ULTRAFAST OPTOMAGNETIC BISTABLE EFFECTS in MAGNETICALLY – ORDERED MATERIALS

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An ultrashort laser pulse (ULP) excites the spin precession in the magnetically-ordered dielectrics, as stated in [1-3]. The spin-reorientation phase transition in orthoferrites can be induced by an ULP and the rise of time of this transition is equal to a few picoseconds [1, 2]. The Landau–Lifshits equation-based description of the reorientation phase transitions dynamics was considered in [4–7]. The generalized coordinate $\sin^2\psi$ expansion was used for the free energy representation:

$$F = F_0 + K_1(T)\sin^2\psi + K_2\sin^4\psi \qquad (1).$$

The summand, which is proportional to the value of {*H(t)M* sinΨ } and corresponds to the interreaction with the field, enters the F_0 term. The parameter ψ is the angle between the magnetization vector and the anisotropy axis and the external field *H(t)*. In the elementary case, the direction of the *H(t)* vector coincides with the axis of all anisotropies; the coefficients $K_1(T)$ and K_2 are the scalar parameters of these anisotropies, whose changing initiates the onset of reorientation phase transitions.
Let us consider the following expansion of the free energy:

$$F = F_0 + K_1(T)\cos^2(\psi - \psi_0) + K_2\cos^4\psi \qquad (2).$$

The free energy representation is due to the fact that the anisotropy axes would be probably nonparallel one another in the general case. The equilibrium magnetization orientation $X = \cos\psi$ is determined by the expression:

$$-16\cdot g^2\cdot X^8 + \left(16\cdot g^2 - 16\cdot p\cdot g\cdot\cos 2\psi_0\right)\cdot X^6 - 8\cdot p\cdot g\cdot X^5 +$$
$$+\left(16\cdot p\cdot g\cdot\cos 2\psi_0 - 4\right)\cdot X^4 + \left(8\cdot p\cdot g - 4\cdot p\cdot\cos 2\psi_0\right)\cdot X^3 + \left(4 - p^2\right)\cdot X^2 +$$
$$+ 4\cdot p\cdot\cos 2\psi_0\cdot X + p^2 - \sin^2 2\psi_0 = 0 \qquad (3),$$

where $p = MH/K_1$ and $g = K_2/K_1$.
We derived the hysteresis dependence of the value X on the external parameter p from expression (3). This hysteresis determines the region for optical bistability observation in the opto-magnetic inverse Faraday effect. This effect may be recorded in the “pump-probe” geometry. The pump is the effective magnetic field of the high-power exciting ULP and the probe is the magnetic polarization of the weak ULP, which is transmitted through the excitation area.

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