Dielektrinės dispersijos metastabiliuose $BiCrO_3$ and $BiCr_{0.9}Sc_{0.1}O_3$ junginiuose ypatumai

Peculiarities of the dielectric dispersion in metastable perovskites $BiCrO_3$ and $BiCr_{0.9}Sc_{0.1}O_3$

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$BiCrO_3$ belongs to the family of perovskite multiferroics which can be produced by high-pressure synthesis route. This compound stabilizes in centrosymmetric *C*2/*c* structure, which reversibly transforms to the nonpolar *Pnma* one at 410 K [1]. This phase transition is accompanied by the dielectric anomaly first reported by S. Niitaka *et al*. [2]. A substitution of Cr^{3+} by Sc^{3+} results in a shift of the transition to higher temperatures and increase of the range of coexistence of the *C*2/*c* and *Pnma* phases [3]. Besides, the negative jump of the unit cell volume upon increasing temperature observed in $BiCrO_3$ [1] becomes bigger in $BiCr_{0.9}Sc_{0.1}O_3$. Therefore, it was interesting to examine these compositions to see how the bigger Sc^{3+} ion distorts the lattice and changes the dielectric and other functional properties.

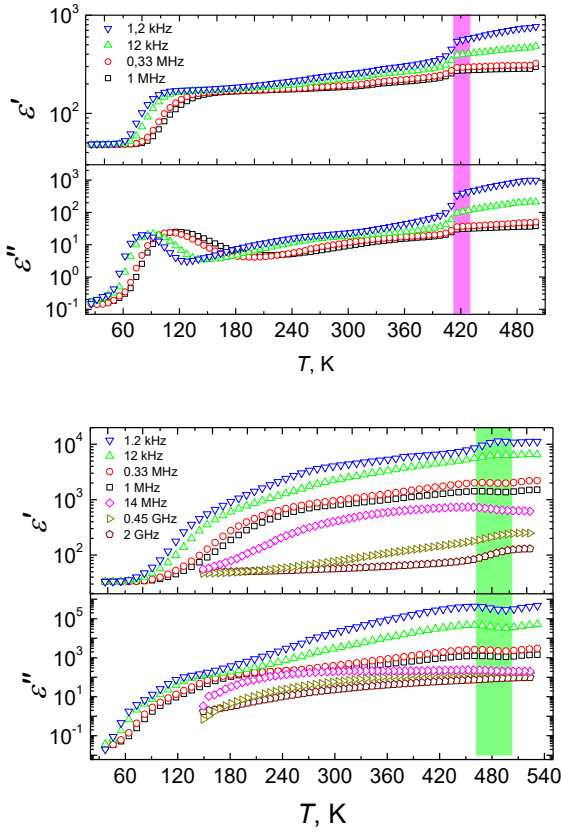
The complex dielectric permittivity was measured with the HP4284A LCR meter and the vector network analyzer Agilent 8714ET in the frequency ranges of 20 Hz – 1 MHz and 2 MHz – 3 GHz, respectively. The temperature range of 40−530 K was covered using a custom made cryostat with a rate of temperature change of 1 K/min.

Dielectric studies have shown a considerable dispersion and big losses for both $BiCrO_3$ and $BiCr_{0.9}Sc_{0.1}O_3$ ceramics. While the dielectric anomaly for $BiCrO_3$ is quite clearly seen, Sc^{3+} substituted compound shows only a weak kink of the dielectric curves in the region of phase transition (1 pav.).

The reason for this is the increased electrical conductivity due to charge accumulation at grain boundaries leading to the Maxwell-Wagner-Sillars relaxation. The electrical conductivity analysis was performed using the Almond−West formalism:

$$\sigma(\omega) = \sigma_{DC} + A\omega^S,$$

from which the frequency-independent (DC) conductivity σ_{DC} was extracted. At temperatures above the phase transition the value of activation energy for $BiCrO_3$ is about 0.31 eV. In phase transition region we see a gradual change in both the values of the DC conductivity and activation energy which increases to 0.49 eV. For $BiCr_{0.9}Sc_{0.1}O_3$ compound the *Pnma*−*C*2/*c* transition is accompanied by an increase in the dc conductivity and a decrease in activation energy from 0.34 eV to 0.23 eV which is the opposite behavior as compared with that of $BiCrO_3$. Anyway, a clear change in the DC conductivity behavior for both compounds at the phase transition temperature is another confirmation of the phase transition in these materials.



1 pav. Temperature dependence of undoped (top picture) and Sc-doped (bottom picture) $BiCrO_3$ at selected frequencies.

Reikšminiai žodžiai: dielectric dispersion, phase transition, metastability, perovskite.

Literatūra

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