Sodium batteries: from liquid to solvent-free ternary polymer electrolytes

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The European Union has been established the SET plan to accelerate the transformation to an energy neutral system by 2050 [1]. Therefore the use of renewable energy sources should be drastically increase in order to achieve the targets, being the energy storage devices, in particular batteries, a key technology. The lithium-ion batteries (LIBs) have been powered portable electronics and electric vehicles owing to their high energy density. In this context the LIBs demand has significantly increased in the last years, raising concerns about the long-term availability and cost of the critical raw materials used in LIB production, *e.g*. cobalt, nickel, lithium, graphite and copper [2,3]. In this scenario, it is required to develop new battery technologies based on low-cost and environmentally friendly raw materials that can complement LIBs. Sodium-ion batteries (SIBs) follows the mentioned philosophy, due to the almost infinite and widely distributed sodium resources, which are postulating as attractive alternatives for stationary large-scale applications and light electromobility [3].

Among the different electrolytes for SIBs, the carbonate-based ones are the electrolyte of choice due to their excellent performances in LIBs. Despite they exhibit excellent ionic conductivity, they possess low thermal stability, high volatility and high flammability. In addition, the excellent performances obtained in LIBs have not been reproduced in SIBs, mainly due to the different chemical properties of the formed species on the electrode-electrolyte interphase. For this reason, the scientific community strongly focused on the development of advanced electrolytes, *i.e*. solid-state electrolytes (SSE). Among them, solvent-free polymer electrolytes have been attracted great interest for next generation batteries, due to their good mechanical properties, good ionic conductivities and safety [4].

This work will focus in the transition from liquid to solvent-free ternary polymer electrolyte using as cathode material the P2-$Na_{2/3}Ni_{1/3}Mn_{2/3}O_2$ (P2-NMNO) layered oxide. First a physicochemical and electrochemical characterization of P2-NMNO has been carried out in liquid electrolyte (carbonate-based). Second a thoroughly study on thermal, electrochemical stability, and ionic conductivity by means of electrochemical impedance spectroscopy of solvent-free ternary polymer electrolyte has been performed. Finally, the electrochemical performance of P2-NMNO cathode using solvent-free polymer electrolytes has been investigated. The obtained results, in terms of delivered capacity and cycling stability using solvent-free ternary polymer electrolyte opens the way for extending the long-term stability and safety of sodium batteries.

References

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