Abstract of the PhD. Thesis –

Applications of ionic liquids in electrolytes
for amperometric gas sensors and Li-ion batteries

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The dissertation presents the results of preparation and characterisation of new aprotic electrolytes based on ionic liquids for the solid-state electrochemical gas sensors and for the electrochemical energy storage devices – secondary lithium-ion batteries.

In the part dealing with the solid-state amperometric sensor for NO_2 research was aimed at development of new solid electrolyte. This electrolyte is developed as a system of ionic liquid embedded in the structure of a polymer, when the ionic liquid joints the properties of a solvent and a dissolved salt. The electrolyte therefore does not contain any volatile component and is long-term chemically and electrochemically stable. Several series of electrolytes were prepared with different polymers or macromonomers and imidazolium-based ionic liquids. The composition, especially the polymer-IL ratio was optimized. The electrolytes were successfully tested in a solid-state NO_2 sensor with a gold minigrid serving as the indicating electrode. The research included the determination of basic electrochemical parameters and study of the sensor behaviour under different conditions. The influence of atmosphere humidity, geometrical size and perimeter length of the gold minigrid indicating electrode, and interferents on the sensor response and sensitivity was studied.

For the new and safe lithium-ion batteries, imidazolium- and pyrrolidinium-based ionic liquids with perflurinated anions were prepared. By dissolving a lithium salt (LiTFSI, LiFSI or $LiPF_6$) in a suitable ionic liquid, liquid electrolytes for lithium-ion batteries were prepared. The electrolytes were consequently characterized from the electrochemical and material point of view and their composition was optimized to achieve sufficient ionic conductivity (3 – 6 mS cm^{-1} at 55 – 60 °C), high electrochemical stability (accessible window over 5 V) and high thermal stability (up to 250 – 450 °C). The most suitable candidates were tested in the experimental electrochemical cells with a material for negative (graphite) as well as for positive (Li_2FeSiO_4) electrodes of the lithium-ion batteries. Both materials (graphite and Li_2FeSiO_4) are compatible with these electrolytes and can be used together in development and construction of new lithium-ion battery with remarkably higher safety and lower risk level.