

Author's Accepted Manuscript

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www.elsevier.com/locate/ceri

PII: S0272-8842(17)32802-X
DOI: <https://doi.org/10.1016/j.ceramint.2017.12.097>
Reference: CER116977

To appear in: *Ceramics International*

Received date: 7 November 2017
Revised date: 13 December 2017
Accepted date: 13 December 2017

Cite this article as: Hongyu Yang, Enzhu Li, Yingfeng Yang, Yan Shi, Hongcai He and Shuren Zhang, Co₂O₃ substitution effects on the structure and microwave dielectric properties of low-firing (Zn_{0.9}Mg_{0.1})TiO₃ ceramics, *Ceramics International*, <https://doi.org/10.1016/j.ceramint.2017.12.097>

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Co₂O₃ substitution effects on the structure and microwave dielectric properties of low-firing (Zn_{0.9}Mg_{0.1})TiO₃ ceramics

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Abstract

Low-firing (Zn_{0.9}Mg_{0.1})_{1-x}Co_xTiO₃ ($x = 0.02 \sim 0.10$) (ZMC_xT) microwave dielectric ceramics with high temperature stability were synthesized *via* conventional solid-state reaction. The influences of Co₂O₃ substitution on the phase composition, microstructure and microwave dielectric properties of ZMC_xT ceramics were discussed. Rietveld refinement results show the coexistence of ZnTiO₃ and ZnB₂O₄ phases at $x = 0.02 \sim 0.10$. (Zn_{0.9}Mg_{0.1})_{1-x}Co_xTiO₃ ceramic with $x = 0.06$ (ZMC_{0.06}T) obtains the best combination microwave dielectric properties of: $\epsilon_r = 21.58$, $Q \times f = 53,948$ GHz, $\tau_f = -54.38$ ppm/°C. For expanding its application in LTCC field, 3 wt. % ZnO-B₂O₃-SiO₂ (ZBS) and 9 wt. % TiO₂ was added into ZMC_{0.06}T ceramic, great microwave dielectric properties were achieved at 900°C for 4 h: $\epsilon_r = 26.03$, $Q \times f = 34,830$ GHz, $\tau_f = -4$ ppm/°C, making the composite ceramic a promising candidate for LTCC industry.

Key words: (Zn_{0.9}Mg_{0.1})TiO₃, Co₂O₃, ZnO-B₂O₃-SiO₂, microwave dielectric ceramics, low temperature sintering, LTCC

1. Introduction

High frequency passive components such as microwave dielectric resonators and antenna have been rapidly developed for cellular phones and global positioning systems in the past decades. Low temperature co-fired ceramics (LTCC) technology has been playing a significant role in this field. Requirements for these dielectric components must combine excellent dielectric properties such as a moderate dielectric constant (ϵ_r), a low dielectric loss of the quality factor ($Q \times f$) and a near-zero temperature coefficient of resonant frequency (τ_f), which allows the components to operate normally under a wide temperature range[1-3].

ZnO-TiO₂ based ceramics have been one favorite research for years because of their excellent microwave dielectric properties. In their phase diagram reported by Yang and Swisher[4], three phases

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