

the role of the magnetically-hard film reduces to a change in the perfection of the  $\text{FeBO}_3$  periodic structure, which leads to a considerable increase of the anomalous effect.

The dependence of the polarization-plane rotation on the incident-light wavelength was measured in the samples with the sputtered magnetic films. Figure 2 shows the dispersion rotation curve at different magnetization states. Curves 1, 2, and 3 correspond to magnetic fields 0, 1, and 8 Oe applied in the plane of the sample. As seen from the figure, the rotation in the blue part of the spectrum decreases for the saturated states, and increases in fields corresponding to the presence of a regular domain structure along the sample thickness. The apparent reason is that in the latter case the wavelength of the propagating radiation comes close to the inhomogeneity period or to its multiple.

We note that the presence of a regular inhomogeneity in anisotropic media, and in particular a helical configuration of dipole electric moments in cholesteric liquid crystals, gives rise to an anomaly in their optical properties [4].

In conclusion, the authors thank A. S. Borovik-Romanov and E. I. Kats for useful discussions, and V. N. Seleznev for supplying the single crystals.

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1) It should be noted that the magnetization-reversal curve obtained by an inductive method for samples in which anomalies of the magneto-optic effect occur is of similar form.

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#### PREPARATION, SUPERCONDUCTING PROPERTIES, AND STRUCTURE OF TECHNETIUM FILMS

V. M. Golanov, L. A. Elesin, and M. N. Mikheeva

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Technetium films were obtained by the ion sputtering method. The dependence of the critical temperature, resistance, and structure of the film samples on their thickness was investigated. For films of thickness  $d < 150$  Å we observed a new modification, stable at room temperature and having an FCC structure with lattice parameter  $a_0 = 3.68 \pm 0.05$  Å.

An ultrahigh-vacuum installation for ion sputtering (Fig. 1) was used to produce polycrystalline technetium films of thickness from 17 to 1600 Å, which were coated for protection with a synthetic-diamond film 40 Å thick [1]. The installation was outgassed for 10 hours at 250°C, after which the ion sputtering was performed at liquid-nitrogen temperature and at the following partial pressures: krypton  $5 \times 10^{-6}$  Torr; hydrogen  $< 10^9$  Torr; nitrogen, oxygen, and water  $< 10^{-10}$  Torr.

The films were deposited on glass substrates with four platinum leads. Sodium-chloride substrates were used for the structure investigations. Eight pairs of technetium samples of varying thickness were prepared simultaneously. After the end of the sputtering, the samples were heated to room temperature and transferred to a helium cryostat.

We investigated the dependence of the critical temperature of the technetium films on their thickness. The temperature of the superconducting transition ranged from 7.70°K for the thickest films,  $d > 150$  Å (which practically coincides with  $T_c$  of bulky pure technetium, viz., 80°K [2]), to 4.90°K for a film of thickness  $d = 50$  Å.

Figure 2 shows a plot of  $T_c = f(d)$ . It is nonmonotonic and has a discontinuity in the 100 - 150 Å region. At the same thicknesses there is also a jump on the plot of  $R_n(d)$ , where  $R_n$  is the resistance of the sample above the transition temperature.

This behavior of the superconducting-transition temperature and of the resistance of the technetium films can be attributed to the presence of a polymorphic transformation in the thickness range 100 - 150 Å. This is confirmed by electron-diffraction and electron-microscope studies. Figure 3 shows electron micrographs and electron-diffraction patterns of technetium samples with

