the form of IF nanoparticles. These compounds are much more ionic than the metal-dichalcogenides and consequently they are very hygroscopic and unstable in the ambient atmosphere. By forming closed-cage nanoparticles, it is shown that the uptake of water molecules is slowed down considerably, rendering these nanoparticles stable for long periods of time in the ambient atmosphere. E-beam irradiation was found to produce closed cage nanoparticles of $CdCl_2$ (R. Popovitz-Biro et al., *Isr. J. Chem*., **41**, 7 (2001)). Laser ablation was used to produce $NiCl_2$ nanoparticles with fullerene-like structure and nanotubes via the VLS growth mechanism (Y. Rosenfeld Hacohen, submitted). IF-NbS_2 nanoparticles were synthesized by reacting $MoCl_5$ with H_2S in a controlled atmosphere and subsequent annealing (C. Schoffenhauer et al., submitted). The synthesis of nanotubes of various oxides reported by a few laboratories will be briefly discussed as well.

High resolution STM combined with STS was used in order to evaluate the relationship between structure and electronic properties of MoS_2 and WS_2 nanotubes (L. Sheffer et al., submitted). In particular it was shown that, in agreement with recent theoretical studies, the bandgap shrinks with a decreasing diameter of the nanotube. A model (G. Seifert et al., *J. Phys. Chem. B*, in press), which takes into account the elastic energy of bending; edge effects (dangling bonds) and the van der Waals energy suggests that in the case of WS2 nanotubes, multiwall nanotubes with a diameter of approximately 10 nm are energetically favorable. These findings are in agreement with the experimental observations (R. Rosentsveig et al., *Chem. Mater*., in press) and they may explain the difficulties in obtaining single wall WS_2 nanotubes.