

A NEW ROOM TEMPERATURE AND SOLVANT FREE CARBON COATING PROCESS

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Active materials used in batteries must exhibit high intrinsic electronic and ionic conductivities in order to have acceptable reaction kinetics. Also, battery calendar life upon cycling is enhanced if side reactions, which result in slow degradation of battery materials and electrolyte, can be avoided. These energetically favored side reactions mostly involve charged electrode materials reacting with nonaqueous electrolytes.

A common practice, especially for low intrinsic conductivity electrode materials such as LiFePO_4 , is to coat the particles surface with a conducting compound most generally, carbon¹. Alternatively, since carbon has a wide electrochemically stable window in organic electrolytes and has good chemical stability, carbon coatings do also prevent surface degradation in electrode materials and hence slow down the capacity fading upon battery cycling. Carbon coating on the powdered active materials used for battery electrode fabrication is currently achieved through chemical procedures with a carbon precursor using a liquid dispersing medium and performing thermolysis of the mixture (C precursor + active material) in order to decompose the precursor into carbon at high temperatures (ca. 700°C), mostly under inert gas flow². This energy consuming procedure also has the drawback of not being applicable for electrode active materials which may decompose under the high temperatures or which may be reduced under the thermal treatment conditions or in materials needing processing under oxidizing conditions which may lead to burn out of added organic precursors. Finally, the control of the thickness and uniformity of the carbon layer is also a challenge.

The alternative procedure being object of the present work^{3,4} is based on a physical deposition of carbon, carried out at room temperature under dry conditions, hence avoiding all the drawbacks mentioned above and being generally applicable to all electrode active materials. Furthermore, excellent homogeneity and fine control of the coating thickness (from ca. 1nm and upwards) were achieved (cf. figure 1). Electrochemical performances of a large variety of carbon coated active materials were then evaluated and compared to uncoated powders for comparison (cf. figure 2).

References

1. H. Li, H. Zhou, Chem. Comm., 48 (2012) 1201.
2. M. Armand et al., US 2004/0033360A1.
3. A. Ponrouch, M.R. Palacín, European Patent Application, N° 12380045.0.
4. A. Ponrouch, A. R. Goñi, M. T. Sougrati, M. Ati, J.-M. Tarascon, J. Nava, M. R. Palacín, Submitted.

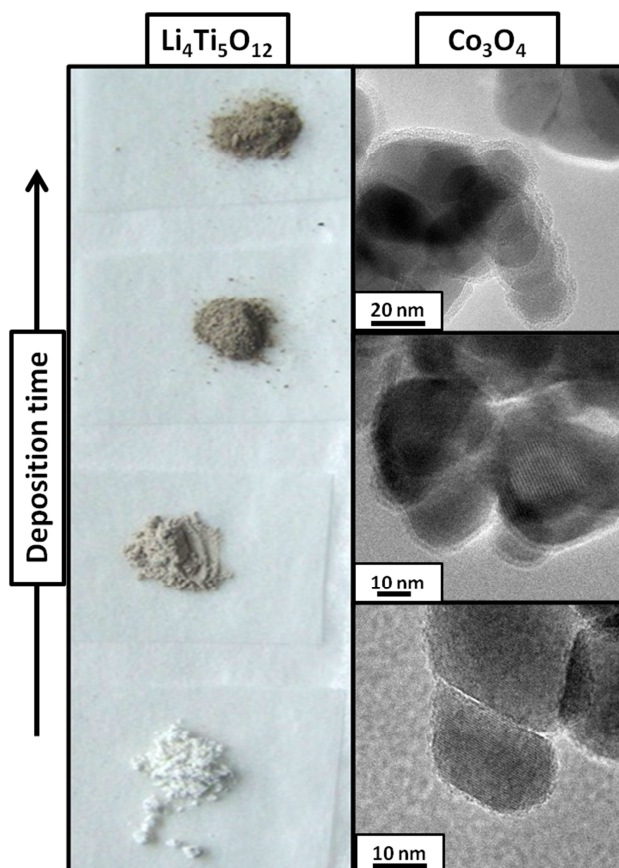


Figure 1: Pictures of $\text{Li}_4\text{Ti}_5\text{O}_{12}$ uncoated powder, and carbon coated $\text{Li}_4\text{Ti}_5\text{O}_{12}$ powder (deposition time ranging from 0 to 30 minutes). High resolution transmission microscopy images of carbon coated Co_3O_4 nanoparticles (deposition time ranging from 0 to 30 minutes).

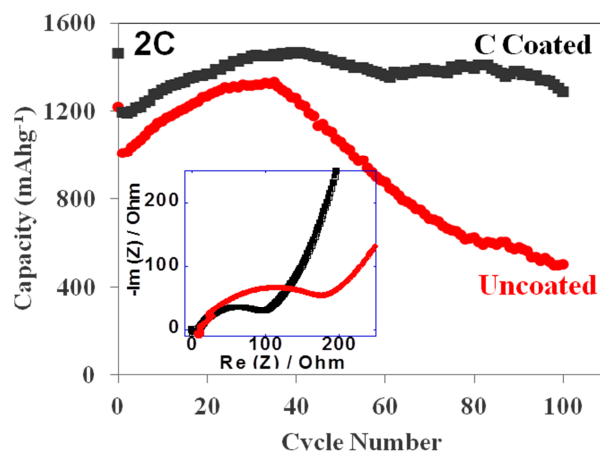


Figure 2: Discharge capacity versus cycle number for carbon coated (black squares) and uncoated (red circles) Co_3O_4 based electrodes (recorded at 2C in half cells). Inset displays the Nyquist diagrams of EIS measurements of the corresponding electrodes recorded before cycling.