# Correlation of the chemical composition, phase content, structural characteristics and magnetic properties of the Bi-substituted M-type hexaferrites

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Abstract: Bi-substituted M-type hexaferrites, BaFe12-xBixO19 (0.1 ≤ x ≤ 1.2), or Bi-BaM, were produced by the solid-state reactions. The correlation between the phase content, chemical composition, crystal structure features, and peculiarities of the magnetic properties of Bi-BaM was established using XRD (X-ray diffraction), SEM (scanning electron microscopy), and VSM (vibrational sample magnetometry). XRD phase analysis made it possible to establish the limit of substitution of Fe3+ ions by Bi3+ ions. It was shown that at a low substitution level ($x \leq 0.3$), no impurity phases were detected, and the samples are characterized by a single-phase state with the space group (SG) P63/mmc. As the degree of substitution ($x \geq 0.6$) increases, the formation of impurity phases was observed, which can be explained by the difficulties of ion diffusion in the process of solid-phase synthesis as well as the formation of defects in the magnetoplumbite structure due to the large ionic radius of Bi3+. As impurity phases in the studied compositions ($x \geq 0.6$) the following were noted: BiFeO3 (SG: Pnma); BiO2 (SG: Fm-3m); BaBi2O6 (SG: R-3); and Ba0.5Bi1.5O2.16 (SG: Im-3m). The content of the main phase (SG: P63/mmc) decreases from 95.11 to 88.27 vol% with an increase in x from 0.6 to 1.2, respectively. Analysis of SEM images showed the growth of particles up to 10 μm, depending on the concentration of bismuth oxide during hexaferrite synthase. The Bi-BaM magnetic characteristics were examined using VSM in the range of 3 T at 300 K. Due to the magnetic structure's frustration, with increased x a decrease in saturation magnetization (Ms) was found. There were two concentration diapasons with different speeds of Ms decrease. In the first diapason, the main contribution belong to the magnetic structure frustration in the frame of the main phase (P63/mmc) due to the long-range Fe-O-Fe exchange interaction weakening (under Bi substitution). In the second diapason, the main contribution belong to the impurity phase formation and decrease of the main magnetic phase concentration in samples.

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