Contribution of XPS (X-Ray Photoelectron Spectroscopy) and AES (Auger Electron Spectroscopy) to the knowledge of solid electrode/electrolyte interfaces (SEI)

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It is now generally admitted that the performance of all lithium ion or lithium batteries (including liquid or solid electrolyte) depends on the surface chemistry developed on the electrode / electrolyte interface system. This work presents a contribution to the knowledge of the solid electrolyte interface (SEI) from two different examples:

The first one concerns Spinel $Li_4Ti_5O_{12}$ (LTO) which is considered as a good alternative negative electrode material for Li-ion batteries due to its negligible change of lattice parameter during insertion/extraction of lithium ions, resulting in a very low capacity decrease upon cycling. The reactivity of LTO toward commons carbonates based electrolytes has been evidenced by surface analysis and an important gassing occurring at the electrode/electrolyte interface was reported. Therefore it is essential to better understand the interfacial phenomena. A precise understanding of the Spinel $Li_4Ti_5O_{12}$ (LTO) electrode/electrolyte interfaces in relation with batteries ($Li_4Ti_5O_{12}$/Li half-cells) electrochemical performances is presented. The influence of various parameters (cycling temperature, electrode and electrolyte composition, cycling potential window) upon the SEI formation and dissolution through the first cycle is investigated. The evolution of those interfaces after long cycling is also studied. Finally, $Li_4Ti_5O_{12}$/$LiMn_2O_4$ cells having potential assets in term of cost and safety will be investigated, in order to point out the changes in the SEI formation due to interactions between both electrodes. The samples are analyzed by X-ray Photoelectron Spectroscopy (XPS) and Scanning Auger Microscopy (SAM), two complementary extreme surface characterization techniques (analysis depth 5-10 nm), operating at different spatial resolutions.

The second example is related to the recent technological development of miniaturized systems which has induced a strong demand for developing compact power sources with high efficiency and small dimensions that are suitable for portable devices. Among these systems, the lithium microbattery may be relevant for a wide range of applications linked to the field of smart cards, implantable medical devices, MEMS (microelectromechanical systems) or other microelectronic devices. An all solid state battery $LiCoO_2$ / LiPON / Li is considered and more specifically the behaviour of the interface between the positive electrode and the solid electrolyte, studied by ion milling cross section / Auger Spectroscopy coupling.