SYLI 7: Hybrid and structured electrolytes

Time: Wednesday 11:45–12:45 Location: IFW A

SYLI 7.1 Wed 11:45 IFW A

Morphology and conductivity of nanohybrid block copolymer electrolyte for lithium-ion batteries — •Ezzeldin Metwalli, Maximilian Kaeppel, Simon Schaper, and Peter Müller-Buschbaum — TU München, Physik-Department, LS Funktionelle Materialien, James-Franck-Str. 1, 85748 Garching

Polymer electrolyte membranes are promising alternatives to conventional liquid electrolytes in lithium-ion batteries [1]. A key challenge is to achieve a highly ionic conductive solid-state polymer membrane that maintains high-modulus, toughness, and chemical stability. The ionic conductivity in relation to the morphology of a ternary system composed of polystyrene-block-polyethylene oxide (PS-b-PEO) diblock copolymer (DBC) electrolyte, lithium salt and ionic liquid (IL) was investigated. An optimized functional morphology of the hybrid membrane was achieved by enabling highly interpenetrated hard PS and soft PEO/IL domains. The high-modulus glassy PS domain of the nanostructured hybrid membranes offers mechanical stability, while the Li-containing PEO/IL hybrid domain enables the requisite high ionic conductivity. The IL doping enhances the solubilization of the undissociated lithium salt at the PS/PEO domain interface. The pronounced conductivity enhancement of the current Li-ion/IL/DBC hybrid electrolyte compared to other previously reported DBC electrolyte systems is discussed. [1] E. Metwalli et al., ChemPhysChem 2015, 16, 2882.

SYLI 7.2 Wed 12:00 IFW A

Preparation of Electrodes for Li-Ion Batteries from Inexpensive Dirty Silicon — •Richard Schalinski[1], Stefan L. Schweizer[1], and Ralf B. Wehrspohn[1,2] — [1]Institute of Physics, Martin-Luther-Universität Halle-Wittenberg, Halle 06099, Germany — [2]Fraunhofer Institute for Mechanics of Materials IWM, Halle 06120, Germany

With the increased development of renewable energies and electric vehicles in our society, there is a greater demand for high capacity, safe and inexpensive storage technologies. Li-ion batteries are the technology of choice for the use in portable devices. To increase the capacity density of these batteries, nanostructured silicon was introduced as a material for the negative electrode. Commonly, either expensive silane or electrical grade silicon is used as the starting material. We introduce an alternative route by using inexpensive metallurgical grade silicon (purity 98%) as a starting material and purify it using metal assisted chemical etching followed by ball milling to obtain silicon nanoparticles. The Si-nanoparticles where mixed with different binders (CMC, PVdF, Na-Alginate) to form slurries, which were coated onto Cu-substrates. The dried electrodes where investigated by SEM and introduced to further electrochemical testing in a half cell setup. A variation of the chemical contents and pretreatments of the substrates were carried out to optimize the capacity and cyclability of the electrodes.

SYLI 7.3 Wed 12:15 IFW A

Polymer paterning: Solid polymer electrolytes for lithium batteries — Preston Sutton, Ilja Gunkel, and •Ulli Steiner — Adolphe Merkle Institute, Fribourg, Switzerland

Patterning materials at the nanoscale can dramatically influence the performance of batteries. At the Adolphe Merkle Institute (AMI) we are applying expertise in structural control to improve electrodes and electrolytes alike. Two goals of our research are: 1- Take advantage of polymer self-assembly as a facile method to attain predictable morphologies in block copolymers (BCPs) quantifying ionic conductivity as a function of grain size and crystallinity. 2- Use BCPs to decouple mechanical properties from ionic conductivity in electrolytes.

SYLI 7.4 Wed 12:30 IFW A

Modulation of the optical properties of LiMn2O4 via Li-ion transport — •Yug Joshi, Susann Nowak, and Guido Schmitz — Institut für Materialwissenschaft, Universität Stuttgart

Extensive research has been carried out in the fields of Li-ion batteries and electrochromic materials. The present study combines both in investigating the changes in the optical properties of the lithium manganese oxide (LMO), a spinel structured cathode material during an electrochemical reaction. To study this behaviors ion-beam sputtering is used to deposit LMO as the active layer onto a layer of platinum serving as a current collector, over an oxidized silicon wafer. The multilayered sample is then characterized using optical spectroscopy at different lithiation states. The measured data is fitted using Cauchy's model to extract the complex refractive index (refractive index and absorption coefficient) of LMO and its dependence on the lithium content. The reversibility of the optical changes is verified by in-situ optical measurements during multiple charging and dis-charging cycles of LMO. The study reveals a reversible change of the complex refractive index during an electrochemical reaction in the wavelength range of 850-1600nm, making it a suitable candidate for the application of optical switching.