substance: EuS
property: crystal structure, physical properties

crystal structure		cubic	(O_h^5 – Fm3m)	
lattice parameters				
a	5.968 Å			72W, 79W
	5.9679(1) Å	T = 298.15 K		74M
melting point				
T_m	2831(16) K			72R
	1940 K			81Z
density				
d	5.750 g cm^{-3}			74M
energy gap				
E_g	≈1.5 eV	4f-cond. band	X-ray spectroscopy	82G
	3.4 eV	val.-cond. band	(K, $L_{2,3}$-emission, K-absorption) Fig. 16	
	2.3 eV	$3p^6$ – 5d, 6s trans. (Fig. 12)		75M
	1.65 eV	4f – 5d trans. (Fig. 12)		71G, 72W
dE_g/dp	– 7.9 meV kbar^{-1}	opt. absorption (4f – 5d) trans.		69W
bulk modulus				
B_0	560(60) kbar			70L
	500(75) kbar	T = 77 K		71S
	610(50) kbar			74J
linear thermal expansion coefficient				
α	14.2·10^{-6} K^{-1}			66D
	12.6·10^{-6} K^{-1}			69L
elastic moduli				
c_{11}	13.1(5)·10^{10} Pa	T = 77 K		71S,
c_{12}	1.1(8·10^{10} Pa	T = 77 K		72S1
c_{44}	2.73(11)·10^{10} Pa	T = 77 K		
compressibility				
κ	1.1·10^{-11} Pa^{-1}			70L
sound velocity				
$\upsilon_{[100]}$	4.74·10^5 cm s^{-1}	T = 77 K		71S
$\upsilon_{[110]}$	4.09·10^5 cm s^{-1}	T = 77 K		

Debye temperature

Θ_D	280 K			66D
	276 K			71S
	262 K			63M, 72S1

heat capacity

C_p	50.96 J mol^{-1} K^{-1}			74M

phonon wavenumbers

$(\nu/c)_{TO}$	178.4 (20) cm^{-1}		IR measurements; for Raman	69A
	186.5 cm^{-1}	T = 2 K	scattering, see [79S, 80S]	73I
$(\nu/c)_{LO}$	266.5(18) cm^{-1}			69A
	278 cm^{-1}	T = 2 K		73I

dielectric constant

$\varepsilon(0)$	11.1(15)			69A
	11.1			74G
$\varepsilon(\infty)$	4.9			68W
	4.7(2)			69A
	4.7			74G

refractive index

n	2.42	at 4f – 5d absorption edge		71G

f-d transition energies

E(4f – 5d)	1.65 eV	edge		71G
E(4f – 5d)	2.42 eV	maximum (Fig. 12)		75S

absorption coefficient

K	1.46·10^5 cm^{-1}	max.4f – 5d trans.		75S

oscillator strength

f	0.18		oscillator strength of 4f – 5d transitions	71G

f-d transition width

W(4f – 5d)	0.7 eV		width of 4f – 5d transition	71G

photothreshold

E_{thr}	4 eV		ionization energy (photothreshold)	76M

work function

ϕ	3.3 eV		work function	76M

electrical conductivity

σ	$\approx 10^{-9}\ \Omega^{-1}\ cm^{-1}$		71B
	$6...60\ \Omega^{-1}\ cm^{-1}$		72S2
	$60...700\ \Omega^{-1}\ cm^{-1}$	$T = 4$ K	

electron concentration

n	$0.5...1 \cdot 10^{19}\ cm^{-3}$	72S2

electron mobility

μ_n	$30\ cm^2/V\ s$	72S2

Figures and further references:

phase diagram: Fig. 1

lattice parameter vs. temperature: Fig. 2

band structure Figs. 3, 4

density of states: Fig. 12; APW calculation [81F]; MO calculation [81Z]

real and imaginary part of the **dielectric constant**: Figs. 14, 5

absorption spectrum: Fig. 13

photosensitivity: Figs. 6, 15

soft **X-ray emission and absorption spectra**: Fig. 7

X-ray spectroscopy: Fig. 16

bulk and surface states [82M]

temperature dependence of **resistivity**: Fig. 8, temperature dependence of resistivity at different magnetic fields: Fig. 9

electron-magnon interaction [82A]

magnetic field dependence of **Hall coefficient**: Fig. 10

temperature dependence of **mobility**: Fig. 11

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Fig. 1.

EuS, Eu_3S_4. Tentative phase diagram for the Eu – S system determined by X-ray diffraction [74A].

