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ELECTROCHEMICAL STUDIES OF Mg-DOPED $Li_4Ti_5O_{12}$ ANODES

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Commercial lithium-ion batteries use carbon as the material of choice for the anode. However, because lithiated carbon has a voltage very close to the potential of metallic lithium, there are concerns about the safety of fully-charged carbon electrodes. The safety issue can be addressed by using a material that intercalates lithium at a higher voltage. A promising material is the lithium-titanium-oxide spinel material $Li_4Ti_5O_{12}$ (Fig.1) which can accommodate 3 Li^+ ions per formula unit (corresponding to 175 mAh/g) in a two-phase reaction at approximately 1.5 V versus lithium (1,2). One of the drawbacks of this system is that the end-member $Li_4Ti_5O_{12}$ is electronically insulating, which limits electron transfer at the electrode surface. By doping this material with magnesium, $Li_{4-x}Mg_xTi_5O_{12}$, we introduced mixed-valent Ti^{4+}/Ti^{3+} into the stoichiometric spinel structure and thereby increased the electronic conductivity by several orders of magnitude without sacrificing electrochemical performance (3). In this presentation we will provide data on the extent of the solid solution in $Li_{4-x}Mg_xTi_5O_{12}$, the variation of electronic conductivity as a function of dopant concentration and the rate capability of the doped material.

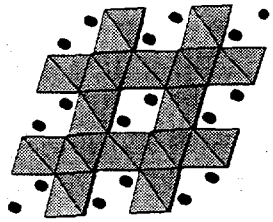

Figure 1. Structure of the titanium-based spinel $Li_4Ti_5O_{12}$. Black spheres represent lithium cations; gray polyhedra represent $[Ti(Li)O_6]$ octahedra.

(1) T. Ohzuku, A. Ueda, N. Yamamoto *J. Electrochem. Soc.* **142** 1431 (1995).
(2) J. Vaughey, K. Kepler, A. Jansen, A. Kahaian, C. Johnson, K. Amine, D. Vissers, M. Thackeray Abstracts *of the 1998 Fall Materials Research Society*, EE3.94, p 568 (1998).
(3) J. Irvine, S. Thiemann, G. Mather, A. Finch, H. Tukamoto *Solid State Ionics* **70/71** 445 (1994).