**substance: SmS**
**property: crystal structure, physical properties**

| | | | | |
|---|---|---|---|---|
| **crystal structure** | cubic ($O_h^5$ – Fm3m) | | | |
| **lattice parameter** | | | | |
| $a$ | 5.97 Å | | | 73J2, 75J, 77M |
| **melting point** | | | | |
| $T_m$ | 2210 K | | | 72G |
| **energy gap** | | | | |
| $E_g$ | ≈0.4 eV | 4f-cond. band | X-ray spectroscopy | 82G3 |
| | 3.4 eV | val.-cond. band | (K, $L_{2,3}$-emission, K-absorption) X-ray spectrum: Fig. 1 Resistivity vs. pressure: Fig. 2, Hall constant vs. pressure: Fig. 3, Hall mobility and magnetoresistance vs. pressure: Fig. 4, Energy gap vs. pressure: Fig. 5 | |
| | 2.3 eV | $3p^6$-$5^d$, 6s trans. | | 78S2 |
| | 0.06 eV | 4f-cond. band | | 72K |
| | 0.2 eV | 4f-5d trans. | | 70J |
| | 0.24(1) eV | 4 f-cond. band | | 78S2 |
| $dE_g/dp$ | – 10 meV/kbar | opt. absorption (4f-5d trans.) | | 73J1 |
| **bulk modulus** | | | | |
| $B_0$ | 150 kbar | | | 72C |
| | 470 kbar | | | 76D |
| | 476 kbar | | | 78M |
| **Debye temperature** | | | | |
| $\Theta_D$ | 247 K | | | 76M |
| | 155(7) K | | | 77S |
| **elastic moduli** | | | | |
| $c_{11}$ | 1200 kbar | | | 76D |
| | 1270 kbar | | | 82S1 |
| $c_{12}$ | 110 kbar | | | 76D |
| | 120 kbar | | | 82S1 |
| $c_{44}$ | 250 kbar | | | 76D |
| | 269 kbar | | | 82S1 |
| $dc_{11}/dp$ | 10.4 | | | 82S1 |
| $dc_{12}/dp$ | – 1.6 | | | |
| $dc_{44}/dp$ | – 0.08 | | | |

**electrical conductivity**

| | | |
|---|---|---|
| $\sigma$ | $10^2...10^3\ \Omega^{-1}\ cm^{-1}$ | 70J |
| | $20...30\ \Omega^{-1}\ cm^{-1}$ | 78S2 |

**electron mobility**

| | | |
|---|---|---|
| $\mu_n$ | $20...25\ cm^2/V\ s$ | 78S2 |

*Further figures and references:*

**lattice parameter** of $Sm_{1-x}Gd_xS$: Fig. 6; for $Sm_{1-x}R_xS$ with R = Ce, Ho, Er, Tm, Lu: Fig. 7
*pT*-diagram: Fig. 8

**lattice parameter** vs. pressure: Fig. 9

**band structure** and density of states: Figs. 10, 11; band structure under pressure [80F]; band structure of the metallic and semiconducting phase: Fig.12; band structure and electron-electron interaction [81F]; s-type conduction band [78K], relativistic ab initio band structure calculation [83N]
intermediate valence and **semiconductor-metal transition** [78S2, 80G, 80K, 76M, 81G1, 81L1, 81K2, 81L2, 81A, 81B, 82G1, 82M2, 82T2, 82S2]

**reflectivity** spectrum: Fig. 13

**dielectric constant**, imaginary part $\varepsilon_2(\omega)$: Fig. 14

**optical properties of thin films** [78G1]

**photoemission spectrum**: Fig. 15

**phonon dispersion curves**: Fig. 16

**Raman spectra** [78G2]

**photoelectron spectra** [82M1]

**inelastic electron scattering** [82C]

**L$\gamma_1$ emission spectra** [82T1]

**thermoreflectance spectra** [81M]

**stress dependent carrier density** [81K2]

**resistivity**: pressure dependence of resistivity: Fig. 17; temperature dependence of resistivity: Fig. 18

temperature dependence of **Hall coefficient**: Fig. 19

temperature dependence of **carrier mobility:** Fig. 20

**electron tunneling** [82G2]

**electron phonon coupling** [81G2]

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**Fig. 1**.

SmS. X-ray spectrum [84G]. Curve *1*: emission of S $L_{II, III}$-band (*A*: S s-states, *C*: S d states); *2*: fluorescence of K band of S. (*B*: S p-states, *D*: mixt. of S p-states and Sm f-states); *3*: Photoemission (*a*: S s-states, $b_1$: S p-states, $b_{2, 3}$: Sm f-state multiplet); *4*: K-absorption edge of S.

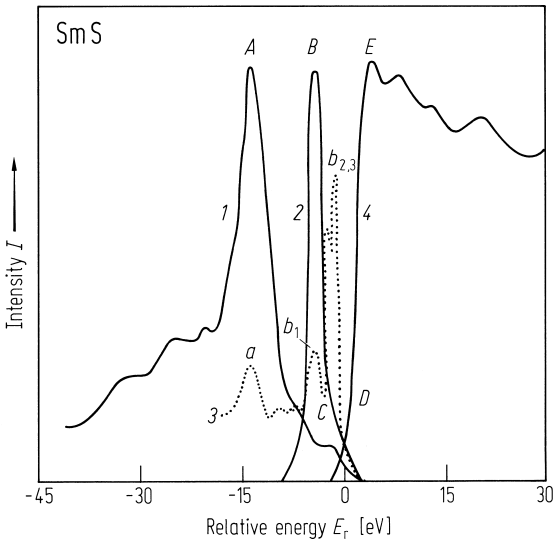


**Fig. 2**.

SmS (lattice constant $a = 5.9684$ Å). Resistivity $\rho$ vs. pressure $p$. Insert: Resistivity vs. temperature at $p = 0.4$ GPa [80M].