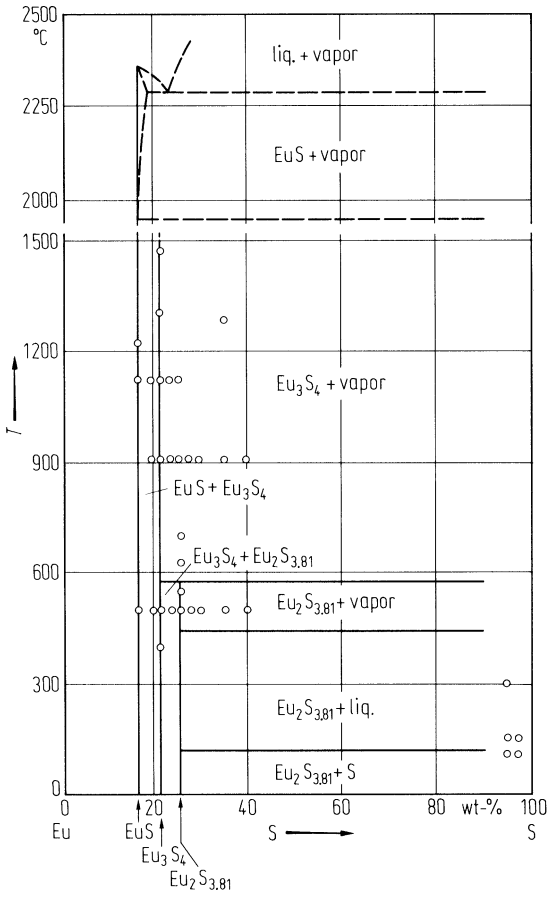

Fig. 2.

EuS. Lattice parameter vs. temperature [69L].

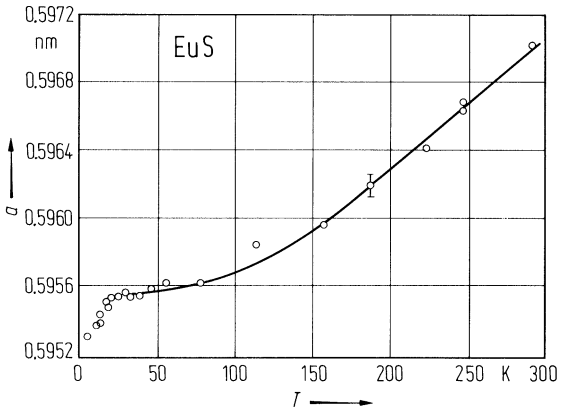

Fig. 3.

EuS. Energy band structure. Solid lines for up-spin electrons, dashed lines for down-spin electrons [70C].

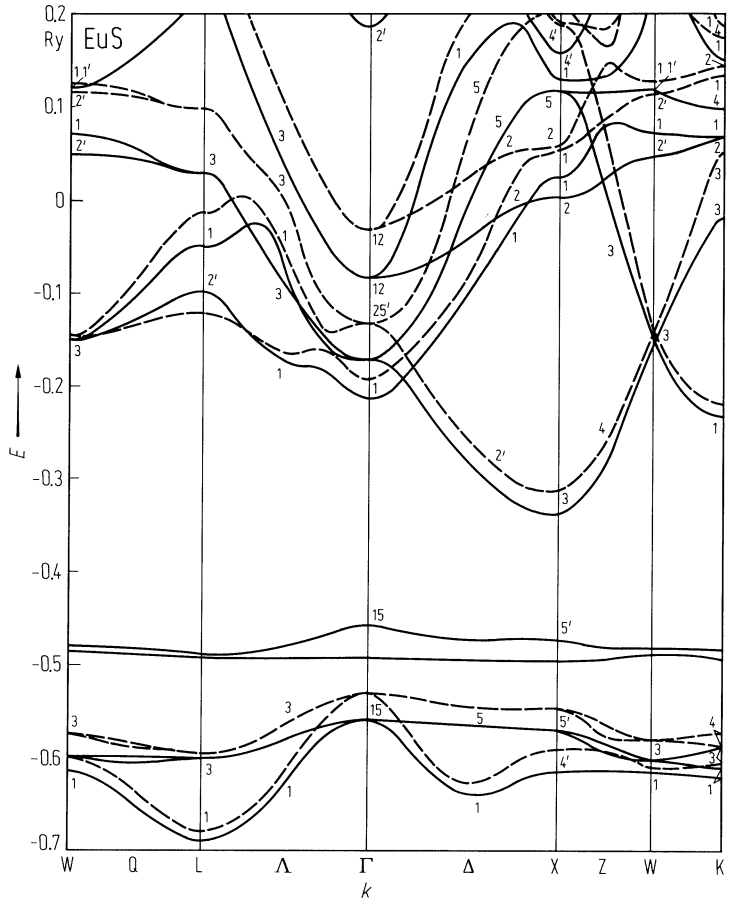

Fig. 4.

