Processing, texture quality, and piezoelectric properties of <001>(C) textured (1-x)Pb(Mg(1/3)Nb(2/3))TiO(3)-xPbTiO(3) ceramics

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Abstract: This paper describes the link between texture quality and electromechanical properties for <001>(C) textured, 0.03(Na(1/2)Bi(1/2))TiO(3) - 0.97[0.715Pb(Mg(1/3)Nb(2/3))TiO(3) - 0.285PbTiO(3)] (0.03NBT-0.97[PMN-28.5PT]) 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(Na(1/2)Bi(1/2))TiO(3)-0.6PbTiO(3) (NBT-0.6PT) templates. Texture fractions of f = 0.92 (for undoped (1-x)Pb(Mg(1/3)Nb(2/3))TiO(3)-xPbTiO(3) (PMN-PT)) and f = 0.49 (for Mn-doped PMN-PT) were determined by fitting 002(C) XRD pole figures to the March-Dollase model, which was modified to account for symmetry-related 200(C) and 020(C) reflections. Using resonance methods, the elastic constants c(ij), s(ij), piezoelectric constants d(ij), e(ij), g(ij), h(ij), dielectric constants e(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 (<001>(C), also the poling axis), but not in transverse directions. In particular, the elastic compliance s(11)(E) (perpendicular to <001>(C)) approaches an average of the single crystal s(11)(E) and s(11)(E)(45 degrees) coefficients, resulting in anomalous -s(12)(E)/s(11)(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 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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