

Colloidal characterization and electrophoretic deposition of $\text{Ba}(\text{Ti}_{1-x}\text{Zr}_x)\text{O}_3$ thick films from nanometric powders

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Solid solutions based on barium titanate (BaTiO_3) offer a large range of possible modification of the dielectric properties. $\text{Ba}(\text{Ti}_{1-x}\text{Zr}_x)\text{O}_3$ ceramics have recently received renewal attention due to a high-strain level and high-piezoelectric effect. Research on ferroelectric and piezoelectric thick films (thickness above 10 μm) is fundamental for the development of microelectromechanical systems (MEMS) due to its higher sensitivity, larger mechanical force and broader working frequency range compared to thin films.

In this work is presented the results of thick films (50-130 μm) produced through electrophoretic deposition of $\text{Ba}(\text{Ti}_{1-x}\text{Zr}_x)\text{O}_3$ ($5 < x < 30$, mol%, named BTZ) nanometric powders prepared by the Pechini method. The BTZ powder presented a single crystalline phase with an average particle size and a crystallite size of ~ 50 nm and ~ 20 nm, respectively, when calcined at $600^\circ\text{C}/2\text{h}$. BZT thick films were deposited on platinum substrates. Different suspensions were obtained from the dispersion of the powder into: ethanol (EtOH) and a mixture of acetylacetone (Acac) and EtOH (1:1 volumetric ratio). An operational pH (O.pH), based on an ethanol-based reference electrode, was used to systematize the suspension properties. The colloidal stability of submicron BTZ powders in solution was studied. Zeta potential and viscosity of BTZ powders suspensions as a function of O.pH were measured. A milling process was used to deagglomerate the powders and it had a great influence in the suspension stability and deposition of thick films with high green-density. The experimental analysis indicated that the use of Acac+EtOH show a better green-density, and consequently, a higher density after sintering when compared to the deposited films using the EtOH suspension. Dense and crack-free thick films with uniform microstructure were obtained after sintering at $1250^\circ\text{C}/2\text{h}$. The dielectric and ferroelectric properties, comparable with those of bulk BTZ ceramics, suggested potential applications of the EDP process for the deposition of ferroelectric/piezoelectric thick films.