STRIPE STRUCTURE IN ORTHOFERRITES

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Of all the ferromagnets with high Curie temperatures, the orthoferrites are the most transparent to visible light. The authors have shown earlier that in orthoferrites whose magnetic moments are directed along the [001] axis the Faraday effect is quite large and greatly exceeds the analogous effect in iron garnets. We report here the first observation, with the aid of the Faraday effect, of a strictly periodic stripe structure in thulium orthoferrites in the vicinity of the point of reorientation of the magnetic moments. Cylindrical domains and sinuous striped structures [2] with very high domain-wall mobility [3] were previously observed in orthoferrites. Figure 1 shows a photograph of the domain structure in a $TmFeO_3$ plate 110 μ thick obtained at 90° with the aid of the Faraday effect at the wavelength 6328 Å of an He-Ne laser. The orthoferrite plate was cut perpendicular to the optical axis.

The normal to the plate is inclined 47° to the [001] axis in the (100) plane. The domain width is 50 μ and can be readily changed by applying a small external magnetic field, since the anisotropy constant of the orthoferrite becomes small in the vicinity of the reorientation point [4]. Figure 2 shows a photograph of the diffraction of a laser beam by this domain structure. This pattern could be readily observed visually in an undarkened room. From the diffraction angles it is also possible to determine the width of the stripe domain. The maximum diffraction angle observed by us was 1.2°. The diffraction angles, as well as the period of the stripe structure in the vicinity of the reorientation point, could be varied by applying an external magnetic field. This may be of interest for wide-beam deflection systems and possibly for magneto-optical holography. The intensity ratio of the first and zeroth orders is 0.2. This is larger by at least two orders of magnitude than in the case of magneto-optical diffraction by stripe structures of metallic ferromagnetic films and iron garnets. The high contrast of the domain structure and the sharp

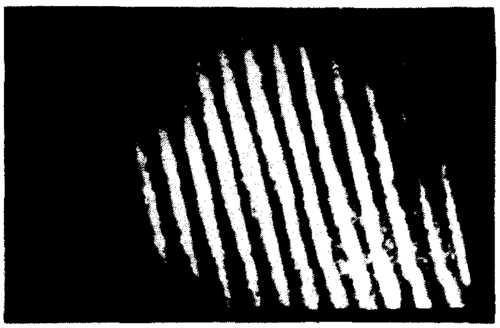

Fig. 1

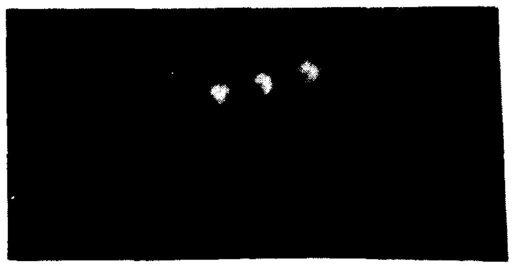

Fig. 2

Fig. 1. Domain structure in $TmFeO_3$ cut perpendicular to the optical axis and obtained with the aid of the Faraday effect. Plate thickness 110 μ, temperature 90°K.

Fig. 2. Diffraction of laser beam λ = 6328 Å by the $TmFeO_3$ domain structure shown in Fig. 1.

diffraction pattern are due to the large Faraday rotation, which amounts to 40° over the thickness of the sample. The absence of the first and succeeding even orders is evidence of good periodicity of the structure. It follows from the theory of diffraction gratings that there should be no even orders other than the zeroth for a grating having a period double the width of the gap [5]. The diffraction picture was observed without an analyzer. An analyzer made it possible to vary the intensity of the zeroth order down to zero. The diffraction angles, as well as the period of the stripe structure in the vicinity of the reorientation point, could be varied by applying small magnetic fields. Analogous stripe structures should be observed also in other orthoferrites, particularly in $Sm_xY_{1-x}FeO_3$ orthoferrites, the reorientation point of which can be readily varied and brought close to room temperature.

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GENERATION OF SHOCK WAVES BY "EXPLODING" CURRENT SHEATH

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In strong-current pulsed discharges such as linear, azimuthal, and inverted pinches, the current sheath serves as a piston trapping the gas. The velocity of the ensuing frontal shock waves is determined entirely by the magnetic pressure on the current layer. Velocities up to (2 - 3) × 10^7 cm/sec were obtained at pressures 1 - 3 Torr. At larger pressures, the velocities are much smaller. Usually two factors limit the velocity at specified current parameters: capture of a large mass of gas prior to the onset of the current maximum and the magnetic pressure maximum, and decrease of the current in the frontal layer as a result of current distribution in the traversed acceleration zone.

When a dense plasma is accelerated in strong magnetic fields and in short nozzles of small diameter [1], the second factor has little effect and when the magnetic piston reaches the end of the nozzle a unique explosion-like rapid expansion of the current sheath occurs, and is of undoubted interest for the generation of intense shock waves. As described in [1], outside the nozzle, outgoing currents that are shunted by the plasma move together with the plasma. The internal electrode has as its continuation the current filament, and the external the plasma shell, as in an ordinary gushing pinch, where azimuthal and longitudinal magnetic fields are produced. Since the bulk of the accelerator gas moves in the direction of the electrode axis with velocity larger than thermal, the outer current sheath is shunted through a layer of unperturbed gas of much lower density and mass than the mass and density of the plasma ejected from the nozzle.

The radial expansion of the current sheath occurs at velocities greatly exceeding the velocity of the longitudinal axial motion. In the described experiments, the plasma piston reached the end of the nozzle at a maximum current 460 kA. The circuit parameters were as follows: Capacitor bank voltage 25 kV,