

# Synthesis and structure of $\text{Bi}_{0.95}\text{La}_{0.05}\text{FeO}_3$ solid solutions using $\text{Bi}_{1.8}\text{La}_{0.2}\text{Fe}_4\text{O}_9$ as a precursor

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Synthesis of polycrystalline ferrite  $\text{Bi}_{1.8}\text{La}_{0.2}\text{Fe}_4\text{O}_9$ , which is a precursor in the preparation of ferroelectric  $\text{Bi}_{0.95}\text{La}_{0.05}\text{FeO}_3$ , was carried out by solid-state method using  $\text{Bi}_2\text{O}_3$ ,  $\text{Fe}_2\text{O}_3$ ,  $\text{La}_2\text{O}_3$  oxides calcined in the air at  $T = 800^\circ\text{C}$  for 8 hours. Prepared solid solution  $\text{Bi}_{1.8}\text{La}_{0.2}\text{Fe}_4\text{O}_9$  with the structure of the orthorhombically distorted perovskite contained extremely small amount of impurity phase  $\text{BiFeO}_3$ . This may be due to the fact that in the range  $25\text{--}800^\circ\text{C}$   $\text{Bi}_2\text{Fe}_4\text{O}_9$  formation from oxides is thermodynamically more favorable than  $\text{BiFeO}_3$  formation, but these processes are competing. For the synthesis of  $\text{Bi}_{0.95}\text{La}_{0.05}\text{FeO}_3$  ferrite powders of  $\text{Bi}_{1.8}\text{La}_{0.2}\text{Fe}_4\text{O}_9$  precursor and  $\text{Bi}_2\text{O}_3$  oxide were mixed in a stoichiometric ratio according to the reaction:  $\text{Bi}_{1.8}\text{La}_{0.2}\text{Fe}_4\text{O}_9 + \text{Bi}_2\text{O}_3 = 4\text{Bi}_{0.95}\text{La}_{0.05}\text{FeO}_3$  and calcined at three different regimes: I –  $T = 830^\circ\text{C}$ , 30 min; II –  $T = 900^\circ\text{C}$ , 30 min; III –  $T = 900^\circ\text{C}$ , 4 h. At the selection of the synthesis temperature we took into account the temperatures of the incongruent melting of the compounds  $\text{Bi}_2\text{Fe}_4\text{O}_9$  ( $960^\circ\text{C}$ ) and  $\text{BiFeO}_3$  ( $930^\circ\text{C}$ ), which limited the upper limit value of the annealing temperature ( $900^\circ\text{C}$ ). The figure shows the diffraction patterns of the  $\text{Bi}_{0.95}\text{La}_{0.05}\text{FeO}_3$  and  $\text{BiFeO}_3$  samples.  $\text{Bi}_{0.95}\text{La}_{0.05}\text{FeO}_3$  solid solutions were prepared under different heat treatment conditions, as well as non-substituted ferrite  $\text{BiFeO}_3$ , was synthesized by the reaction:  $\text{Bi}_2\text{O}_3 + \text{Fe}_2\text{O}_3 = 2\text{BiFeO}_3$  [1].

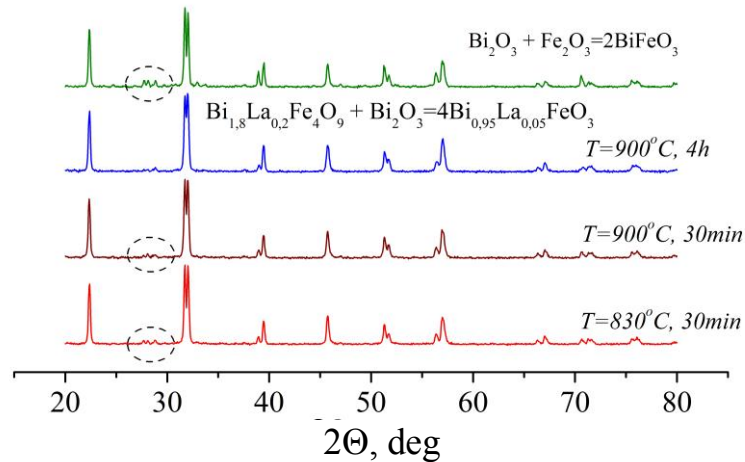


Fig. X-ray diffraction patterns of ferrites  $\text{Bi}_{0.95}\text{La}_{0.05}\text{FeO}_3$  prepared using regimes (I – III) and  $\text{BiFeO}_3$

Analysis of the diffraction patterns showed that  $\text{Bi}_{0.95}\text{La}_{0.05}\text{FeO}_3$  samples had crystal structure of rhombohedrally distorted perovskite, unit cell parameters of which were in a good agreement with the literature data. Note, that diffractograms of the  $\text{Bi}_{0.95}\text{La}_{0.05}\text{FeO}_3$ , heated at  $T = 830^\circ\text{C}$  for 30 min and at  $T = 900^\circ\text{C}$  for 30 min, contained trace amounts of impurity phases such as antiferromagnetic  $\text{Bi}_2\text{Fe}_4\text{O}_9$  of mullite phase and paramagnetic  $\text{Bi}_{25}\text{FeO}_{39}$  of sillenite phase. The regions of existence of these impurity phases are marked by dotted lines in the diffraction patterns. Synthesis conducted at longer heating time (4 h at  $T = 900^\circ\text{C}$ ) led to the production of the practically single-phase  $\text{Bi}_{0.95}\text{La}_{0.05}\text{FeO}_3$  samples. Thus we can conclude that this time-temperature regime is the best for preparation of substituted ferroelectric  $\text{Bi}_{0.95}\text{La}_{0.05}\text{FeO}_3$  using  $\text{Bi}_{1.8}\text{La}_{0.2}\text{Fe}_4\text{O}_9$  as precursor.

## References

1. A.A. Zatsiupa.: Diss. ...PhD: 02.00.04, 02.00.21. Minsk, 2013. 196 p.