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Cryogenic microwave dielectric properties of Mg_2TiO_4ceramics added with CeO_2nanoparticles

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Abstract. The microwave dielectric properties of CeO_2 nanoparticles (0.5, 1.0 & 1.5wt%) doped Mg_2TiO_4 (MTO) ceramics have been investigated at cryogenic temperatures. The XRD patterns of the samples were refined using the full proof program reveal the inverse spinel structure without any secondary phases. The addition of CeO_2 nanoparticles lowered the sintering temperature with enhancement in density and grain size as compared to pure MTO ceramics. This is attributed to the higher sintering velocity of the fine particles. Further, the microwave dielectric properties of the MTO ceramics were measured at cryogenic temperatures in the temperature range of 6.5-295 K. It is observed that the loss tangent (tanδ) of all the samples increased with temperature. However, the CeO_2 nanoparticles doped MTO ceramics manifested lower loss tangents as compared to the pure MTO ceramics. The loss tangents of the pure and MTO ceramics doped with 1.5 wt% of CeO_2 nanoparticles measured at 6.5K are found to be 6.6×10-5 and 5.4×10-5, respectively. The addition of CeO_2 nanoparticles did not cause any changes on the temperature stability of the MTO ceramics at cryogenic temperatures. On the other hand, the temperature coefficient of the permittivity increased with rise in temperature and with the wt% of CeO_2 nanoparticles. The obtained lower loss tangent values at cryogenic temperatures can be attributed to the decrease in both intrinsic and extrinsic losses in the MTO ceramics.

Keywords: cyogenic temperatures; microwave dielectric properties; CeO_2 nanoparticles; densification, microstructure

1. Introduction

The tremendous growth in telecommunication and satellite broadcasting has resulted in a need for low loss and low cost high frequency devices, such as, dielectric resonator and dielectric filters. The dielectric resonator provides the compactness, light weight, temperature stability (due to the lower temperature coefficient of resonant frequency), miniaturization (due to a high dielectric constant), and high-frequency selectivity. The dielectric resonators with a high dielectric constant (ε_r), a low loss (large $Q\times f_o$) and a temperature coefficient of resonant frequency (τ_f) are used in filters, oscillators, amplifiers and tuners in communication circuits, which results in the high

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