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Phase composition, microstructure and microwave dielectric properties of rock salt structured Li_2ZrO_3-MgO ceramics

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Abstract

A novel series of rock salt structured (1-x)Li_2ZrO_3-xMgO ceramics were prepared via the conventional solid state method. The tetragonal-cubic phase transition can be observed in the case of 0.5≤x≤0.6, which has been testified by the results of XRD and SEM-EDS. Relatively dense and homogeneous microstructure can be obtained for all the compositions sintered at 1500 °C. With the x value increasing from 0.5 to 0.8, the relative permittivity linearly decreases from 16.50 to 12.65, and the τ_f value decreases from ~-10 ppm/°C to ~-35 ppm/°C. The addition of MgO stabilizes the crystal structure and increases the bond energies in Li_2ZrO_3-MgO system, so there is an upward tendency in $Q{\cdot}f$ values from ~77,000 GHz to ~166,000 GHz. Typically, the $Li_2Mg_4ZrO_7$ ceramics sintered at 1500 °C possesses excellent properties with ε_r=12.65, $Q{\cdot}f$=165,924 GHz and τ_f=-34.66 ppm/°C, which makes these materials good candidates for microwave devices.

Keywords: microwave dielectric properties; Li_2ZrO_3-MgO ceramics; bond energy; phase transition

1. Introduction

Low-permittivity microwave dielectric ceramics play an important role in a wide range of applications from millimeter wave communication to substrates for microwave integrated circuits, which promote the development of related industries such as Internet of Things (IoT), Direct-Broadcast Satellite (DBS), and Global Positioning System (GPS). To meet the demands for high-speed transmission, these materials should possess appropriate relative permittivities (ε_r), higher quality factors ($Q{\cdot}f$) and near-zero temperature coefficients of resonant frequency (τ_f). In addition, lower sintering temperature and preparation costs are also required to make these materials suitable for practical applications [1, 2].

Recently, the rock salt structured Li_2AO_3-MgO (A=Ti, Zr, Sn) ternary system has attracted extensive attentions due to their excellent and adjustable microwave dielectric properties [3-16]. For instance, a series of (1-x)Li_2TiO_3-xMgO ceramics were synthesized according to the partial subsolidus phase diagram reported by A.R. West [3-11]. Although the relative

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