Synthesis and Characterization of Nanostructured Li Transition Metal Silicate (Li2MSiO4) Cathodes

Xia Lu, Huijing Wei1, Hsien-Chieh Chiu1, Raynald Gauvin1, Pierre Hovington2, Karim Zaghib2 and George P. Demopoulos1,*
1 Department of Materials Engineering, McGill University, Montréal, Québec H3A 0C5, Canada.
2 Institut de recherche d’Hydro-Québec (IREQ), Varennes, Québec J3X 1S1, Canada.
Corresponding author: george.demopoulos@mcgill.ca

Following the successful development-commercialization of the C-LiFePO4 (LFP) cathode by Hydro-Québec attention is directed towards the development of a higher specific energy polyoxyanion family of cathode materials, that of orthosilicates, Li2MSiO4, where M=Fe, Mn, Co, Ni. Orthosilicates are characterized by a theoretical specific capacity that is twice that of LiFePO4, namely 340 vs. 170 mAh/g, hence the great potential and opportunity. Hydro-Québec researchers led by Michel Armand were the first to identify orthosilicates as Li-ion cathode materials over 15 years ago [1 (a,b,c,d)]. Since then a number of studies have been reported in particular over the last few years as summarized in two recent reviews2,3. In this work, the synthesis of Li2MSiO4 (M = Fe, Mn), using a combination of hydrothermal solution and reducing annealing treatment steps is studied4. From this routine, different polymorphs of silicates can be obtained that are structurally and compositionally analyzed by XRD and TEM techniques before subjected to electrochemical characterization. In order to enhance the intrinsic poor electronic/ionic conductivity of the orthosilicate nanoparticles, they are coated in-situ with nitrogen-doped carbon5, which is characterized by Raman and XPS. Lastly, the atomic-scale Li ion storage and transport mechanisms are investigated by a via first-principle simulations.

References
3. Gummow, R.J. and He Y., recent progress in the development of Li2MnSiO4 cathode materials, J. Power Sour., 254, 315-331 (2014)