EuS. Spin polarized energy bands: (a) spin-up, (b) spin-down [81F].

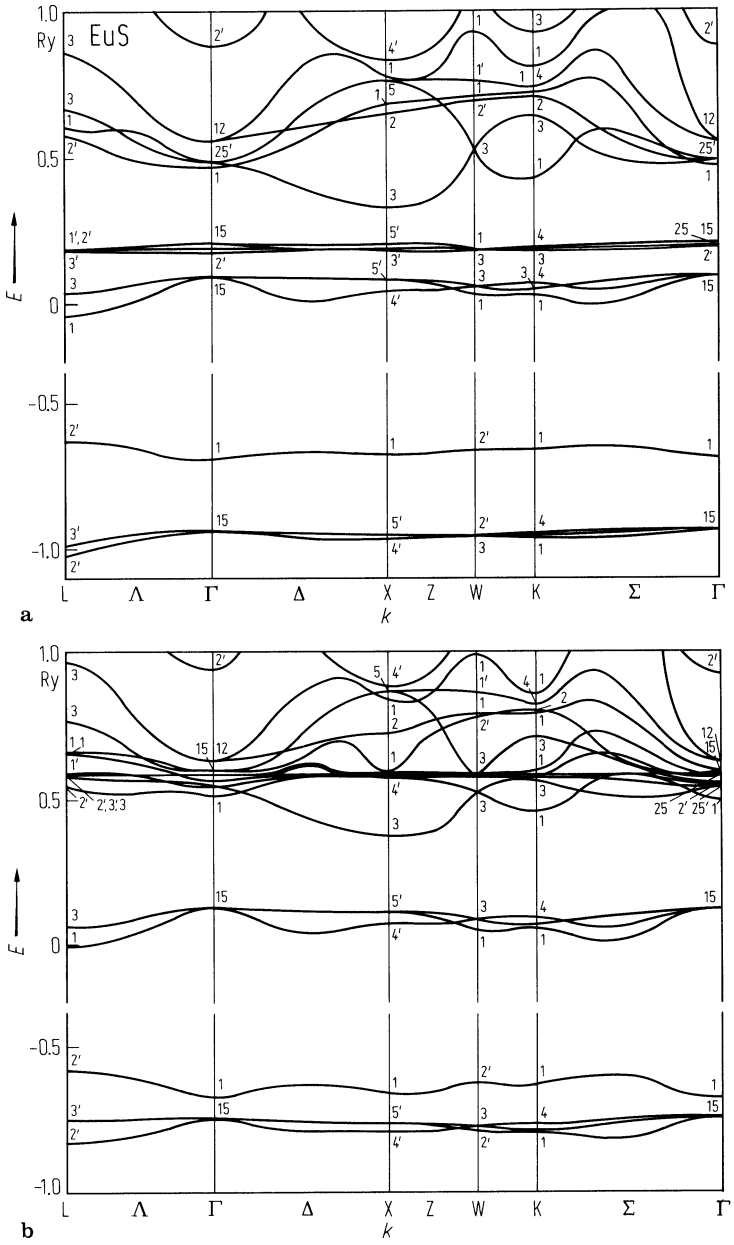

Fig. 5.

Eu-chalcogenides. Imaginary part of the dielectric constant vs. photon energy at 300 K [74G].

