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INVESTIGATION OF RARE-EARTH-DOPED BARIUM-TITANATE CERAMICS

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Investigation of impurity centers and microstructure of $BaTiO_3$ ceramics doped by rare-earth ions Y, La, Nd, Sm, Dy and Lu with concentration 0.001-0.005 were carried out. Electron spin resonance, X-ray diffraction and electron microscopy methods were used for measurements. The most intense ESR lines were shown to belong to paramagnetic complexes Fe^{3+}-V_O and Ti^{3+}-Ln^{3+} (Ln is rare-earth ion, V_O is oxygen vacancy). The change of Fe^{3+}-V_O centers symmetry at transition temperature from ferroelectric to paraelectric phase was revealed for the first time. Measurements of the dependence of ESR line intensities and electrical resistivity on rare-earth ion concentrations were performed. The observed correlation in their behaviour showed an essential role of the revealed paramagnetic complexes in the appearance of $BaTiO_3$ ceramic semiconductor properties and posistor effect. The latter effect was shown to exist at $x \leq x_c$ where $x_c \approx$ 0.002-0.003 is rare-earth ion critical concentration. This concentration was shown to define the rare-earth ion position in the lattice, namely at $x < x_c$ or at $x > x_c$ all these ions, but Lu, mainly substitute for Ba^{2+} or for Ti^{4+} respectively. The influence of the impurities on $BaTiO_3$ microstructure, including the grain sizes, is discussed.