

Preparation and Highly Enhanced Electrocaloric Effect in a Bimodal-Structured 0.9KNbO₃-0.1BaTiO₃ Solid Solution at Room Temperature

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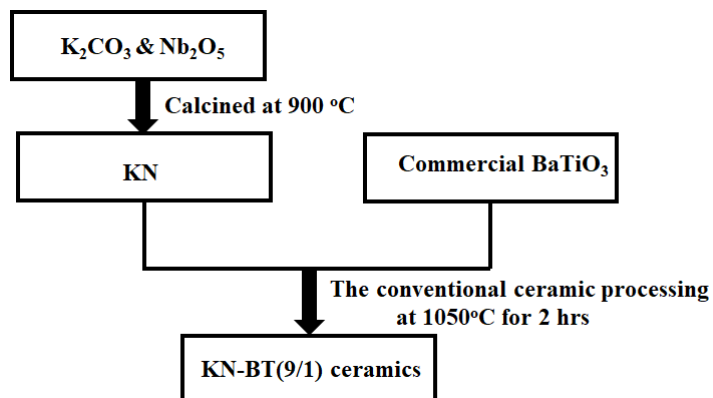
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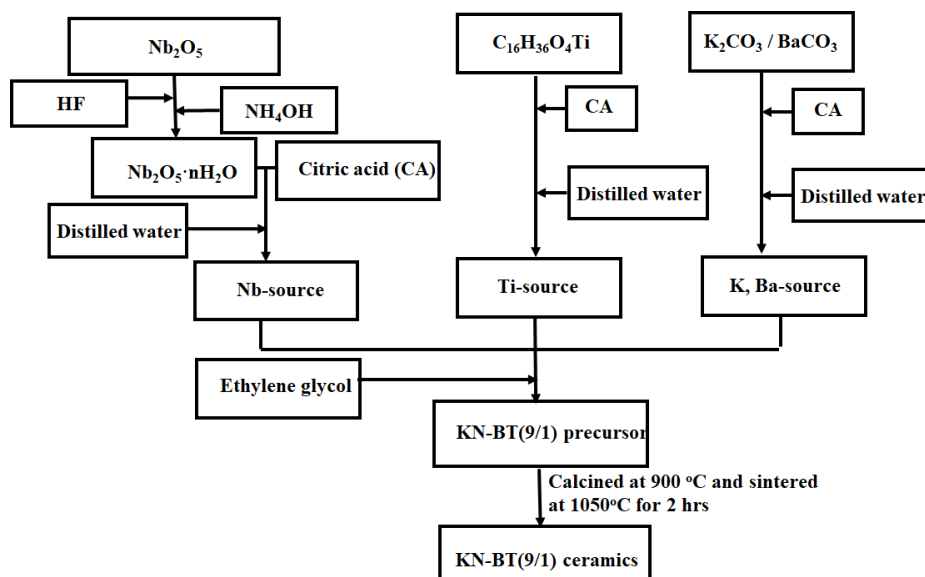
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1. Experimental procedure

