Radioelectronics and Communications Systems
Vol. 47, No. 6, pp. 55–57, 2004

Izvestiya VUZ. Radioelektronika
Vol. 47, No. 6, pp. 77–80, 2004
UDC 537.8.029.6

MAGNETIC SPECTRA OF ALUMINUM-SUBSTITUTED FILMS OF BARIUM HEXAFERRITE

V. I. Kostenko, T. G. Chamor, and L. V. Chevnyuk

T. G. Shevchenko National University, Kiev, Ukraine

The paper represents the first-ever study of aluminum-substituted films of barium hexaferrite $BaFe_{12-x}Al_xO_{19}$, grown on a substrate of strontium hexagallate 400 μ thick. The investigations were carried on by the waveguide method with the aid of measurement lines R1-32 and R1-33. In the course of experiment, the field of the crystal anisotropy H_a, the ferromagnetic resonance linewidth $2\Delta H$, and the resonant field H_{res} have been determined. It is shown that the degree of substitution x affects substantially the crystalline magnetic anisotropy. The H_a magnitude has been raised nearly by 10 000 oersted as compared with non-doped epitaxial films of barium hexaferrite. Comparison of magnetic parameters of pure and substituted epitaxial thin films of barium hexaferrite is performed.

The prospects of using the hexaferrites for creation of devices operating in the range of frequencies from 40 to 140 GHz are related to the possibility of increasing the fields of crysrallographic anisotropy. It seems that application of yttrium iron garnet (YIG) in this range of frequencies becomes practically impossible because of the necessity of operation in strong external constant fields. Moreover, we hardly could find any other materials able to compete with hexaferrites in this range of frequencies [1]. On the other hand, to make possible the operation of devices in this range of frequencies, the materials must have not only a large H_a magnitude, but also a small loss value, i.e. a narrow resonant line of ferromagnetic resonance (FMR). At the present time, hexaferrites rank below YIG (in the best single-crystal spheres or plates, and also in perfect epitaxial films we have $2\Delta H$ = 25–30 kilo-oersted). The possibility of variation of saturation magnetization $4\pi M$ and H_a of hexaferrites makes it possible to vary the range of operating frequencies of devices, where these materials are used in the circuitry. The crystalline anisotropy field of non-doped barium hexaferrite is 17 kOe, while of strontium one — 19 kOe. In literature [2] we can find some information on the properties of titanium- and cobalt-substituted monocrystals of barium hexaferrite in the microwave range of frequencies. Also, the spectra of magnetic oscillations and waves have been investigated as a function of magnitude and direction of the magnetization field H_0 for different degrees of substitution x. As can be seen from experiments, such substitution substantially decreases the H_a value. The magnetic spectra for single-crystal plates of barium hexaferrite with plane-parallel and cylindrical domain structure (the plates were magnetized along the easy axis) were investigated in [3, 4]. In [5] investigations were performed for aluminum-substituted solid monocrystals, enabling us to obtain the relation between the saturation magnetization $4\pi M$ and the substitution parameter x at the room temperature. As can be seen, $4\pi M$ decreases linearly as x grows. As distinct from [5], we were working not with single-crystal plates, but with epitaxial films, which were more promising. By substituting part of the trivalent Fe^{3+} ions by Al^{3+} ions, it is possible to raise the field of anisotropy up to 27 kOe [6] — to pass to a range of higher frequencies and to diminish the saturation field value, but at the expense of widening the FMR line.

The purpose of our work was to study the impact of the substitution parameter x on magnetic parameters of epitaxial films of barium hexaferrite. Investigation of magnetic spectra of the specimens was conducted in the range of frequencies

REFERENCES

1. S. V. Lebedev, Carl E. Patton, and M. A. Wittenauer, J. Appl. Submission, p. 12, October 2001.

2. S. L. Vysotskii, Yu. A. Filimonov, S. A. Nikitov, Ye. Kreizel', and A. Vensan, Radiotekhnika i Elektronika, Vol. 47, No. 9, pp. 1105–1113, 2002.

3. V. I. Kostenko and M. A. Sigal, Phys. stat. sol. (b), issue 170, pp. 569–584, 1992.

4. V. I. Kostenko and M. A. Sigal, Phys. stat. sol. (a), issue 128, pp. 219–234, 1991.

5. Yu. M. Yakovlev and S. Sh. Gendelev, Ferrite Monocrystals in Radioelectronics [in Russian], Sov. Radio, Moscow, 1975.

6. S. R. Shinde, S. E. Lofland, and C. S. Ganpule, Appl. Phys. Let., Vol. 74, No. 4, pp. 594–596, 1999.

8 April 2004