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Separators – Technology Review

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Abstract. In general Batteries contain beside the anode and cathode layer an additional polymeric separator layer that has to adjust an accurate distance between the electrode layers. To achieve a high power density on the one side the separator has to show a sufficient porosity which can be filled with conducting liquid electrolyte. On the other side a good stability of the polymeric layer is required in order to ensure a constant and small distance between the electrodes. Problems arise from different failure mechanisms in batteries which can affect integrity and functionality of the separator film. In case of excessive heating or mechanical damage the polymeric separators become an incalculable security risk. The mechanical strength drops markedly at increased temperatures what in turn leads to hot spots, short circuits and also fire. Also the growth of metallic dendrites between the electrodes leads to unwanted short circuits. The strength of polymer separators can be enhanced by the addition of ceramic particles which are tough, temperature stable and inflammable. So the risk of thermal damage can be minimized, but the internal resistivity rises. This drawback can be compensated by the use of lithium ion conducting glass ceramics as solid state electrolytes. Suitable compositions are offered in the $Li_{1+x}Al_xTi_{2-x}(PO_4)_3$ –system. Within this study glasses with varying TiO_2 to Al_2O_3 ratios were molten and crystallized by selected heat treatments and characterised (TGA, HSM, DTA, XRD, EIS). The crystalline phases are lithium analogues to the well known NaSICON-Structures. Impedance spectroscopic measurements were carried out for determining ionic conductivities with respect to the chemical compositions, crystallising conditions and temperature. The results prove pure ionic conductivity for the compositions varying from 10^{-11} up to 10^{-4} S/cm. In a further step, the ceramic particles can be sintered to dense bodies or substrates which can be used as solid electrolytes with a separators function. Such ion conducting substrates are required for Lithium-Air-Batteries where liquid electrolytes must be hermetically packages together with the anode electrode.