Samples of Sr- and Mg-doped LaGaO₃ (LSGM) with various concentrations of Sr and Mg were prepared by using solid-state reaction method. Results show that ionic conductivities increase with the increase of relative densities. It can also be known that the optimized concentration in La₃₋ₓSrₓGa₁₋ₚMgₚO₃₋₀.₅(x+y) with high conductivity is LSGM1520 or LSGM2015. The results also show that, in various concentrations of LSGM, equiaxed, rod-like, polygonal secondary phases such as LaSrGaO₄ or LaSrGa₃O₇ were detected besides (La,Sr)(Ga,Mg)O₃ by means of SEM and EDX. With the increase of doped elements, i.e. x + y, the grain size increases.

1. Introduction

SOFCs convert chemical energy of a fuel gas directly into electrical work, with great current density and transformation efficiency (more than 50%), and are environmentally clean without corrosion and leakage of liquid electrolyte. So they have been widely used in many fields [1–5]. The key materials for SOFCs are solid electrolytes. Yttria-stabilized zirconia (YSZ), as it is well known, is the most widely used solid electrolyte in SOFCs, because of its attractive ionic conductivity at higher temperature, stability in dual environment (oxidizing and reducing) and stability against the electrode materials [3]. But ionic conductivity of YSZ decreases quickly with the decrease of the working temperature [6, 7]. So it must be used at higher temperature. This leads to degeneration when used for a long time and the joint materials for SOFC being oxidized and reduced at high temperature and under oxidizing and reducing atmosphere. Therefore, many scientists are much more interested in the ways to lower the temperature of SOFCs [8]. Sr- and Mg-doped LaGaO₃, first synthesized by Ishihara [9] and Goodenough [10], appears high promising as a new solid electrolyte for use at intermediate temperature [11]. The oxide ionic conductivity of La₃₋ₓSrₓGa₁₋ₚMgₚO₃₋₀.₅(x+y)(LSGM) is around 0.10 S/cm at 800°C (comparable to that of yttria-stabilized zirconia at 1000°C) [12]. It has negligible electronic conduction at temperature lower than 800°C and a stable performance over long operating time [12]. These superior electrical and chemical properties appear to make it the leading new generation material for use as a solid electrolyte in SOFCs operating at or below 800°C [13]. It was reported that the synthesis of LSGM without secondary phase was found to be rather difficult [13–16], the secondary phases such as LaSrGaO₄, LaSrGa₃O₇, La₄Ga₂O₉ or LaGa₂O₄, appeared easily. Goodenough et al. investigated the synthesis of LSGM powders by Sol-gel method [17]. Tarancon et al. investigated the synthesis of LSGM powders by acrylamide polymerization [18]. Cong et al. investigated the synthesis of LSGM powders by glycine-nitrate combustion method [19]. Baskaran et al. investigated mechanical properties of LSGM [20, 21], the results show that the addition of 2 wt% Al₂O₃ could increase the bending strength effectively. The systematic works about this materials on phase relationships, ion conductivity, microstructures and testing of single cells were done by Goodenough et al. [22–24]. It was found that the structure of LSGM is cubic, while Lerch and Yao reported that the structure of LSGM is orthorhombic [25, 26] by means neutron scattering and Raman spectroscopy methods. It was found that higher conductivity was found if LSGM was composed of cubic perovskite, the conductivity of LSGM would be decreased quickly if there exist secondary phases [22]. However, the systematic works on the microstructures of this material, especially the effect...
Figure 1 X-ray diffraction patterns of LSGM with various concentrations of Sr and Mg.