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Chemical substitution in spinel structured LiZnNbO_4 and its effects on the crystal structure and microwave performance

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Abstract:

$\text{LiZn}_{1-x}\text{M}_x\text{NbO}_4$ (M=Co, Ni) ($x=0-0.06$) systems were fabricated by a facile solid-state reaction method. Structure and property relationships of spinel structured $\text{LiZn}_{1-x}\text{M}_x\text{NbO}_4$ were investigated systematically. Appropriate amount of Co^{2+} and Ni^{2+} greatly improved the dielectric loss of LiZnNbO_4 ceramics. While, the dielectric loss deteriorated seriously when the doping content exceeded $x=0.02$. The origin of dielectric loss in $\text{LiZn}_{1-x}\text{M}_x\text{NbO}_4$ ceramics was investigated systematically. Moreover, the theoretical dielectric constant and linear expansion coefficient were calculated on the bases of the crystallographic parameters from XRD refinement. The temperature coefficient of resonant frequency calculated by the P-V theory agreed well with the test values. Due to the small doping content, the change in chemical bonds was negligible. Density became the major factor determining the variation of dielectric constant in LiZnNbO_4 ceramics. At last, excellent microwave dielectric properties were obtained: $T_s=1010^\circ\text{C}$, $\epsilon_r=15.25$, $Qf=107,000\text{GHz}$, $\tau_f=-63.3\text{ppm}/^\circ\text{C}$ for $\text{LiZn}_{0.98}\text{Co}_{0.02}\text{NbO}_4$ and $T_s=995^\circ\text{C}$, $\epsilon_r=14.85$, $Qf=104,000\text{GHz}$, $\tau_f=-61.7\text{ppm}/^\circ\text{C}$ for $\text{LiZn}_{0.98}\text{Ni}_{0.02}\text{NbO}_4$.

Keywords: Lattice vibration; Raman; Dielectric loss; Band gap; Linear expansion coefficient

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