

# Processing, texture quality, and piezoelectric properties of $\langle 001 \rangle$ (C) textured $(1-x)\text{Pb}(\text{Mg}(1/3)\text{Nb}(2/3))\text{TiO}_3$ - $x\text{PbTiO}_3$ ceramics

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Abstract: This paper describes the link between texture quality and electromechanical properties for  $\langle 001 \rangle$  C textured,  $0.03(\text{Na}(1/2)\text{Bi}(1/2))\text{TiO}_3 - 0.97[0.715\text{Pb}(\text{Mg}(1/3)\text{Nb}(2/3))\text{TiO}_3 - 0.285\text{PbTiO}_3]$  ( $0.03\text{NBT}-0.97[\text{PMN}-28.5\text{PT}]$ ) ceramics with and without Mn-doping. Here, the subscript C denotes pseudocubic indices. Textured ceramics were prepared by templated grain growth of PMN-25PT on platelet-shaped  $0.4(\text{Na}(1/2)\text{Bi}(1/2))\text{TiO}_3$ - $0.6\text{PbTiO}_3$  (NBT-0.6PT) templates. Texture fractions of  $f = 0.92$  (for undoped  $(1-x)\text{Pb}(\text{Mg}(1/3)\text{Nb}(2/3))\text{TiO}_3$ - $x\text{PbTiO}_3$  (PMN-PT)) and  $f = 0.49$  (for Mn-doped PMN-PT) were determined by fitting  $002(\text{C})$  XRD pole figures to the March-Dollase model, which was modified to account for symmetry-related  $200(\text{C})$  and  $020(\text{C})$  reflections. Using resonance methods, the elastic constants  $c_{ij}$ ,  $s_{ij}$ , piezoelectric constants  $d_{ij}$ ,  $e_{ij}$ ,  $g_{ij}$ ,  $h_{ij}$ , dielectric constants  $\epsilon_{ij}$ , and coupling coefficients  $k_{ij}$  of textured PMN-PT ceramics were characterized. It was found that the properties of textured PMN-PT approach the single crystal values along the texture axis ( $\langle 001 \rangle$  C, also the poling axis), but not in transverse directions. In particular, the elastic compliance  $s_{11}(\text{E})$  (perpendicular to  $\langle 001 \rangle$ (C)) approaches an average of the single crystal  $s_{11}(\text{E})$  and  $s_{11}(\text{E})(45 \text{ degrees})$  coefficients, resulting in anomalous  $-s_{12}(\text{E})/s_{11}(\text{E})$  ratios of  $-0.01$  and  $0.04$  in pure and Mn-doped textured PMN-PT, respectively. The 33-mode properties as measured by resonance-antiresonance methods were  $d_{33} = 852 \text{ pC/N}$ ,  $k_{33} = 0.83$ ,  $\epsilon_{33} = 3500$ , and mechanical quality factor  $Q(m) = 94$  for undoped textured ceramics and  $d_{33} = 515$ ,  $k_{33} = 0.76$ ,  $\epsilon_{33} = 2200$ , and  $Q(m) = 714$  for Mn-doped textured ceramics.

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