# ALL-SOLID-STATE LITHIUM ION BATTERY MATERIALS AND STUDIES

J. Schwenzel, V. Thangadurai and W. Weppner

Chair for Sensors and Solid State Ionics
University of Kiel, Faculty of Engineering
Kaiserstr.2, D-24143 Kiel, Germany

**Abstract**

To date, lithium ion secondary battery developments are mainly based on $LiCoO_2$ as positive electrode, lithium ion conducting organic polymer as electrolyte ($LiPF_6$ dissolved in polyethylene oxide (PEO)) and Li-metal or graphite as anode. The formation of a solid electrolyte interface (SEI) at the anode leads to a large irreversible capacity loss during the discharge cycles. A further major concern is the safety aspect of liquid and common polymetric electrolytes. Thus, the development of alternative solid state lithium ion conductors is an important issue of present day development of all-solid-state batteries.

Solid inorganic electrolytes have a considerably lower ionic conductivity of about $10^{-6}$S/cm at room temperature. In thin film application, the ratio of the thickness over the area is very small in order to decrease the resistance of the electrolyte and the diffusion length of the electrodes to allow high power generation.

Currently, all-solid-state-Li- thin film batteries make use of $LiCoO_2$ as cathode, Lipon as electrolyte and Li-metal as anode (1).

In the present study, alternative materials have been considered for higher energy and power density. Elemental Li has been replaced against Al and $Li_2AMn_3O_8$ (A = Co, Fe, Cu) has been employed instead of $LiCoO_2$ for higher energy density (2, 3).

Lithium metal oxides with the nominal composition $Li_5La_3M_2O_{12}$ (M = Nb, Ta), possessing a garnet-like structure, have been investigated with regard to the electrical properties. Both the Nb and Ta member exhibit the same order of magnitude of bulk $Li^+$-ion conductivity (~ $10^{-6}$ S/cm at 25 $^oC$ ) (4).

**References:**

1. J.B.Bates, N.J. Dudney, B. Neudecker, A. Ueda, and C. D. Evans, Solid State Ionics, **135**, 33 (2000).
2. J.Schwenzel and W.Weppner, Ionics, to be published.
3. H. Kawai, M.Nagata, H. Tukamoto and A.R. West, J. Power Source, **81-82**, 67 (1999)
4. V. Thangadurai, H. Kaack and W.Weppner, J.Am. Ceram. Soc. In press.