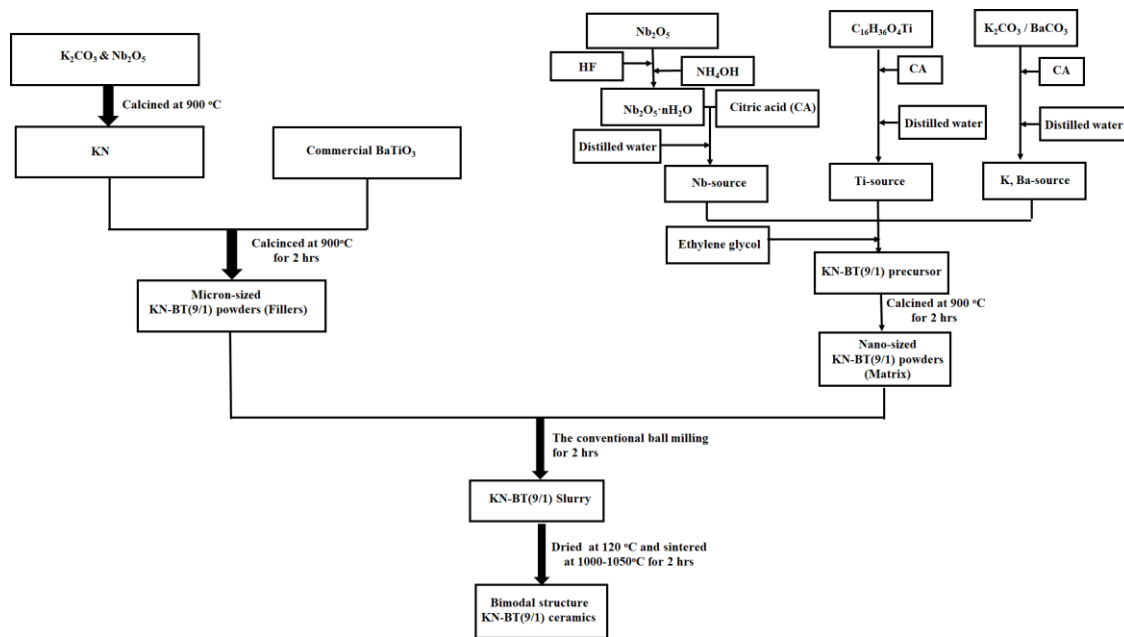
For the preparation of KN-BT (9/1) compound ceramics by the conventional ceramic processing and sol-gel technique were shown in Figs. S1a–b. and Fig. S1–c shows the schematic route of the IAGG method.



(a) The conventional ceramic processing.



(b) Sol-gel technique using the modified Pechini method.



(c) The scheme of an induced abnormal grain growth method (IAGG).

Figure S1. Synthesis routes using (a) the conventional ceramic processing, (b) Sol-gel technique using the modified Pechini method, and (c) The induced abnormal grain growth method (IAGG).

As shown in Fig. S1, for the preparation of the bulk ceramics, all the KN-BT (9/1) green pellets were uniaxially pressed with a diameter of 13 mm and a thickness of about 1 mm at a pressure of 4 MPa in a stainless steel die, and sintered at 1000–1050 °C for 2 hrs in air with a heating rate of 2 °C/min.

2. XRD patterns

Fig.S2 shows the XRD pattern of the bimodal structure of KN-BT (9/1) bulk ceramic sintered at 1050 °C, together with the magnified (200) peak at 2 theta: 44–47°.

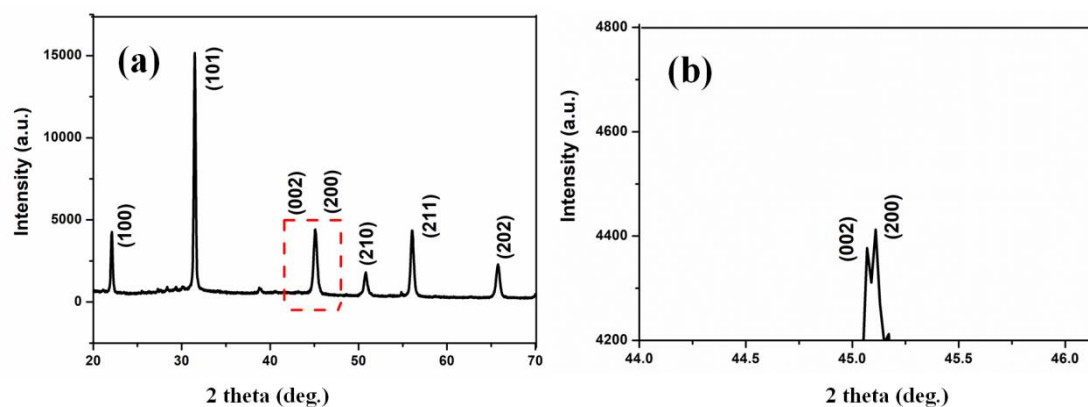


Figure S2. (a) XRD patterns of the bimodal structure KN-BT (9/1) bulk ceramics sintered at 1050 °C using IAGG method. respectively. (b) Zoom-in view of 44–47°. The dash line and arrow are drawn to guide eyes.

