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Investigation of structure, dielectric and energy-storage properties of lead-free niobate glass and glass-ceramics

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Abstract

Lead-free glass and glass-ceramics in Na_2O-BaO-Nb_2O_5-SiO_2 (mol%) system were successfully synthesized. The tailoring effect of crystallization temperature on the structural, dielectric, and energy storage properties of the material system was investigated. Two types of nano-sized crystalline phases of $Ba_2NaNb_5O_{15}$ and $NaNbO_3$ were formed in succession in the crystallization temperature range from 700□ to 1000□. The crystallinity and size of the crystallites were increased with the increasing crystallization temperature. The dielectric constant demonstrated good thermal and frequent stability. The loss tangent was well controlled below 0.035. At electric field of 10 kV/mm, the highest charged energy density and discharged energy density reached 0.19 J/cm^3 and 0.17 J/cm^3, respectively in the glass-ceramic crystallized at 1000□, indicating the excellent energy storage properties could be tailored by controlling the crystallization temperature.

Key words

Glass-ceramic; Structure; Dielectric; Energy storage; Niobate

1. Introduction

Glsss-ceramic has been deemed as a large family of potential composite material. The particular structure associated with fine grains nucleated and grown in the glass matrix makes them to have great interest in tailoring the various physical properties. A variety of studies were conducted on the promising properties of the glass-ceramics such as the optical[1,2], thermal[3,4], and mechanical[5,6] ones, and so on.