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Challenges and perspectives on high and intermediate-temperature sodium batteries

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ABSTRACT

Energy storage systems are selected depending on factors such as storage capacity, available power, discharge time, self discharge, efficiency or durability. Additional parameters to be considered are safety, cost, feasibility and environmental aspects. Sodium based batteries (Na–S, $NaNiCl_2$) typically need an operation temperature of 300–350 ºC. The high operating temperature substantially increases operating cost and raises safety issues. This updated review describes the state-of-the-art of materials in high temperature sodium batteries and the trends towards the development and optimization of new designs for intermediate and low-temperature devices. Recent advances in inorganic solid electrolytes, glass-ceramic electrolytes and polymer solid electrolytes are of great importance in all solid-state sodium batteries. Systems such as NASICON with the chemical formula $Na_{1+x}Zr_2P_{3-x}Si_xO_{12}$ ($0 \le x \le 3$), glass-ceramic $94Na_3PS_4{\cdot}6Na_4SiS_4$ and polyethyleneoxide (PEO)–sodium triflate ($NaCF_3SO_3$) are considered. Room temperature ionic liquids (RTILs) are also included as novel electrolyte solvents. The update discusses progress on-going strategies on enhancing conductivity, optimizing electrolyte/electrode interface, and improving cells design in emerging technologies. This work aims to cover the recent advances on electrode and electrolyte materials for Sodium-sulfur and ZEBRA batteries on high and intermediate-temperature.