SOLID Li-ION. Novel light-weight lithium conductors to be used as solid electrolyte in Li-ion batteries

DESCRIPTION FOR THE GENERAL PUBLIC

Rapid development of mobile and portable electronic devices places large pressure on development of more efficient electrochemical energy storage systems. Lithium batteries, due to the very low mass of lithium and its favourable charge to mass ratio, are the best candidates to power light portable devices. However, issues concerning safety and potential flammability of Li-ion batteries are being broadly discussed.

A general trend of minimisation of flammable components in Li-ion batteries can be observed over the last several years. The ultimate goal is to eliminate all flammable organic solvents from the system and to realize an all solid-state Li-ion battery. Solid Li-ion batteries are believed to exhibit superior properties over standard systems in term of safety, weight and energy density.

So far, solid state Li-ion batteries are not available in the market because of unsolved technical problems and high cost of proposed solutions. One of the main issues is centred on the solid electrolyte, which is aimed to replace flammable organic solvents. Such solid electrolytes, to be used in Li-ion batteries, need to have performance metrics at least as good as liquid organic solvents: high lithium conductivity at room temperature, high stability, very good electrical contact to electrodes, low cost and environmental friendliness. Until now, several classes of lithium conducting materials were discovered and described as potential solid electrolytes, but none of them fulfils all of the requisite demands.

SOLID Li-ION considers design, synthesis and characterisation of novel light-weight lithium conducting materials as potential new class of solid electrolytes suitable for all solid state Li-ion batteries. The materials will be synthesised using mostly ultra-light elements (lithium, boron, nitrogen, hydrogen), which could help in minimisation of the overall weight of Li-ion batteries.

Systematic scientific studies of lithium conductivity and electrochemical stability of various compounds will be conducted. Standard modification methods allowing for the enhancement of general properties of the materials will be performed. Several methods to ensure proper electric contact of the solid electrolyte to the electrodes will be tested. Eventually, all solid-state Li-ion batteries utilizing a solid electrolyte will be developed and subjected to standard battery tests.

IMPED-Cell, a novel solid-state materials characterization device, will be used to investigate solid electrolytes. It was originally constructed at the University of Warsaw to study powder samples sensitive to air and moisture, and is highly suitable for the battery research described in this project.

The project will be realised in a collaboration with University of Cambridge, UK, one of the world's leading research centres focused in Li-ion batteries.

Successful realisation of the project will result in the design, preparation and characterisation of a novel class of solid electrolytes based on ultra-light elements only. Results obtained might be valuable for the scientific community focused on Li-ion battery research. Potential positive tests of all solid state batteries with solid electrolyte designed within this project might be important for future battery research and industrial applications.