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QUALITY FACTOR OF MAGNETOSTATIC OSCILLATIONS IN (111)-YIG FILMS

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The paper presents results of theoretical study of the intrinsic quality factor for various types of magnetostatic oscillations in ferrite film resonators. The limits of variation of the Q-factor are investigated in the frequency range allowing for existence of the respective oscillation modes depending on the magnetization field.

The intrinsic quality factor of a cavity resonator at a given type of oscillation is defined as the ratio between the real part of the complex proper frequency and the doubled imaginary part of the proper frequency (relaxation frequency) $\omega_k = \omega'_k + i\omega''_k$ [1, 2]:

$$Q_k = \omega'_k / (2\omega''_k). \quad (1)$$

The inclusion of the magnetic loss phenomenon, at variations of magnetization $\vec{M}$ in effective magnetic field $\vec{H}_e$ in some volume of magnetic material, can be performed based on the Landau-Lifshits equation with the relaxation term in Hilbert's form [3]:

$$\frac{\partial \vec{M}}{\partial t} = -|\gamma|\left[\vec{M} \times \vec{H}_e\right] + \frac{\alpha}{M}\left[\vec{M} \times \frac{\partial \vec{M}}{\partial t}\right] \quad (2)$$

where α is the dimensionless attenuation parameter, and γ is the gyromagnetic ratio.

Analysis of (2), with the effective magnetic field and the magnetization being represented as respective sums of their static and dynamic parts, permits us to assert (as a first approximation) that assessment of attenuation in the permeability tensor, deduced for a medium without loss, reduces to a trivial replacement of $\omega_{H_e} = |\gamma| H_e$ by the complex quantity $\omega_{H_e} + i\alpha\omega$ [3].

The simplest type of magnetostatic oscillation (the uniform precession of magnetization in an isotropic ferrite ellipsoid placed into a constant magnetic field directed along the ellipsoid axis) is characterized with the intrinsic quality factor

$$Q_0 = 1/2\alpha = \omega/|\gamma|\Delta H, \quad (3)$$

where ΔH is the measured width of the resonant curve in terms of the magnetic field. This width is evaluated at a fixed frequency of the alternating magnetic field and for variable intensity of the dc magnetic field [2]. Here we assume that all other types of loss are negligibly small compared to magnetic ones.

Rectangular geometric resonators [4, 5] are most widely used among the film magnetostatic resonators. Analysis of the intrinsic quality factor (quality — for brevity) of magnetostatic oscillations in such resonators, with regard for the oscillation type and for the impact of the magnetic crystalline anisotropy, is the subject of this inquiry.

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