Supporting information

Metastable cubic phase of sodium niobate nanoparticles stabilized by chemically bonded solvent molecules

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Figure S1. FE-SEM images of the samples synthesized at 220 °C for 4 h with different EG/water ratios: (a) 40/0, (b) 35/5, (c) 30/10, (d) 0/40.

The texture of the NaNbO$_3$ powders prepared with different EG/water ratios observed by FE-SEM, are shown in Figure S1. The cubic NaNbO$_3$ presents a severe degree of aggregation composed of nanoparticles with an average size of ~ 50 nm [Figure S1(a)]. With increasing water content [Figure S1(b-d)], the dispersity of these nanopowders is slightly improved, and their edges could be clearly identified. As the EG/water ratio further increased to 35/5, the average particle size increases to ~100 nm, and some cubic-shaped particles emerge [Figure S1(b)]. In pure water, orthorhombic NaNbO$_3$ presents the cubic morphology with an average size of 2.0 μm [Figure S1(d)].
Figure S2. Hydrothermal synthesis of NaNbO$_3$ with the addition of D-glucose: (a) photographs of the residual solution after reaction with different amount of D-glucose, (b) XRD patterns of the samples synthesized with and without D-glucose, (c) FE-SEM images of the samples synthesized with and without D-glucose.
When different amounts of D-glucose (0 ~ 0.564 g) are introduced into the hydrothermal precursors, there is a change in the appearance of solution after hydrothermal reaction, from transparent to brown [Figure S2(a)]. XRD patterns and FE-SEM images in Figure S2(b) and Figure S2(c) show that the products are orthorhombic NaNbO$_3$ cubes, and the presence of D-glucose has only decreased the particle size. The XRD patterns of NaNbO$_3$ derived from hydrothermal process with the presence of carbon nanoparticles are shown in Figure S3. It remains an orthorhombic structure [Figure S3(a)], and there is only a slight change in the intensity and position of diffraction peaks [Figure S3(b-c)]. This indicates that carbon particles may have changed the relative growth rate of (100) and (110) planes.
Figure S4. (a) XPS survey spectra and (b) high-resolution XPS of Nb 3d core levels detected in orthorhombic NaNbO$_3$ crystals; (c) XPS survey spectra and (d) high-resolution XPS of Nb 3d core levels detected in orthorhombic NaNbO$_3$ crystals. Scattering circles, dark line, gray line and other color lines represent experimental data, fitting data, background and resolved peak, respectively.
Figure S5. Thermal behavior of as-synthesized cubic (dashed line) and orthorhombic (solid line) NaNbO$_3$ powders reflected by DTA (blue line) and TG (red line) as a function of temperature (25 ~1300 °C)

Figure S5 depicts the DTA-TG curves of cubic and orthorhombic NaNbO$_3$ crystals. With the temperature increasing from room temperature to 1300 °C, three distinct weigh losses, at about 100°C, 300 °C and 650 °C are observed in cubic NaNbO$_3$, while for orthorhombic NaNbO$_3$, there is a gent weight loss emerged over the whole temperature range.

Figure S6. FE-SEM images of as-synthesized cubic NaNbO$_3$ powders followed by calcination treatment at (a) 200 °C, (b) 400 °C and (c) 600 °C for 5 h in air.
Figure S7. (a) TEM image of samples calcined at 500 °C for 5 h in air, (b, c) HR-TEM image and (d) FFT patterns of orthorhombic NaNbO$_3$.

Figure S8. FE-SEM images of as-synthesized cubic NaNbO$_3$ powders followed by calcination treatment at (a) 400 °C, (b) 600 °C and (c) 700 °C for 5 h in argon.