Hydrothermal Synthesis of Vanadium Sulfate supported on Graphene Oxide as Novel Cathode for Magnesium Ion Batteries

Gioele Pagot[1,2], Federico Bertasi[1], Giuseppe Pace[3], Keti Vezzù[1], Enrico Negro[1], Antoine Bach Delpeuch[1], Graeme Nawn[1], and Vito Di Noto[1,2]

[1]Department of Industrial Engineering, University of Padova, Via Gradenigo 6/A, I-35131 Padova (PD), Italy
[2]Centro Studi di Economia e Tecnica dell'Energia Giorgio Levi Cases, Via Marzolo 9, I-35131 Padova (PD), Italy
[3]CNR-IENI, Via Marzolo 1, I-35131 Padova (PD), Italy

vito.dinoto@unipd.it

Abstract

Lithium ion batteries are currently dominating the market [1]. Unfortunately, due to his high cost, low abundance, and quite high toxicity, an urgent need for new secondary batteries with similar performances, but lower disadvantages is necessary. Magnesium ion batteries seem to be a valid alternative to lithium: Mg is 20000 times more abundant in the Earth crust and his cost is 20 times lower [2]. Research activities have then moved to the development of new materials (electrodes and electrolytes) able to reach lithium ion batteries performance and able to substitute them [3-6]. Parallel to innovative magnesium research in batteries, graphene and graphene oxide start to become interesting active materials used as electrode in ion batteries [2, 7-10]. In particular, vanadium species supported on graphene based materials show good performance in terms of working potential, specific capacity, and cycle life, if used as cathode in magnesium batteries.

In this work we propose the solvothermal synthesis of a $VOSO_4$/GO cathode material, starting from suitable redox vanadium solutions. After the coordination of vanadium species to GO, an annealing in Ar atmosphere occurs. Synthesized materials are characterized by inductively coupled plasma atomic emission spectroscopy (ICP-AES) to study the vanadium uptake and composition, by high resolution thermo gravimetric analyses (HR-TGA) to understand the thermal behavior, field emission scanning electron microscopy (FE-SEM) and high resolution transmission electron microscopy (HR-TEM) to study the morphology and the structure. Structure is also characterized by powder X-ray diffraction (XRD) as well as variety of vibrational spectroscopy techniques (FT-IR and Raman). Finally, electrochemical techniques are achieved to study the electrochemical performance of the material used as cathode in magnesium ion batteries.

References

[1] B. Scrosati, J. Garche, J. Power Sources, **195** (2010) 2419-2430.
[2] E. Sheha, Graphene, **2014** (2014).
[3] F. Bertasi, C. Hettige, F. Sepehr, X. Bogle, G. Pagot, K. Vezzù, E. Negro, S.J. Paddison, S.G. Greenbaum, M. Vittadello, ChemSusChem, **8** (2015) 3069-3076.
[4] V. Di Noto, S. Lavina, D. Longo, M. Vidali, Electrochim. Acta, **43** (1998) 1225-1237.
[5] D. Aurbach, G.S. Suresh, E. Levi, A. Mitelman, O. Mizrahi, O. Chusid, M. Brunelli, Adv. Mater., **19** (2007) 4260-4267.
[6] O. Chusid, Y. Gofer, H. Gizbar, Y. Vestfrid, E. Levi, D. Aurbach, I. Riech, Adv. Mater., **15** (2003) 627-630.
[7] Q. An, Y. Li, H.D. Yoo, S. Chen, Q. Ru, L. Mai, Y. Yao, Nano Energy, **18** (2015) 265-272.
[8] X. Du, G. Huang, Y. Qin, L. Wang, RSC Advances, **5** (2015) 76352-76355.
[9] Y. Liu, L. Jiao, Q. Wu, Y. Zhao, K. Cao, H. Liu, Y. Wang, H. Yuan, Nanoscale, **5** (2013) 9562-9567.
[10] R. Raccichini, A. Varzi, S. Passerini, B. Scrosati, Nat. Mater., **14** (2015) 271-279.