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Effect of ZnO on the microstructure and dielectric properties of $BaTiO_3$ ceramic coatings prepared by plasma spraying

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Abstract: Three contents of zinc oxide (2 wt. %, 4 wt. % and 6 wt. %) were added into raw $BaTiO_3$ powders. The maximum relative permittivity value (ε_r) is in the range 230-406 and the dielectric loss (tanδ) varies between 0.18 and 0.09 for all ZnO modified $BaTiO_3$ coatings for frequency1 kHz at ambient temperature. The reasons for enhancing the relative permittivity are attributed to the elimination of micro-cracks and pores. The detail discussion was conducted on the characteristics morphologies (cross section, fracture surface and spreading behavior of $BaTiO_3$+xwt. % ZnO composite powders) and phase. With the analysis, the addition of ZnO leads to the improvement in the melting state and increment in amorphous phase. Zn existed in the form of secondary phase (ZnO) and substitution in the $BaTiO_3$ lattice. The enhancement in structure and dielectric performance is highly discussed based on the phase equilibria and chemical defect.

Key words: Plasma spraying, Barium Titanate, Zinc Oxide, Microstructure, Splat morphology

1. Introduction

ABO_3-type perovskite has attracted a lot of attentions because of their wide applications in movable power source, hybrid vehicles, and so on [1, 2]. Owing to the global energy crisis, large dielectric constant and high electrical breakdown strength (BDS) materials are generally needed to meet the rapid developing technical requirements. As one kind of lead-free ferroelectric materials with high dielectric constant, barium titanate ($BaTiO_3$) ceramics are most commonly applied on multilayer ceramic capacitors, posistors, ultrasonic actuators, pyroelectric detectors, temperature sensors and controllers et. al. [3-6]. However, there is an obvious difference between $BaTiO_3$ in the form of thin films and sintered bulk ceramics [7]. Compared to the sintered bulk ceramics, ferroelectric thin films process interface layer and lattice mismatch between substrate, and therefore leads to inevitable distortion of grain lattice, as well as residual stress caused in preparing process [8]. As the results, thin ferroelectric films don't perform as well as the bulk materials.

Air plasma spray (APS) provides an effective way to obtain 'bulk-like' thickness hard coatings. Coatings with dielectric properties such as Lead zirconium titanate (PZT) [9], Barium titanate ($BaTiO_3$) [10, 11] and Potassium-sodium niobate (KNN)[12] have been successfully deposited via air plasma spray. But the dielectric performance of the sprayed coatings with micro-cracks is not comparable to the sintered bulk materials. In previous researches [11], the

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