STUDY OF TORQUE ACTING ON MAGNETIZATION DURING 180° PULSED REVERSAL PROCESS IN FERRITE-GARNET FILMS WITH BIAXIAL ANISOTROPY

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Abstract. The mode of 180° pulsed magnetization reversal process of ferrite-garnet films with in-plane anisotropy in the external fields region, in which the mechanism of the homogeneous rotation of magnetization takes place, was firstly investigated. Analysis of calculated and experimental longitudinal signals showed that the presence of biaxial anisotropy in real ferrite-garnet film leads to the occurrence of nonlinear damped magnetization oscillations (with a period of the main harmonic of ~1.5 ns).

To calculate the torque acting on the magnetization during the 180° pulsed reversal process in real ferrite-garnet films, in which besides in-plane anisotropy biaxial anisotropy is present, the method based on the analysis of the trajectory of an operating point is used [1]. As the coordinates of the operating point the azimuthal angle φ and the torque component T_p caused by the switching field H_p are used. During the calculations we used the parameters of the real film: saturation magnetization $M_S = 14$ G, saturation magnetization field $H_{sat} = 2.5$ Oe and effective uniaxial, biaxial and in-plane anisotropy fields, respectively: $H_{K1} = 4$ Oe, $H_{K2} = 16K_2/M_S = 36$ Oe and $H_{Kp} = 1100$ Oe. Composition of the film — $(YLuBi)_3(FeGa)_5O_{12}$, thikness $d = 4\ \mu$m. Landau-Lifshitz damping constant λ was equal to $2\cdot10^7$ Hz (in that way the best possible agreement of the calculated and experimental signals occurs). Fig.1 illustrates this

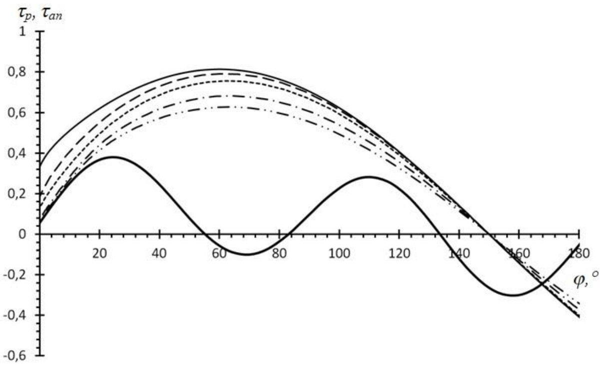

Fig. 1. The normalized components of the torque τ_φ acting on the magnetization vector as a function of the angle φ.

statement. Solid thick line corresponds to the braking torque $\tau_{an} = T_{an}/(M_S\cdot H_{K2})$ (here we use the normalized value of the torque) caused by the uniaxial H_{K1} and biaxial H_{K2} anisotropy and setup field H_0. Other lines correspond to the different values of accelerating torque $\tau_p = T_p/(M_S\cdot H_{K2})$ and applied switching field H_p (= 30 Oe): thin solid line corresponds to the H_p field pulse with rise time of 0.3 ns, dashed line – 0.9 ns, dotted line – 1.5 ns, dash-dotted line – 3.5 ns, dash-dot-dotted line – 6.5 ns. The behaviour of the magnetization vector in this regime is similar to the process of 90° pulsed magnetization of such ferrite-garnet films, which was investigated earlier [2,3]. Thus it has been shown that the «effect of delayed acceleration of the transient process» also takes place during this regime (at the time moment t^* - see Fig.2, where the longitudinal calculated

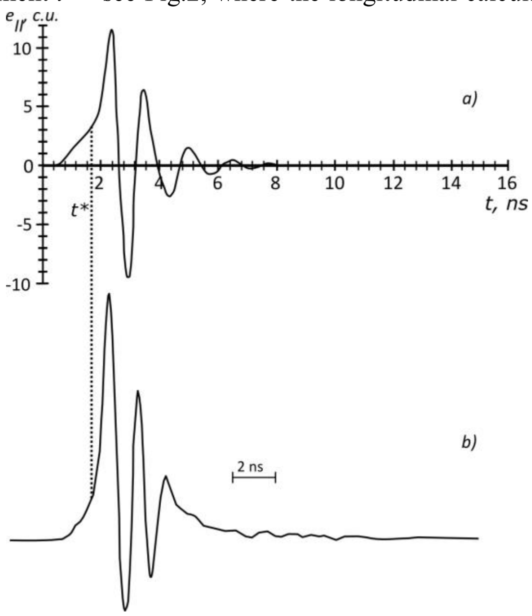

Fig. 2. Longitudinal calculated (*a*) and experimental (*b*) magnetization reversal signals obtained for the H_p field pulse with rise time of 1.5 ns and the value of 30 Oe.

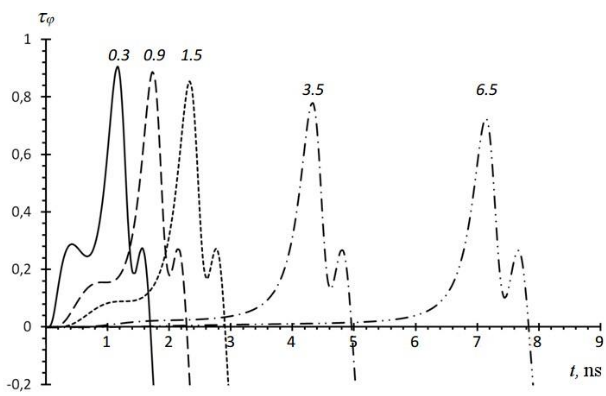

Fig. 3. The time dependences of the torque τ_φ.The numbers above the dependences represent the corresponding front duration values.

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and experimental signals represented). Meanwhile an additional maximum on the resulting torque $\tau_\varphi = \tau_p - \tau_{an}$ is observed (Fig.3). It appears at the moment of excitation of nonlinear magnetization oscillations (with a period of the main harmonic of ~1.5 ns (see Fig.2)) [3], when magnetization reaches easy axis. Its influence is not significant and can be explained by the magnetization's inertia.

Conclusion

Thus, the 180° pulsed reversal process is similar to the 90° pulsed magnetization process in many manifestations: for example, the «effect of delayed acceleration of the transient process» is also observed. Also an additional maximum on the resulting torque is observed. Its influence is not significant and can be explained by the magnetization's inertia.

References

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