Efficiency of carbon layer growth in $Li_4Ti_5O_{12}$/C composites studied by XPS and Raman spectroscopy

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The understanding of carbon layer formation is very important for core-shell composite electrodes, comprised of a low conductive core (active material) with a thin carbon shell (conductive additive). In this work we analyze the carbon morphology evolution for the two series of $Li_4Ti_5O_{12}$/C samples with carbon content increasing from 0.9 to 5.6 wt%. The usage X-Ray Photoelectron Spectroscopy (XPS) allowed us to conclude about the existence of the efficiency threshold of carbon layer growth over lithium titanate core. Although the carbon layer thickness is increasing with carbon concentration growth in LTO/C composites, the efficiency of uniform carbon shell formation was shown to decrease with the threshold carbon concentrations about 1-2 %. This peculiarity is observed for two different methods of carbon deposition– sucrose and acetylene decompositions. Also, the same XPS data was used for C@LTO interface characterization via chemical bonding analysis. Supplementary Raman spectroscopy study reveals the growth of both morphological and structural heterogeneities of grown carbon layers. The proposed approach can be used for optimization of producing different composites with core-shell structure (carbon-based composites, materials with protective layers of different compositions, and materials with gradient core-shell structure).

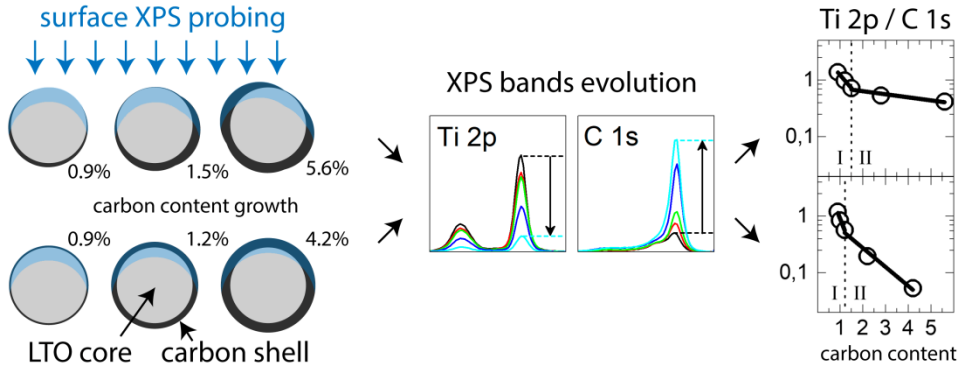

Fig. 9 The scheme of carbon shell morphology XPS probing, revealing the threshold nature of carbon layer growth.