

GRAFTED CARBON-SILICON NANOCOMPOSITES FOR LI-ION BATTERIES

Olivier Crosnier^{a,d}, Cédric Martin^a, Mélanie Alias^a, Martin Weissmann^{a,d}, Richard Retoux^b,
Daniel Bélanger^c, and Thierry Brousse^{a,d}

^a *Institut des Matériaux Jean Rouxel (IMN), CNRS, Nantes, France*

^b *Département Chimie, Université du Québec à Montréal, Montréal, Québec, Canada*

^c *Laboratoire CRISMAT-CNRS/UMR 6508 ENSICAEN, Caen, France*

^d *Réseau sur le Stockage Electrochimique de l'Energie (RS2E), CNRS, Amiens, France*

olivier.crosnier@univ-nantes.fr

The recent development of silicon-based negative electrodes has already shown the possibility to enhance the specific capacity of standard graphite electrodes by nearly one order of magnitude [1]. In order to enhance both the cycling stability and the power capability of such composite electrodes, the concept of coupling silicon with a carbon material (graphite, carbon nanotubes, graphene) with a chemical bond developed by using a phenyl group [2-4]. Such a bridge can be formed by a two-step procedure (Figure 1) which makes use of the diazonium chemistry [5].

The chemical and electrochemical modification of silicon and carbon-based materials by the reduction of a diazonium salt involves the formation of an aryl radical which subsequently reacts with the surface to form a covalent carbon-carbon bond. For example, the first step consists in the grafting of aminophenyl groups onto carbon multiwalled nanotubes in p-phenylenediamine followed by sodium nitrite addition. The second step consists in the grafting of silicon on aminophenyl modified carbon (MWCNTs- ϕ -NH₂) which yields MWCNTs- ϕ -Si [3].

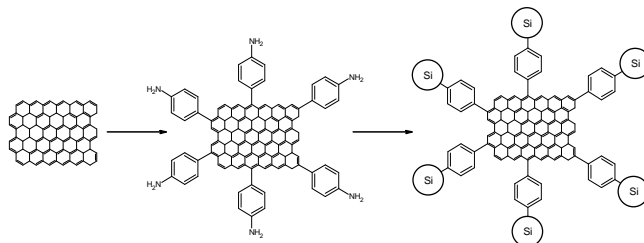


Figure 1: Step 1: functionalization of carbon; Step 2: construction of a molecular bridge between carbon particles and silicon

The MWCNTs- ϕ -Si nanocomposite electrode shows improved electrochemical performance compared to a simple mixture of the two compounds: higher specific capacity, better cycling ability and rate capability.

The obtained silicon-based nanocomposite materials (using graphite, carbon nanotubes or graphene) have been characterized by different physical and electrochemical techniques (TGA-MS, BET, SEM, IR / Raman spectroscopy, electrochemical experiments...) at different stages of the synthesis in order to confirm the presence of the grafted molecules and to determine their influence on the cycling performance when used in lithium-ion batteries.

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[4] M. Weissmann, O. Crosnier, B. Lestriez, B. Humbert, C. Agnès, F. Duclairoir, L. Dubois, G. Bidan, T. Brousse, in preparation.

[5] D. Bélanger, J. Pinson. *Chem. Soc. Rev.* 40 (2011) 3995-4048.