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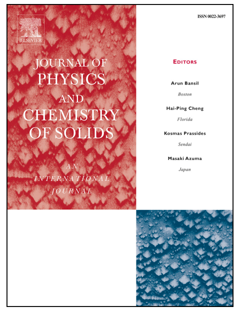

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PII: S0022-3697(17)31282-9

DOI: 10.1016/j.jpcs.2017.12.049

Reference: PCS 8356

To appear in: *Journal of Physics and Chemistry of Solids*

Received Date: 15 July 2017

Revised Date: 22 December 2017

Accepted Date: 23 December 2017

Please cite this article as: Z. Liu, Z. Xing, H. Wang, Z. Xue, S. Chen, X. Cui, G. Jin, Zn^{2+} in-situ substitution behavior during the formation of $BaTiO_3$ coatings from plasma-sprayed powders collected in liquid nitrogen, *Journal of Physics and Chemistry of Solids* (2018), doi: 10.1016/j.jpcs.2017.12.049.

Zn^{2+} in-situ substitution behavior during the formation of $BaTiO_3$ coatings from plasma-sprayed powders collected in liquid nitrogen

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Abstract: The dielectric performance of $BaTiO_3$ ceramic coatings is enhanced significantly by the addition of ZnO. In this study, the maximum relative permittivity value ($\varepsilon_r \approx 923$) was measured in $BaTiO_3$ coatings with ZnO added at 6 wt.%. The Curie temperature (T_c) was in the range of 111°C to 121°C for all of the ZnO-modified $BaTiO_3$ coatings. T_c shifted to low temperatures as the ZnO content increased. Detailed analyses were performed to determine the phase composition and optical band gaps of powders collected in liquid nitrogen, which showed that the Zn^{2+} ions were incorporated into the $BaTiO_3$ lattice where they substituted into the Ti^{4+} sites, and the composite powders ($BaTiO_3$ + 6 wt.% ZnO) tolerated high temperatures in the plasma beam. In addition, some residual Zn accumulated in the grain boundary in the form of ZnO. X-ray diffraction and Raman spectroscopy showed that the substitution led to changes in the compositional and structural properties. The red shift in the optical band gap of $BaTiO_3$ indicated that the Zn''_{Ti} defects caused by the dopants acted as carriers in the doped $BaTiO_3$ coatings.

Key words: Air plasma spray, $BaTiO_3$, Dielectric performance, Liquid nitrogen, ZnO.

1. Introduction

Air plasma spraying is a highly efficient method for obtaining "bulk-like" thickness hard coatings for various electrical applications [1, 2]. Perovskite structure ceramics exhibit excellent electrical performance characteristics due to their unique crystal structure. Coatings based on perovskite structures such as lead zirconium titanate [3], barium titanate ($BaTiO_3$) [4, 5], potassium-sodium niobate [6], and lead magnesium niobate [7] have been successfully deposited via air plasma spraying in recent years. $BaTiO_3$ is an important lead-free dielectric material, which might be suitable for various applications after deposition using the plasma spraying process. $BaTiO_3$-based ceramic materials have attracted much attention due to their unique ferroelectric, piezoelectric, dielectric, and optical properties, and they are now used widely in various applications such as capacitors, sensors, and electronic and photocatalytic applications.

Barium titanate and its doped variants have been applied extensively due to their excellent ferroelectric, piezoelectric, and thermoelectric properties [8, 9]. Acceptor and donor dopants can significantly change the concentration of carriers to affect the dielectric performance, especially the dielectric loss. The incorporation of extra ions in the primary lattice of $BaTiO_3$ is expected to

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