Homogeneity Issues in Chemical Solution Deposition of $Pb(Zr,Ti)O_3$ Thin Films

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Research into chemical solution deposition (CSD) methods for ferroelectric thin films is oriented towards higher reliability and lower processing temperatures. Alkoxide-based sol-gel processing of multicomponent materials is recognized to yield more homogeneous products than solid state synthesis, and at lower processing temperatures, owing to the formation of heterometallic bonding already in solution. During the synthesis and subsequent processing steps, that is the deposition of the film, drying, consolidation and crystallization of the target ferroelectric phase; however, different reactivities of the constituent transition metal alkoxides, may decrease the homogeneity on the molecular level in the ceramic precursors. Various strategies have been employed to improve the stability and homogeneity of the sols.

In the 2-methoxyethanol based synthesis of $Pb(Zr_{0.53}Ti_{0.47})O_3$ a selective modification of the reactive Zr-alkoxide by acetic acid results in a homogeneous distribution of constituent metal atoms in the sol. The persistence of Zr-O-Zr bonding formed in the sol is traced through the process of film formation by X-ray absorption (EXAFS) spectroscopy. The addition of the modifier evokes the crystallization of the perovskite phase in the films at a lower temperature. The improved chemical homogeneity is reflected in the improved functional response of the films.