Development of relaxor ferroelectric materials for screen-printing on alumina and silicon substrates

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Abstract

Depending on composition, the solid solutions of Pb(Mn1/3Nb2/3)O3 (PMN) and PbTiO3 (PT) present a combination of the advantages of both relaxor PMN and ferroelectric PT. At low PT content (x¡0.1), (1-x)PMN-xPT exhibits interesting electrostrictive properties, whereas compositions with approximately 30-35% PT exhibit a morphotropic phase boundary and large piezoelectric properties Recently there has been an increasing interest in miniaturized piezoelectric transducers, for example for high frequency medical imaging applications and microactuators. The screen-printing technology was selected because its fast and low-cost production process enables to deposit designed elements on flat substrate. In this paper, we describe a thick films deposited by screen-printing technology on silicon substrates, which can be subsequently micromachined, and on alumina substrates. This study is focused on the (i) optimization of inks composition and heating treatment in order to improve the adhesion properties on ceramic or smooth substrates like Si-wafers, (ii) on the thick film densification and the performance of these films, and (iii) on the influence of the substrate, bottom electrodes and of adhesion layer on thick film processing. The paste was made from different compositions of (1-x)Pb(Mn1/3Nb2/3)O3-xPbTiO3, with 2 and 4 wt.% of Li2CO3 and organic vehicles. Screen-printed thick films were fired at 850950 C for 5 to 10 h either in air or PbO atmosphere (PbZrO3 + PbO). The dielectric properties of these films were investigated. The maximum of relative permittivity of 0.65PMN-0.35PT thick films sintered at 890C during 8h were 8200 and 6000 for films deposited on alumina and silicon substrate, respectively. These values are lower than in bulk ceramics (18000) prepared at a higher sintering temperature (1190C). By an optimisation of the general heating treatment we have obtained thick films with a relative permittivity of 13000.