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Influence of Nb⁵⁺, Ti⁴⁺, Y³⁺ and Zn²⁺ doped Na₃Zr₂Si₂PO₁₂ solid electrolyte on its conductivity

Dan Chen^{1*}, Fa Luo¹, Wancheng Zhou¹, Dongmei Zhu¹

State Key Laboratory of Solidification Processing, Northwestern Polytechnical University, Xi'an, Shaanxi 710072, China

ABSTRACT: In this study, Na₃Zr_{2-x}Nb_{0.8x}Si₂PO₁₂, Na₃Zr_{2-x}Ti_xSi₂PO₁₂, Na₃Zr_{2-x}Y_xSi₂PO_{12-0.5x}, Na₃Zr_{2-x}Zn_xSi₂PO_{12-x} ceramics with x=0.1, 0.2, 0.3 and 0.4 were sintered to explore the influence of the valence state and the content of dopants on the conductivity of NASICON solid electrolyte. Archimedes method, X-ray diffraction, scanning electron microscopy and complex impedance spectroscopy were used to characterize the sintered samples. Results show that the dopant with +2 oxidation state cations improves the bulk conductivity mainly due to the less electrostatic interactions between Zn²⁺ ions and Na⁺ ions. The optimal doping content of Nb⁵⁺, Ti⁴⁺ and Y³⁺ doped NASICON ceramics is 0.1 mol and that of Zn²⁺ doped NASICON ceramic is 0.2 mol for the highest ionic conductivity. Among all the doped NASICON ceramics, Na₃Zr_{1.8}Zn_{0.2}Si₂PO_{11.8} ceramic displays the highest total conductivity of 1.44 × 10⁻³ S/cm and bulk conductivity of 3.41 × 10⁻³ S/cm at room temperature. Furthermore, doping strategy both increases the density and decreases the sintering temperature of Na₃Zr₂Si₂PO₁₂ ceramic.

Keywords: Na₃Zr₂Si₂PO₁₂; Valence state; Ionic conduction; Dopant

1. Introduction

¹ Corresponding author at: State Key Laboratory of Solidification Processing, Northwestern Polytechnical University, Xi'an 710072, China. Tel./fax: +86 029 88494574.
E-mail address: chendan900408@163.com (D. Chen).

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