C/Nanorod-$LiFePO_4$ Nanocomposite. A High-rate Cathode far Advanced Li-ion Batteries

F. Croce*, B. Scrosati, C. R. Sides[§], C.R. Martin[§]

**Department of Pharmacological Sciences, University'G. D'Annunzio', 66013 Chieti, Italy*
°Department of Chemistry, University La Sapienza, 00185 Rome, Italy
[§]Department of Chemistry, University of Florida, Gainesville, Florida 32605, USA

Lithium-ion batteries are today the power sources of choice far portable electronics, a multi-billion dollar market[1]. This outstanding success has spawned great international interest in applying this technology to more demanding systems, such as electric of hybrid vehicles[2]. However, to achieve full success in this area, new electrode materials, less expensive, more energetic and more compatible with the environment than the present ones, have to be identified. Accordingly, intense R&D are in progress to reach this goal and few variable alternatives to the original lithium-ion battery design, have been proposed. Particularly interesting is the olivine-structured $LiFePO_4$ cathode developed by Goodenough and co-workers[3], which offers several appealing features, such as high, flat voltage profile and relatively high specific capacity, combined with low cost and low toxicity. However, $LiFePO_4$ has one crucial disadvantage, i.e. its inherently low electric conductivity which reflects in the inability to deliver high capacity at high discharge rates. Such as poor rate capability has been the object of investigation by various groups who have proposed different approaches to overcome it, including carbon coating[4], nano-fibril textures[5], optimized synthesis procedures[6] and foreign metal doping[7]. We have considered an alternative, new route to obtain high performance $LiFePO_4$ electrodes. By adapting the template synthesis originally developed by Martin[8], we were successful in producing revolutionary morphologies consisting in an honeycomb-like intersected $LiFePO_4$ nanowires in intimate contact with carbon particles. We demonstrate that this new approach leads to a nanostructured cathode material which, keeping all the basic advantages of $LiFePO_4$, has a very high rate capability. We show in this work that the nanocomposite carbon- $LiFePO_4$ electrode is capable to deliver a capacity of 150 mAh g^{-1} even if the rate is exceeding 5C, to our knowledge a performance of this level has so far never been achieved by other types of $LiFePO_4$ electrodes

References :

1) Nagaura T .a. T, *Progress in Batteries and Salar Cells*, 9, 1990, 209-215

2) Tullo A. H., *Chemical & Engineering News*, 80,2002,25-26

3) Padhi A. K., Nanjundaswamy K.S., Masquelier C., Okada S., Goodenough J.B., *Journal of the Electrochemical Society*, 144, 1997, 1609-1613

4) Ravet N., Chouninard Y., Magnan J.F., Besner S., Gauthier M., Armand M., *J. Power Sources*, 97-98, 2001, 503- 507

5) Huang H, Yin S-C., Nazar L.F., *Electrochemical and Solid-State Letters*, 4(10), 2001, A170-A172

6) Arnold G. Garche J., Hemmer R., Strobele S.,Vogler C., Wohlfahrt-Mehrens A., *J. Power Sources*, 119-121,2003,247-251

7) Chung S-Y. Blocking J.T., Chiang Y-M., *Nature Materials*, 1,2002, 123-128

8) Martin C.R., *Science*, 266,1994,1961-1966