Novel layer-by-layer electrode surface design for long-lasting Na-ion batteries

Modern society cannot be imagined without rechargeable batteries to store energy for electric cars, mobile devices, and some domestic and industrial machines. Today, the market is dominated by the lithium-ion batteries due to high energy density and great time stability. At the same time, old and robust system – lead battery is extensively used in vehicles till today.

Despite being well-established, there are alternative technologies to address lithium scarcity and high cost or lead toxicity. One of the alternatives is the sodium-ion battery which relies on a nonaqueous sodium cation electrolyte, sodium cation intercalation type cathode (positive electrode), and sodium storing anode (negative electrode). The last decades of research resulted in the synthesis and investigation of various perspective cathode materials such as layered transition metal oxides, and anode materials such as hard carbon or metal alloys.

While the combinations of metal oxide cathode with carbon or alloy anode show promising energy densities, long-term stability remains a significant challenge. The cyclic stability of a battery is largely defined by the processes that occur on electrode surface. The interface between electrode and electrolyte is extremely reactive. In practice, cathode materials suffer from many side reactions leading to material decomposition and degradation. These parasitic surface processes, including etching and dissolution of cathode materials and passivation of anode materials pose significant obstacles to achieve the desired stability.

The main goal of the project is to develop a protective layer that would prevent cathodic material from destruction and at the same time would possess high ionic conductivity to maintain high battery performance. The layer will be deposited via a novel layer-by-layer deposition method that would allow precise control of its thickness. The obtained modified electrodes will be studied in terms of kinetic and electrical properties. A fundamental study of charge transport, including ionic conductivity, diffusion and ongoing redox processes will be accomplished within the scope of the project.