

The solid electrolyte is one of the most important components for a solid oxide fuel cell (SOFC). The various divalent or trivalent metal ion-doped bismuth-based materials exhibit good ionic conductivity. Therefore, these materials are used as electrolytes in the SOFC. In this paper, the samples of  $(\text{Bi}_{0.92-x}\text{Ho}_{0.03}\text{Er}_{0.05})_2\text{O}_3 + (\text{ZnO})_x$  solutions with a  $0 \leq x \leq 0.2$  molar ratio are synthesized by the solid state reaction method. The detailed structural and electrical characterizations are investigated by using x-ray diffraction (XRD), alternating current electrochemical impedance spectroscopy, and scanning electron microscopy (SEM). The XRD patterns of all samples are indexed on a monoclinic symmetry with a P21/c space group. In addition, the rietveld parameters are determined by using the FullProf software program. The impedance measurements of the samples are obtained at the 1 Hz to 20 MHz frequency range. The impedance value of the pellets increases with temperature. Based on the impedance results, it is found that the contribution of grain (bulk) is more than a grain boundary in terms of conductivity, which permits the attribution of a grain boundary. The ionic conductivity decreases with an increasing amount of Zn contribution. The value of highest electrical conductivity among all samples is calculated as  $0.358 \text{ S cm}^{-1}$  at  $800^\circ\text{C}$  for undoped  $(\text{Bi}_{0.92}\text{Ho}_{0.03}\text{Er}_{0.05})_2\text{O}_3$ .