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## Pb<sub>2</sub>Nb<sub>2</sub>O<sub>7</sub>-NaNbO<sub>3</sub>-SiO<sub>2</sub>纳米复合材料的制备及其介电性能

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**摘 要:**通过辊压成型及随后的可控结晶过程, 制备Pb<sub>2</sub>Nb<sub>2</sub>O<sub>7</sub>-NaNbO<sub>3</sub>-SiO<sub>2</sub>系纳米复合材料。X射线衍射分析结果表明: 温度为750~900 °C时, Pb<sub>2</sub>Nb<sub>2</sub>O<sub>7</sub>, NaNbO<sub>3</sub>和PbNb<sub>2</sub>O<sub>6</sub>晶相可在玻璃基体中析出; Pb<sub>2</sub>Nb<sub>2</sub>O<sub>7</sub>相在750 °C结晶析出, 850 °C消失; NaNbO<sub>3</sub>为850 °C时的主晶相; 而PbNb<sub>2</sub>O<sub>6</sub>相的晶化温度为850 °C; 由可控结晶技术制备的玻璃陶瓷介电性能受热处理过程中所形成的相组成影响很大; 试样在850 °C退火3 h, 具有最高的介电常数(>600)。微观结构分析结果表明, 残余玻璃相填充在纳米晶粒的晶界处。电镜分析进一步发现, 850 °C退火3 h的试样中不均匀地分布着纳米NaNbO<sub>3</sub>和PbNb<sub>2</sub>O<sub>6</sub>颗粒, 这是材料具有高介电常数的主要原因。

**关键字:** 玻璃陶瓷; 铌酸盐; 介电性能; 显微结构; 电介质

## Preparation and dielectric characterization of nano-composite in Pb<sub>2</sub>Nb<sub>2</sub>O<sub>7</sub> - NaNbO<sub>3</sub>-SiO<sub>2</sub> system

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**Abstract:** The glass-ceramics with nanometer-sized crystals grown in the glass phase in Pb<sub>2</sub>Nb<sub>2</sub>O<sub>7</sub>-NaNbO<sub>3</sub>-SiO<sub>2</sub> system were synthesized to produce bulk materials via roll-quenching followed by controlled crystallization. X-ray diffraction studies indicate that Pb<sub>2</sub>Nb<sub>2</sub>O<sub>7</sub>, NaNbO<sub>3</sub> and PbNb<sub>2</sub>O<sub>6</sub> phases are formed from the as-quenched glass at temperature ranging from 750 to 900 °C. Pb<sub>2</sub>Nb<sub>2</sub>O<sub>7</sub> crystallizes at 750 °C and disappears at 850 °C, NaNbO<sub>3</sub> is the primary phase at 850 °C, while PbNb<sub>2</sub>O<sub>6</sub> forms at a higher temperature of 850 °C. The dielectric properties of the glass-ceramics formed through controlled crystallization have a strong dependence on the phase assemblages developed during heat treatment. The highest dielectric constants (>600) are found in samples annealed at 850 °C for 3 h. Microstructural observation shows that randomly oriented, nanometer-sized crystalline are found with residual glass concentrated at crystallite boundaries. Further studies by scanning tunneling electron microscopy (STEM) in conjunction with energy dispersive spectroscopy (EDS) reveals inhomogeneous distribution of NaNbO<sub>3</sub> and PbNb<sub>2</sub>O<sub>6</sub> in the sample annealed at 850 °C for 3 h and these phases

contribute to the high dielectric constant

**Key words:** glass-ceramic; niobate; dielectric properties; microstructure; dielectrics

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