

A study of ferroelectric multilayer structures based on BST films containing high concentration of magnetic ions

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A combination of ferroelectric and ferromagnetic materials allows realizing electronic tuning in ferrite-ferroelectric structures by means of magnetoelectric (ME) and electrodynamic effects (ED). The investigated structure could be realizing as layered ferrite-ferroelectric system as well as heterophase system of the ferroelectric mixed with compounds containing magnetic ions.

This work presents the results of the investigation of influence of Mn ions concentration on dielectric properties of Cu-Cr/BSTO/ α -Al₂O₃ and Cu-Cr/BSTO/GGG film structures and to the results for multilayer structures study such as Cu-Cr/BSTO/YIG/GGG. The films BSTO (Ba_xSr_{1-x}TiO₃; x=0.5–0.6) and YIG (Y₃Fe₅O₁₂) had thickness 0.3–0.5 μ m and 5–8 μ m, respectively. The Mn ion concentration was changed in the region 0 – 20wt%. The measurements of capacitance – voltage characteristics $C(U)$, the dependencies $\tan\delta(U)$ and temperature dependencies $C(T)$ of the planar capacitors were carried out at the frequencies 1 MHz and 29.7GHz. The structure and phase composition of the samples were studied by means of XRD and PIXE (Particle Induced X-ray emission) analysis.

It was shown that presence of Mn additives of 0-2wt% leads to decrease of lattice parameter of BST films. At Mn concentration ~ 2wt% the second phase was detected (Ba,Sr)(Mn,Ti)O_{3-z}. The dielectric permittivity and tunability coefficient K of the investigated structures (K – the ratio of initial capacitance value to the one at biasing voltage) are considerably decreased at Mn concentration increase for the indicated region. The coefficient K equals to 1.2–1.3. However, Mn concentration increase to 15wt% leads to tunability coefficient increase up to ~2.0.

The $C(U)$ characteristics of Cu-Cr/BSTO/YIG/GGG structures was studied in magnetic field with intensity 2000Oe (see Fig.1). Some change of the characteristic is connected with ME effect. The magnetic field applied to the ferrite layer leads to deformation of its crystal lattice due to magnetostrictive effect. Good mechanical contact of YIG and BST films provides a transfer of mechanical tension to ferroelectric layer, where piezoelectric effect takes a place, so the dielectric constant is changed and it is displayed in capacitance value.

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References

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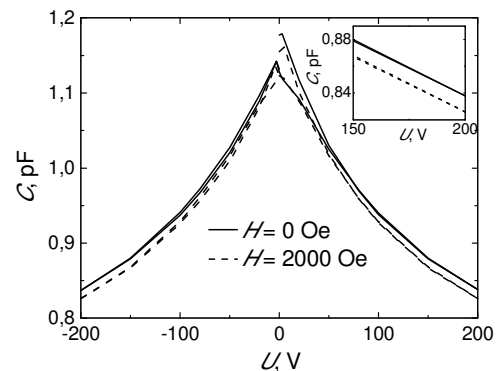


Fig.1. Capacitance-voltage dependence of Cu-Cr/BSTO/YIG/GGG structure