Yu.A. Siryuk, A.V. Bezus, V.V. Smirnov

THE ROLE OF MAGNETOSTATIC PRESSURE IN THE MECHANISM OF PHASE TRANSITIONS OF HONEYCOMB DOMAIN STRUCTURE OF FERRITE-GARNET FILMS

The features of two types of honeycomb domain structure (HDS) are experimentally studied at the change of the magnetic displacement field (H) and the temperature (T). HDS is created by the effect of $H < 0$ on the formed lattice of cylindrical magnetic domains (LCD). The field $H < 0$ is aligned with magnetization of saturation within CMD. HDS properties are determined by the method of lattice formation. LCD is formed by the pulse magnetic field which is perpendicular to the film plane: LCD_1 at $H = 0$; LCD_2 at $H \neq 0$. Being formed in such a way, HDS_1 and HDS_2 are rigid because pulse field produces vertical Bloch lines in domain boundaries. Field and temperature effect on phase transitions in HDS are studied in the present work. The conception of magnetostatic pressure is applied to estimation of regularities and peculiarities of the mechanism of the phase transitions. Under H effect, at T = const, the first-order phase transitions (PTs) occur in HDS, when HDS_1 and HDS_2 are transformed from the ordered domain structure to disordered cellular structure with lower number of domains. When the temperature changes, HDS stays in the temperature interval ΔT. At the ends of the interval, the first-order phase transitions take place, being different in the character. The pressure of equilibrium HDS and the character of PT are determined by the sign of the change of the characteristical length of the film l. When $\Delta l > 0$ (at the approach to the compensation point (T_c)), the pressure of equilibrium HDS increases; at $\Delta l < 0$ (at the motion away of T_c) the pressure is reduced. The character of phase transitions in HDS depends on Δl as follows: at $\Delta l > 0$, phase transition to diphase structure with increased number of HDS parameters and conserved domain number occurs; at $\Delta l < 0$, the phase transition forms new HDS with large parameters and lower number of domains.

Keywords: ferrite-garnet film, bubble lattice, honeycomb domain structure, phase transition, magnetostatic pressure

Fig. 1. H–T-diagram of the $(TmBi)_3(FeGa)_5O_{12}$ film: *1*, *2* – $H_c(T)$ CMD, $H_m(T)$; *3*, *5* – $H_c(T)$ LCD_1, LCD_2, respectively; *4*, *6* – $H_b(T)$ HDS_1, HDS_2, respectively, where H_c is collapse field, H_m is the field of transition to the monodomain state, H_b is «blast» field, T_f is the temperature of DS formation, $(T_1 - T_2)$ is the temperature interval of LCD_1, LCD_2 stability at $H = 0$

Fig. 2. The temperature dependences of the saturation magnetization $4\pi M_s$ (*1*) and the characteristic length l (*2*)

Fig. 3. The type of DS at the T = const: *а* – LCD, *б* – HDS, *в* – HDS_1 at H_{b_1}, *г* – «nets», *д* – DS at $H = -120$ Oe, *е* – HDS_2 at H_{b_2}, *ж* – HDS at T_2, *з* – HDS at T_1

Fig. 4. The temperature dependences of P/P_0 of the HDS: ●, ○ – an equilibrium HDS at –35 and –65 Oe; point *A* – the equilibrium HDS at –50 Oe; *AB* and *AD* – the nonequilibrium HDS at –50 Oe