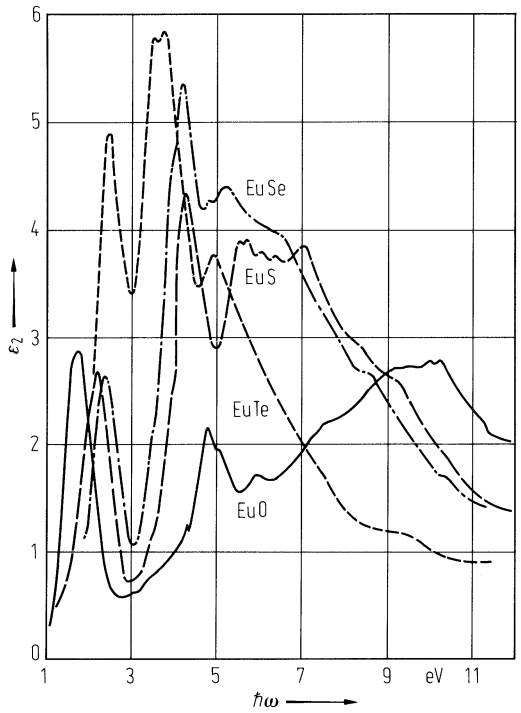

Fig. 6.

EuS. Normalized photosensitivity vs. photon energy for two temperatures. Also shown is the photosensitivity at 6 K for light polarized parallel and perpendicular to the direction of the magnetic field [72W].

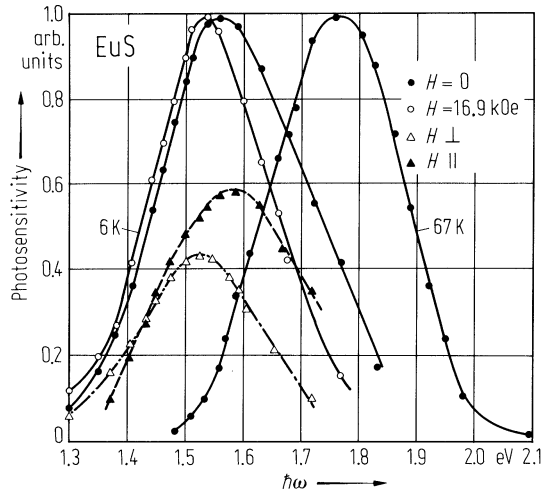

Fig. 7.

EuS. Soft X-ray M_{IV} and M_V emission spectra (optical density (d_{opt}) and emission intensity (I) vs. photon energy) of a thin film ($3d^{10}4f^7 \rightarrow 3d^9 4f^8$) [75M].

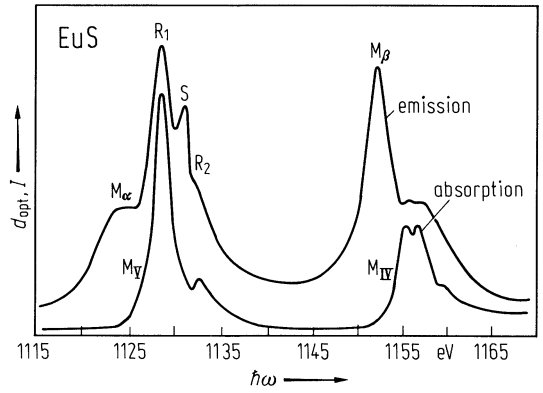

Fig. 8.

EuS. Resistivity vs. temperature. The insert shows the resistivity vs. temperature in a linear scale near the resistivity minimum [72S2].

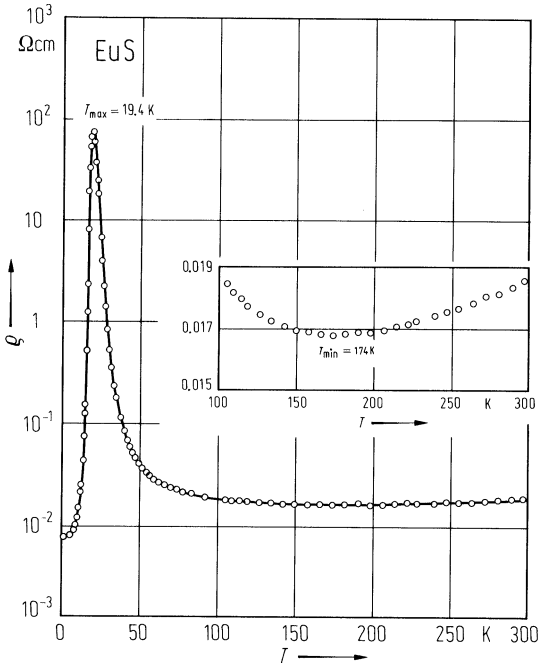

Fig. 9.

EuS. Resistivity vs. temperature at several applied magnetic fields for an Eu-rich sample [72S2].

