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Rechargeable batteries based on chloride ion transfer

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Alternative battery chemistries beyond lithium ion and using abundant electrode materials have been developed. Chloride ion battery (CIB) is a new rechargeable battery based on Cl- anion transfer. This battery shows a variety of electrochemical couples with theoretical energy densities up to 2500 Wh l^{-1}, which is superior to those of conventional lithium ion batteries. Abundant material resources such as Mg, Ca, Na and metal chlorides (e.g., $FeCl_3$, $CuCl_2$ and $MgCl_2$) can be sustainable electrode candidates. The CIB includes a metal chloride/metal electrochemical couple and an ionic liquid electrolyte allowing chloride ion transfer, as reported in the proof-of-principle study of CIB operated at room temperature. The problem is that the metal chloride cathode can react with chloride ions in the electrolyte, leading to the formation of soluble complex anion. This electrode dissolution and the subsequent shuttle would limit the use of metal chloride cathode in the liquid electrolyte system. Metal oxychlorides with higher stability have been proved to be new cathode materials for CIBs. Metal oxychloride/metal systems could also show high theoretical energy densities during the chloride ion transfer. By carbon incorporation in the cathode or optimization of electrolyte composition, more than 70% of the theoretical discharge capacity of single-electron cathode such as FeOCl or VOCl could be delivered. A preliminary study on the multi-electron VOCl2 cathode was also reported in the electrode system using VOCl as cathode and Mg/MgCl2 composite as anode. Besides inorganic electrode materials in rechargeable batteries, organic electrode materials, in particular polymers, have been attracting much attention, due to their advantages of good electrochemical performance, high stability, abundant chemical elements, structural tunability and designing flexibility. Chloride ion doped polymer materilals have been studied and developed as new cathodes for chloride ion batteries. Reversible reversible redox reactions and superior cycling stability were obtained.

Biography

Xiangyu Zhao has his expertise in Electrochemical Energy Storage including Electrochemical Hydrogen Storage and Rechargeable Batteries such as chloride ion batteries, lithium ion batteries and magnesium batteries. He received his PhD in Materials Science from the Nanjing Tech University in 2010. He was awarded by the Guest Scientist Fellowship and has worked at Karlsruhe Institute of Technology. He is the (co-)author of 9 patent applications and has more than 60 papers published in international journals such as *Angew. Chem. Int. Ed., Adv. Energy Mater and Energy Environ. Sci.*

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