Lead free $CaTiO_3$-based ceramics: Sintering, Phase transitions and Dielectric properties

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The perovskite-type compounds ABO_3 are of great interest for several applications thanks to their easy synthesis by various methods and their properties. Calcium titanate $CaTiO_3$ belongs to this important family and is well known for the treatment of nuclear wastes or as catalyst in the oxidation of light hydrocarbons. In the last decade, the expansion of microwave technologies and the system's miniaturization induced the need of new generation of dielectrics and $CaTiO_3$ related materials attracted a lot of researchers. The objectives of the present work are, first the sintering at low temperature of lead free $CaTiO_3$-based ceramics, then the investigation of phase transitions and dielectric properties in the obtained samples.

$CaTiO_3$ was synthesized in air at 850 ° C by the conventional solid state method. Various chemical compositions 1-x $CaTiO_3$ + x MgF_2 + x LiF were then prepared and dry-ground. The mixtures thus obtained were pressed to pellets and sintered at 900 °C for 2 h. X-ray spectra were recorded at room temperature. SEM observations were performed on fractured ceramics. The phase transitions were investigated between room temperature and 873 K by differential scanning calorimetry. Dielectric measurements were carried out in the temperature range 150 - 773 K at various frequencies:10^2 Hz, 10^3 Hz, 10^4 Hz and 10^5 Hz.

As results, a new oxifluoride solid solution was obtained in the initial composition range $0 \leq x \leq 0.25$. The fluoride mixture MgF_2 + LiF lowered significantly the sintering temperature of $CaTiO_3$ and the ceramic compactness increased with increasing x. Above room temperature, one or two second order phase transitions were detected by DSC. These ones were confirmed by dielectric measurements. Moreover, below room temperature, a frequency dependent peak of the permittivity and the losses was observed. These novel ceramics could be of interest for electronic application.

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