

## AMORPHOUS IRON OXIDE AS A NEW LITHIUM INTERCALATION CATHODE

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Development of newer and larger applications of lithium battery technology depends largely on the development of environment friendly battery components that are inexpensive and deliver better performance. The current cathodes are marred by some or many of the cost, toxicity and performance problems, leading to a great demand for development of new and better materials. Iron-based compounds are a most favorable choice from cost and environmental standpoints but have not been studied nearly as extensively as manganese-based compounds. Efforts to synthesize Lithium Iron Oxides through high temperature ceramic processes have yielded crystalline phases other than the desired layer-structured phase [1]. A number of other synthesis routes such as ion exchange [2,3,4] and hydrothermal reactions [5] for synthesis of the layered structure have been pursued but have yielded cathode materials with poor electrochemical performance. Most of these compounds yield very low specific charge capacities of less than 100 mAh/g and exhibit rapid capacity fading. In a recent paper Kim et al [6] reported nano-crystalline lithium iron oxides with a specific capacity of 140 mAh/g with good cycling performance when cycled in a wide voltage range of 4.3-1.5V. In recent years, lithium iron phosphates that exhibit a theoretical capacity of 170 mAh/g and a high voltage against lithium anode have gained rapidly increasing attention.

We present here development of iron oxides bearing a completely x-ray amorphous structure synthesized via a low temperature aqueous oxidation route as potentially promising lithium intercalation cathodes. The iron oxide powders obtained from this synthesis process bear a very fine, nano-structured morphology with a BET surface area of 305 m<sup>2</sup>/g. Our amorphous materials exhibit a specific capacity of 210 mAh/g at a discharge rate as high as 0.5 mA/cm<sup>2</sup> in the voltage range of 4.0-1.5V, the highest specific capacity reported so far for any iron oxide. These amorphous iron oxides show a capacity fading of less than 0.3% per cycle and we believe that optimization of the engineering aspects of the composite cathode will yield a significantly improved cycling performance. Our electrochemical data also suggest an intrinsically superior structural stability of the amorphous iron oxides upon cycling. In this contribution systematic data on chemical, structural and electrochemical aspects of various amorphous iron oxide samples with varying lithium contents will be presented and the rationale behind the high capacity and cycling performance of samples with different chemistries will be discussed.

### References:

1. J. C. Anderson and M. Schieber: *J. Phys. Chem. Solids*, 25, 961 (1964)
2. B. Fuches and S. Kemmler-Sack: *Solid State Ionics*, 68, 279 (1994).
3. T. Shirane, R. Kanno, Y. Kawamoto, Y. Takeda, M. Takano, T. Kamiyama, and F. Izumi: *Solid*

- State Ionics*, 79, 227 (1995)
4. M. Tabuchi, C. Masquelier, T. Takeuchi, K. Ado, I. Matsubara, T. Shirane, R. Kanno, S. Tsutsui, S. Nasu, H. Sakaebe, and O. Nakamura: *Solid State Ionics*, 90, 129 (1996)
5. K. Ado, M. Tabuchi, H. Kobayashi, H. Kageyama, O. Nakamura, Y. Inaba, R. Kanno, M. Takagi, and Y. Takeda: *J. Electrochem. Soc.*, 144, L177 (1997).
6. J. Kim and A. Manthiram: *J. Electrochem. Soc.*, 146 (12), 4371-4374 (1999).