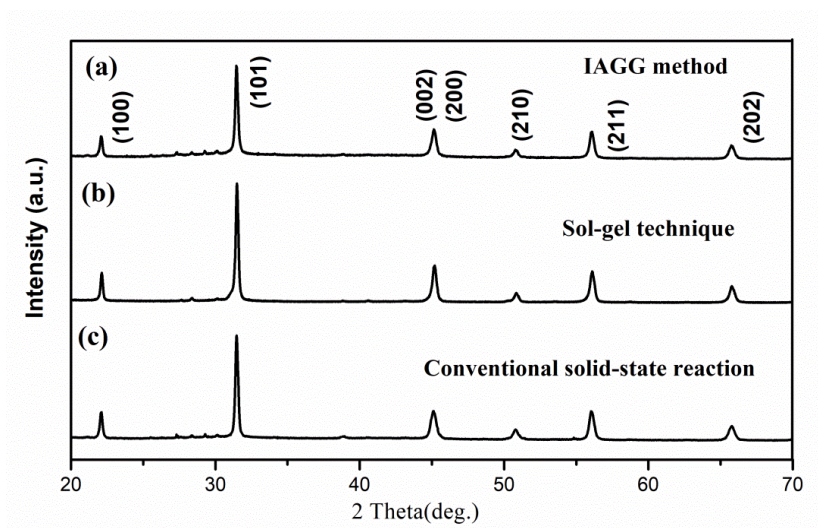


Figure S3. The XRD patterns of KN-BT (9/1) bulk ceramics prepared by the conventional ceramic processing (i.e., solid-state reaction), sol-gel technique and IAGG method at 1050 °C respectively.

3. SEM images

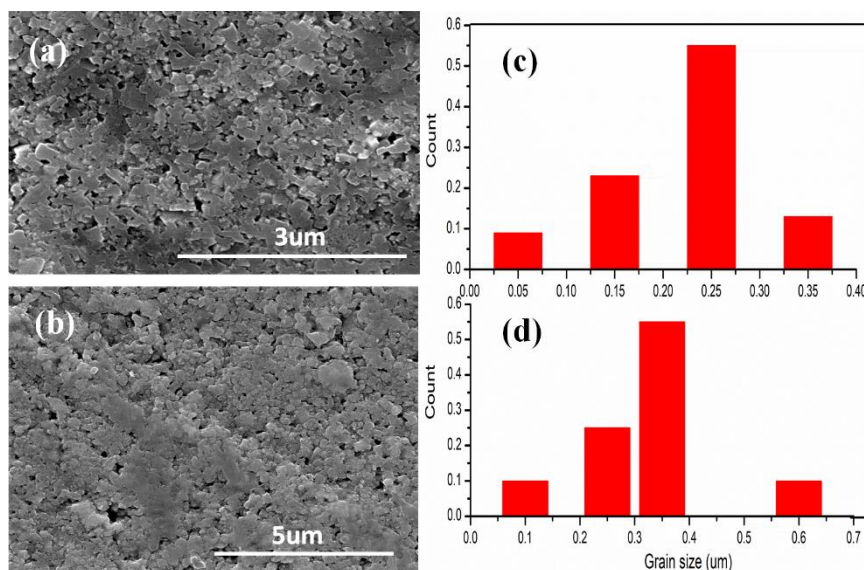


Figure S4. SEM images of the KN-BT (9/1) ceramics prepared at 1050°C by using (a) sol-gel technique and (b) the conventional solid-state processing, (c) and (d) are corresponding to (a) and (b) respectively.

