Novel printable and self-healing electrolytes for Li-ion batteries

Lithium-ion batteries (LiBs) are the most widely used type of rechargeable battery. An increasing demand for efficient energy storage systems encourages development of next-generation LiBs with higher energy densities, improved safety and longer cycle life. Current commercial LiBs containing liquid, organic electrolytes suffer from the shortcomings of high price, low energy density, environmental issues and safety hazards.[1] Moreover, lithium dendrite formation may occur, leading to short circuits and thermal runaway. Additionally, volumetric changes on the electrodes during charging/discharging may lead to cracking of the electrode and loss of electrical contact. Polymer electrolytes (PE) and polymer composite electrolytes are promising alternatives for achieving desired properties and improving current LiBs.[2] Furthermore, the development of 3D printable electrolyte material gives us the ability to design next generation batteries with complex architecture.

Here we present novel 3D printable, self-healable and conductive PEs as well as composite electrolytes based on poly(ethylene oxide) (PEO). PEO as one of the most advantageous PE can suppress dendrite growth.[3] In addition, embedded self-healing abilities in PE can overcome issues caused by volumetric changes. PEO-1500 and Jeffamine® ED-900 was end group modified using ureidopyrimidinone (UPy) moieties for introducing hydrogen bonds and enhancing lifetimes by self-healing-effects[4]. Jeffamine ED-900-UPy and PEO-1500-UPy were mixed with lithium bis(trifluoromethanesulfonyl)imide (LTFSI) and investigated for 3D printability and conductivity. Jeffamine ED-900-UPy based materials were successfully printed using fused deposition modeling (FDM)[5]. In case of PEO-1500-UPy silica nanofillers (Si-NPs) modified with ionic liquid groups on the surface were used for improving mechanical properties[6]. Composites showed excellent printability via FDM and higher shape fidelity.

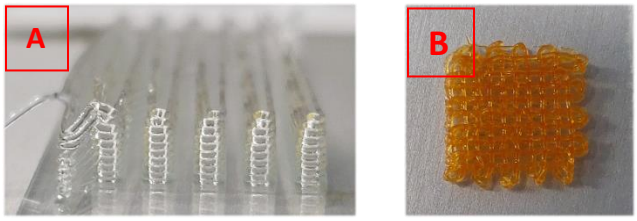

Figure 1. 3D printed samples A) Jeffamine ED-900-UPy/LiTFSI mixture. B) PEG-1500-UPY/LiTFSI/SiNPs mixture

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