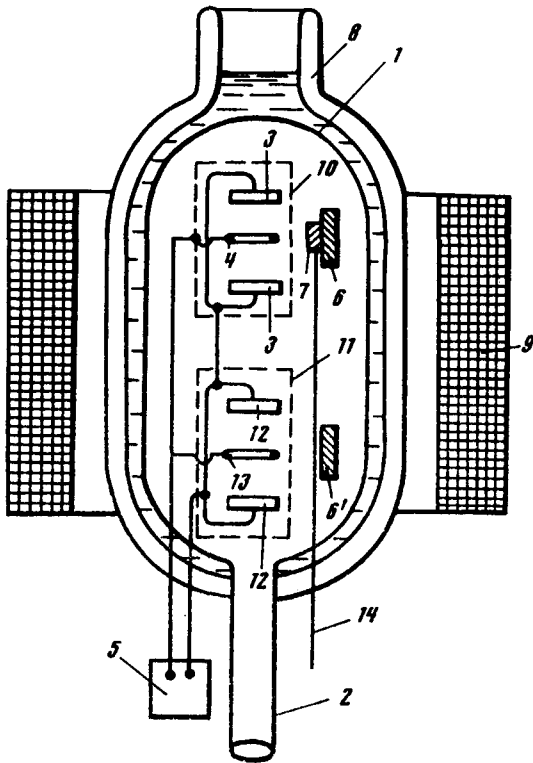


Fig. 1

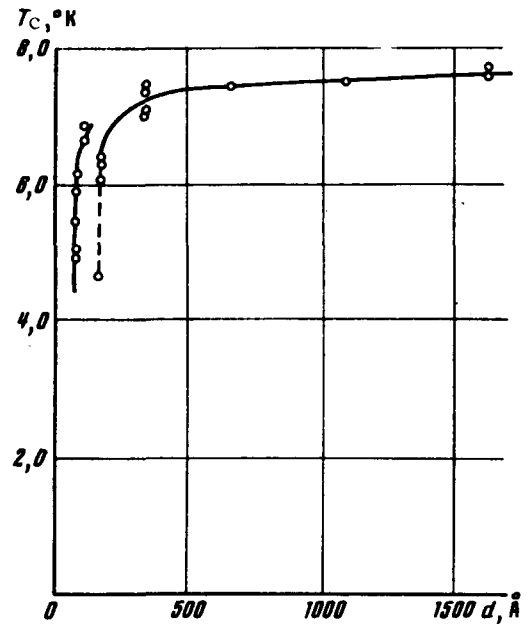


Fig. 2

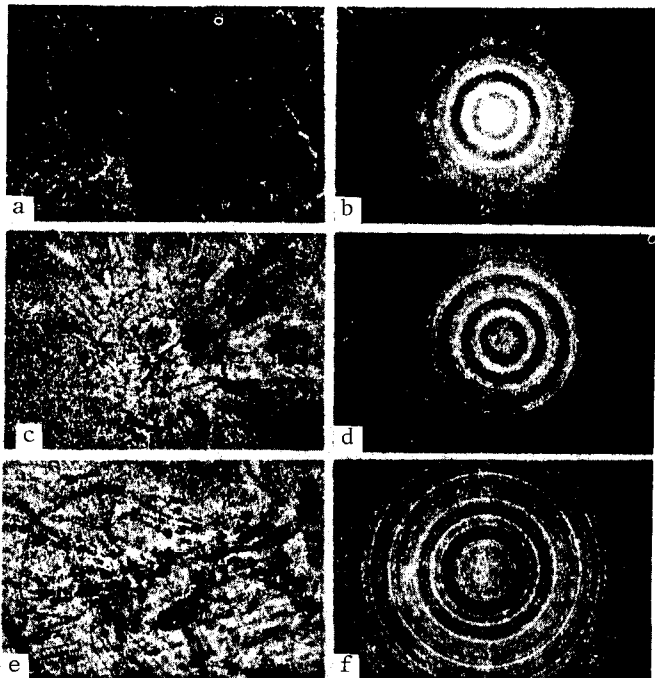


Fig. 3

Fig. 1. Discharge chamber of ion-sputtering setup: 1 - flask, 2 - entrance tube, 3 - graphite cathode, 4 - copper anode, 5 - dc source, 6 - holder, 7 - backing, 8 - Dewar, 9 - solenoid, 10 - upper section for ion sputtering, 11 - lower section of ion sputtering, 12 - technetium cathode, 13 - copper anode, 14 - manipulator.

Fig. 2. Critical temperature  $T_c$  of technetium film vs. the thickness  $d$ .

Fig. 3. Electron micrograms and electron diffraction patterns of Tc films of varying thickness  $d$ : a) 70 Å, 300,000×; b) electron diffraction pattern of sample a; c) 150 Å, 3000×; d) electron diffraction pattern of sample c; e) 600 Å, 25,000×; f) electron diffraction pattern of sample e.

different thicknesses. At  $d > 150 \text{ \AA}$  there is observed the usual HCP structure of bulky technetium, and the lattice parameters of the thick films practically coincide with those of the bulky sample (Table 1). Technetium films with  $d < 150 \text{ \AA}$  have a BCC structure with lattice parameter  $a = 3.68 \pm 0.05 \text{ \AA}$ .

Table 1  
Lattice parameters of HCP technetium modification

Bulky Tc [3]	Tc films ( $d > \text{\AA}$ )
$a = 2.729 \pm 0.001 \text{ \AA}$	$a = 2.732 \pm 0.002 \text{ \AA}^{1)}$
$c = 4.379 \pm 0.001 \text{ \AA}$	$c = 4.381 \pm 0.002 \text{ \AA}^{1)}$

The transformation of the metal from one modification to the other is accompanied by a strong increase in the grain size  $a$  (see Table 2).

Table 2  
Grain size in technetium films with different thicknesses

$d$	17 $\text{\AA}$	35 $\text{\AA}$	50 $\text{\AA}$	75 $\text{\AA}$	150 $\text{\AA}$	300 $\text{\AA}$
$a$	100 $\text{\AA}$	200 $\text{\AA}$	500 $\text{\AA}$	600 $\text{\AA}$	5 $\mu$	5-10 $\mu$

We have thus observed in the films the presence of a face-centered cubic modification that is stable at room temperature at thicknesses  $d < 100 \text{ \AA}$ .

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1) The parameters of the technetium film lattice were determined with a TlCl standard.

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#### GIANT FARADAY EFFECT AND OPTICAL ABSORPTION IN EPITAXIAL FILMS OF THE SYSTEM $Y_{3-x}Bi_xFe_{5-y}Al_yO_{12}$

A. M. Balbashov, A. Ya. Chervonenkis, A. P. Cherkasov, V. E. Bakteuzov, A. A. Tsvetkova, and V. P. Cheparin  
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Single-crystal magneto-uniaxial films of the garnet  $Y_{3-x}Bi_xFe_{5-y}Al_yO_{12}$  were grown by a liquid epitaxy method. The Faraday rotation, the optic extinction coefficient, the magnetic characteristics of the films, and the domain-structure parameters were measured at wavelengths 0.5 - 1.0  $\mu$ . The obtained material was found to have a unprecedented large optical Q factor and a stable cylindrical magnetic domain structure.

An anomalously large level of the Faraday effect (FE) has been observed in single-crystal garnet films of the system  $Y_{3-x}Bi_xFe_{5-y}Al_yO_{12}$ ; it exceeds in the visible band 50,000 deg/cm, which is many times larger than the FE of all known nonmetallic magnets at room temperature. Owing to the large relatively high transparency of the films at wavelengths below 0.5 micron, their magneto-optic Q factor  $\psi$  (the ratio of the specific Faraday rotation  $\phi_F$  to the extinction coefficient  $\alpha$ ) is also unusually large.