Ferroelectric Properties of Ceramics in Lead Zirconate Titanate - Lead Magnesium Niobate System

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ABSTRACT

The ferroelectric and piezoelectric properties of xPZT-(1-x)PMN were measured by means of a modified Sawyer-Tower circuit and LVDT strain gage, and d_{33}-meter, respectively. The P-E hysteresis loop measurements demonstrated that the ferroelectric properties of the ceramics in PZT-PMN system changed gradually from the normal ferroelectric behavior in PZT ceramic to the relaxor ferroelectric behavior in PMN ceramic. The s-E relations showed a so-called "butterfly" curve in some compositions, while the relation was of a quadratic electrostrictive nature in the PMN ceramic. Finally, the piezoelectric constant (d_{33}) decreased from, in the units of pm/V, 280 in piezoelectric PZT ceramic to less than 5 in electrostrictive PMN ceramic.

Key words: PZT-PMN, Ferroelectric properties, Hysteresis loops

INTRODUCTION

Lead–based perovskite-type solid solutions consisting of the ferroelectric and relaxor materials have attracted a growing fundamental and practical interest because of their excellent dielectric, piezoelectric and electrostrictive properties which are useful in actuating and sensing applications (Koval et al., 2003). Among the lead–based complex perovskites, lead zirconate titanate ($Pb(Zr_{1-x}Ti_x)O_3$ or PZT) and lead magnesium niobate ($Pb(Mg_{1/3}Nb_{2/3})O_3$ or PMN) ceramics have been investigated extensively , both from academic and commercial viewpoints (Cross, 1996; Haertling, 1999). These two types of ceramics possess distinct characteristics that in turn makes each of them suitable for different applications. With the complementary features of PZT and PMN described in many publications (Wongsaenmai et al., 2003; Yimnirun et al., 2003), the solid solutions between PZT and PMN are expected to combine the properties of both normal ferroelectric PZT and relaxor ferroelectric PMN, which could exhibit better piezoelectric and dielectric properties than those of the single-phase PZT and PMN. Furthermore, the properties can also be tailored over a wider range by changing the compositions to meet the strict requirements for specific applications (Cross, 1987; He et al., 2001). In recent years, there have been several investigations on PZT-PMN system (Shilnikov et al., 1999; Burkhanov et al., 2000; Koval et al., 2003a). However, these previous works have focused only on a few compositions in the vicinity of the morphotropic phase boundary and of the end members. Therefore, the overall