

Doping Effects of Conductivity Improvement in Anti-perovskite Na₃OX Solid Electrolytes

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Abstract:

There has been increased attention of solid electrolytes for all solid sodium(Na)-ion batteries as an alternative energy storage system, which have the advantage of being extremely safe because it can be charged quickly and is nonflammable. We have synthesized anti-perovskite type Na₃OBr_{1-a}I_a (a= 0~0.5) and Na₃O_{1-b}S_b Br (b= 0.05~0.25) electrolytes with high purity. The replacement of halogen ions is for introducing lattice distortion to loosen bottleneck. The sulfur (S) doping might introduce additional lattice distortion by its larger ionic size. It is confirmed that a large crystal strain was introduced by eutecticization, which might reduce the activation energy of Na ion conduction and lead to an improvement of the conductivity. A relatively higher ionic conductivity of $\sigma=1.55 \times 10^{-7}$ S/cm at 60 °C has been obtained for Na₃OBr_{0.6}I_{0.4}, which is about three orders higher than that of Na₃OBr in literature. The S doping was also effective, especially for Na₃O_{0.8}S_{0.2}Br, in which the ionic conductivity was confirmed to be 6.2×10^{-4} S/cm at room temperature, a value comparable to the application requirement for solid electrolytes. The activation energy was found to be reduced also, indicating that doping of S ions is indeed beneficial.

Key words: sodium ion battery, solid electrolyte, ionic conductivity, anti-perovskite, S doping