Morphotropic PMN-PT system investigated through comparison between ceramic and crystal

Gaël Sebald, Laurent Lebrun, Benoît Guiffard, Daniel Guyomar

LGEF, INSA de Lyon, Villeurbanne, France

Abstract

Ferroelectric perovskite ceramics (1-x)$Pb(Mg_{1/3}Nb_{2/3})O_3$-x$PbTiO_3$ were widely studied over the last twenty years, especially ceramics in the morphotropic phase boundary (x=0.3-0.4). More recently a new interest focuses on single crystals of the same composition grown either by Bridgman or flux technique. Giant electromechanical factor k_{31}, piezoelectric coefficient d_{31}, and field-induced strain S_3 were found (k_{31}>0.85,-d_{31}>1000pC/N, S>1%) making them very attractive for non-resonant applications. For resonant applications, despite their medium mechanical factor Q_{31} these materials exhibit higher figure of merit $Q_{31}d_{31}$ than the best PZT ($Q_{31}d_{31}>3.10^5$ for crystal, and $Q_{31}d_{31}>10^5$ for the best PZT ceramic).
However the origin of these outstanding properties is not well understood. The comparison between ceramic and crystal of the same composition (0.67PMN-0.33PT) towards the macroscopic properties was investigated. First the polarisability of materials was studied. Crystal shows an optimum poling electric field, which gives a maximum electromechanical coupling factor and piezoelectric charge. It is believed that this surprising behaviour is due to the domain and phase engineering.
Temperature and electric field stability was investigated for ceramic and crystal for different crystallographic cuts. A discussion is presented on the mechanical losses which are especially unstable.