As shown in Fig. S4, the samples showed unimodal structure with the average grain size about 250 nm in Fig.S4(a) and about 300~400 nm in Fig.S4(b) respectively. No abnormal grain growth was observed by the conventional processing, and sol-gel technique.

4. The specific heat capacity

The specific heat capacity is shown in Fig. S5.

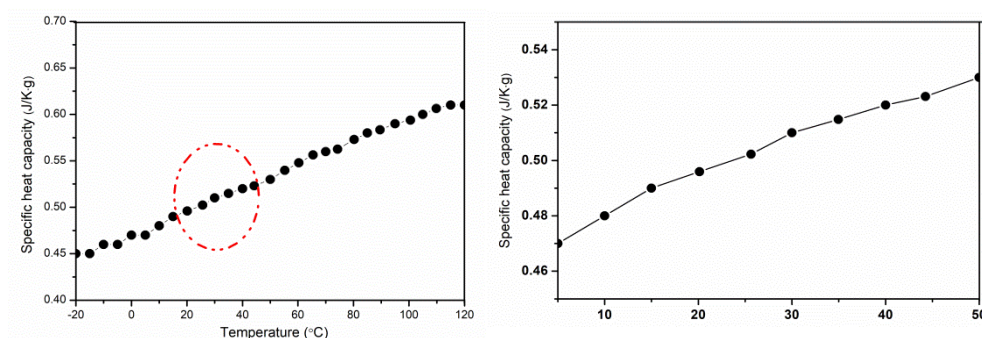


Figure S5. the measured specific heat capacity as a function of temperature, together with the enlarge segment between 10–50 °C. The red dash circle was drawn to guide eyes.

5. P-E loops

Fig. S6 shows the room-temperature PE loops of the KN-BT (9/1) ceramics prepared by the conventional solid state processing、sol-gel technique and IAGG method at 100 Hz. Insets of Fig. S6(a) and (b) show the enlarged segment of PE loops respectively. As shown in Fig. S6(a) and (b), the PE loops exhibited the obvious lossy loop compared with IAGG method at the same electric field strength.

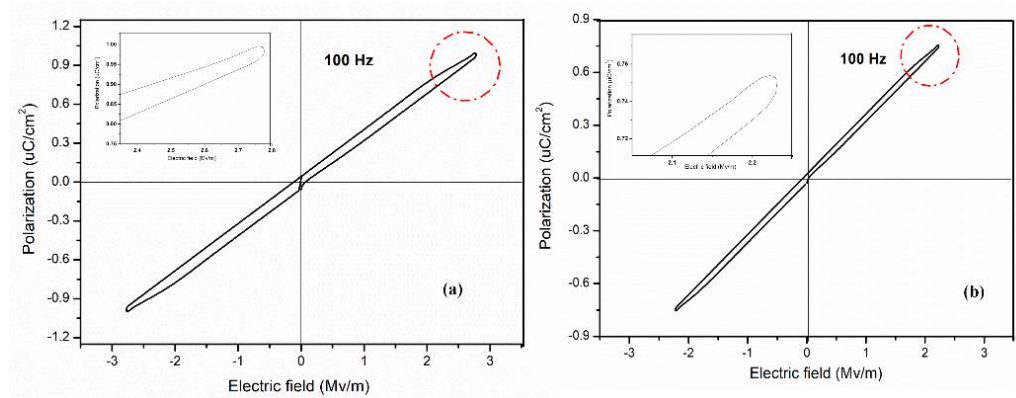


Figure S6. Room-temperature P-E loops of the KN-BT (9/1) ceramics made by using (a) the conventional solid-state processing, (b) the sol-gel technique. The enlarged segments of loops were shown in the insets of Figs. S6(a) and (b) respectively, the red dash circles were drawn to guide eyes.