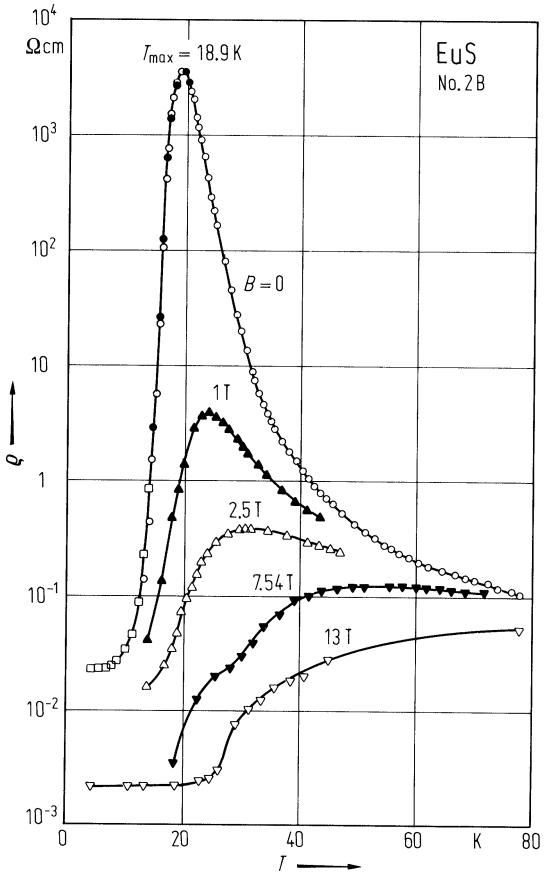

Fig. 10.

EuS. (External) magnetic field dependence of the Hall coefficient for an n-type sample. Charge carrier density is of the order of 10^{19} cm^{-3}. Note the hysteresis at 4.2K [72S2].

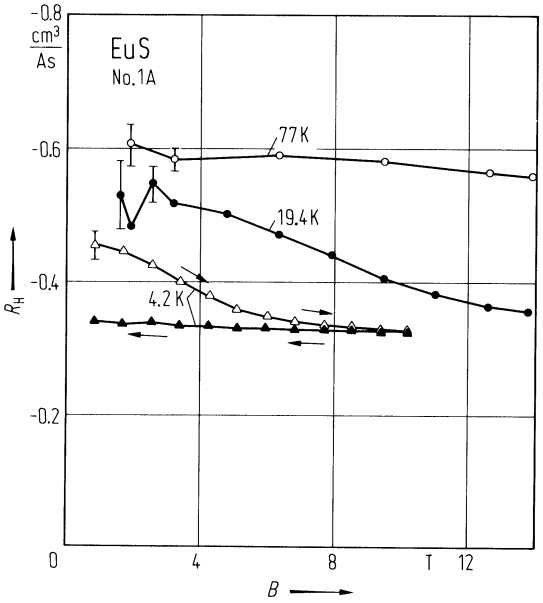

Fig. 11.

EuS. Calculated spin-dependent effective mobility as a function of temperature. The dashed curve gives the Boltzmann result for spin-up electrons in the spin-polarized subband model [83E].

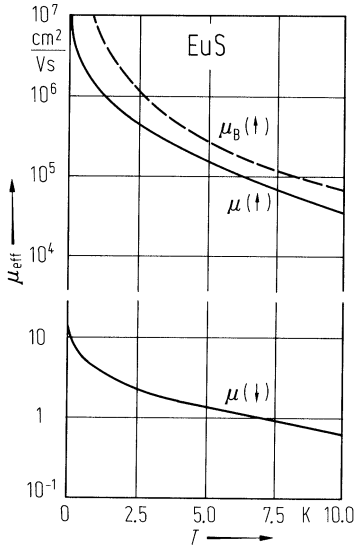

Fig. 12.

Eu-chalcogenides. Schematic density of states [79W].

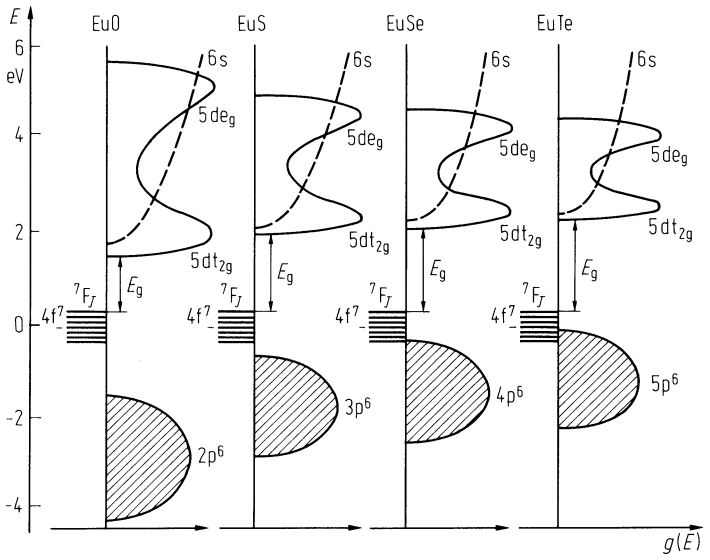

Fig. 13.

