

论文

**Mn掺杂( $K_{0.5}Na_{0.5}$ ) $_{0.96}Sr_{0.02}NbO_3$ 无铅压电陶瓷的研究**

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摘要

采用常压烧结方法制备了Mn掺杂的( $K_{0.5}Na_{0.5}$ ) $_{0.96}Sr_{0.02}Nb_{1-x}Mn_xO_3$ 无铅压电陶瓷.

研究了Mn含量对该体系材料的相组成、微观结构、介电、压电和热稳定性能的影响.

XRD表明随着Mn含量的增加, 体系由正交相过渡到四方相; 而且, 富Na的第二相消失,

得到纯净的钙钛矿相结构. 在Mn含量为 $x=0.03$ 和 $0.04$ 时, 观察到了两个温度( $200$ 和 $390^\circ\text{C}$ )处的介电反常, 这和晶格畸变引起的复晶胞结构有关. Mn含量为 $x=0.02$ 时, 得到综合性能优良的压电超声换能器用材料:介电常数 $\epsilon_{33}^T/\epsilon_0=479$ , 压电常数 $d_{33}=121\text{pC/N}$ , 机电耦合系数 $K_p=41\%$ , 机械品质因子 $Q_m=298$ ,介电损耗 $\tan\delta=1.6\%$ , 居里温度 $T_c=391^\circ\text{C}$ , 谐振频率 $f_r$ 和机电耦合系数 $K_p$ 随温度的变化率 $\alpha_{fr}(80^\circ\text{C})$ 和 $\alpha_{Kp}(80^\circ\text{C})$ 分别为 $-1.85\%$ 和 $1.19\%$ .关键词 [无铅](#) [压电陶瓷](#) [介电](#) [换能器](#)分类号 [TM282](#)**Mn-modified ( $K_{0.5}Na_{0.5}$ ) $_{0.96}Sr_{0.02}NbO_3$  Lead-free Piezoelectric Ceramics**

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Abstract

Dense lead free ceramics of ( $K_{0.5}Na_{0.5}$ ) $_{0.96}Sr_{0.02}Nb_{1-x}Mn_xO_3$  ( $x=0,0.01,0.02,0.03,0.04$ ) were successfully prepared by a conventional mixed oxide method. The X-ray diffraction patterns revealed pure perovskite structure after Mn doping as compared to the original composition. This was attributed to the inhibition of  $K^+$  volatility during sintering process. Dielectric anomaly was observed and explained by multiple-cell structure resulting from Mn-induced lattice distortion. Low loss tangent and relatively high planar electromechanical coupling factor were obtained at  $x=0.02$ . The main parameters for the composition of  $x=0.02$  are:  $\epsilon_{33}^T/\epsilon_0=479$ ,  $d_{33}=121\text{pC/N}$ ,  $K_p=41\%$ ,  $Q_m=298$ ,  $\tan\delta=1.6\%$ ,  $T_c=391^\circ\text{C}$ . The rates of resonant frequency variation,  $\alpha_{fr}$ , and planar coupling factor variation,  $\alpha_{Kp}$ , with temperature are  $-1.85\%$  and  $1.19\%$  at  $80^\circ\text{C}$ , respectively. This material may be suitable for applications in ultrasonic transducers.

Key words [lead free](#) [piezoelectric ceramics](#) [dielectric](#) [transducer](#)

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