Eu-chalcogenides. Absorption coefficient vs. photon energy at 300 K, from reflectivity measurements [74G].

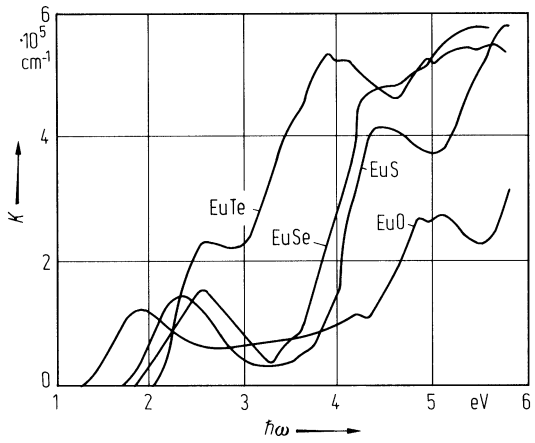

Fig. 14.

Eu-chalcogenides. Real part of the dielectric constant vs. photon energy at 300 K [74G].

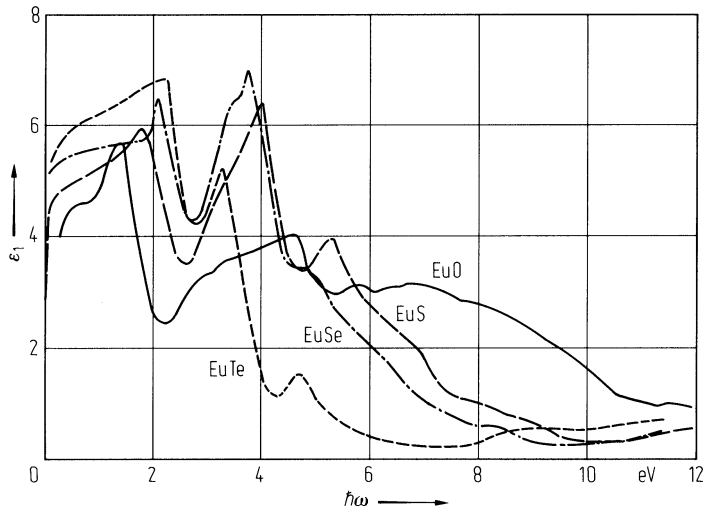

Fig. 15.

Eu-chalcogenides. Photosensitivity (photo current / light intensity) vs. temperature. The exciting wavelength is kept at the maximum of the photo-response [72W].

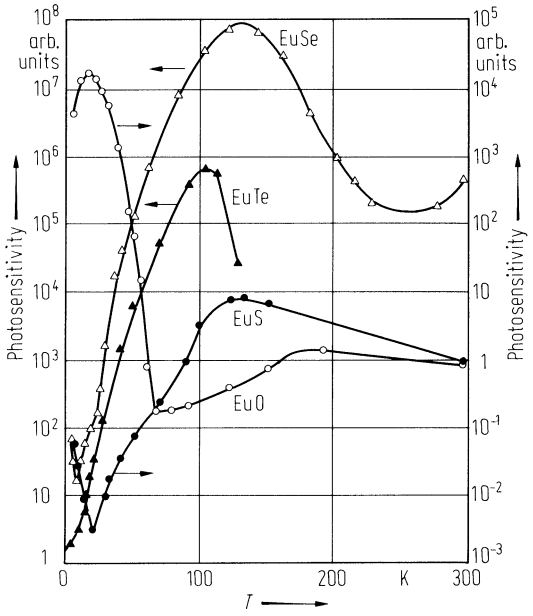

Fig. 16.

RS. X-ray spectra of EuS (semiconductor) and LaS (metal) [82G]. Energy band diagrams for comparison. Energy zero is at E_F for LaS and at the middle of the forbidden energy band for EuS.