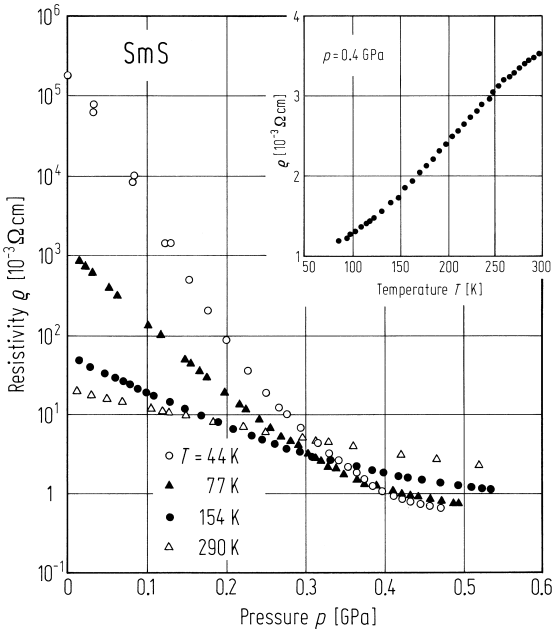


**Fig. 3**.

SmS (lattice constant $a$ = 5.9690 Å). Hall constant $R_H$ vs. pressure $p$ [80M].

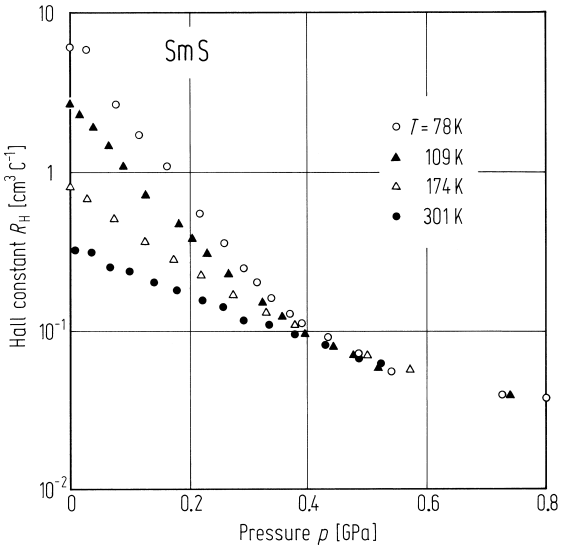


**Fig. 4**.

SmS (lattice constant $a$ = 5.9690 Å). Hall mobility $\mu = R_H \rho^{-1}$ and magnetoresistance coefficient $\alpha = -\Delta\rho\,\rho^{-1}B^2$ vs. pressure $p$ [80M].

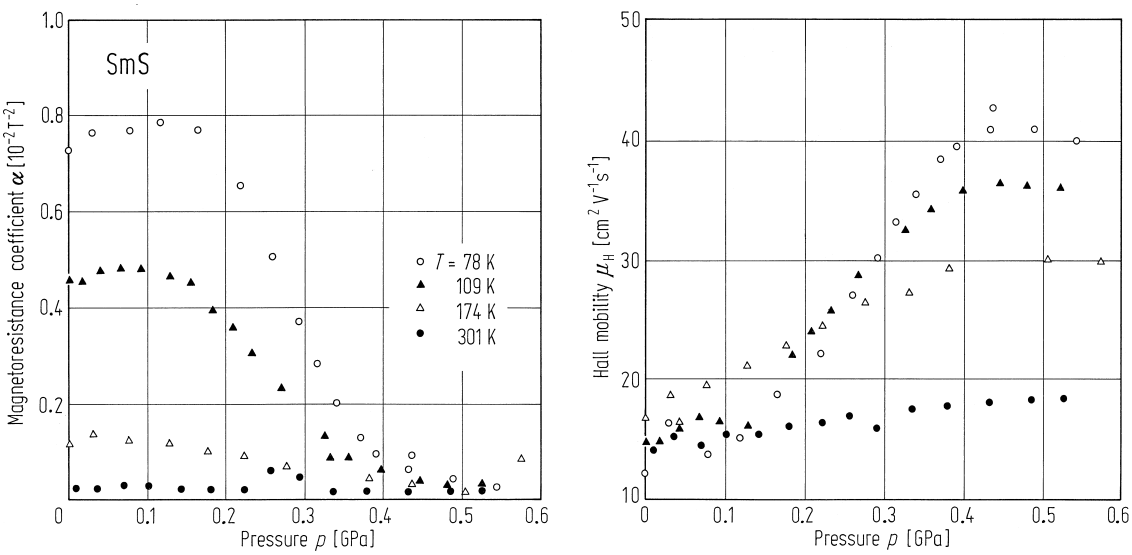
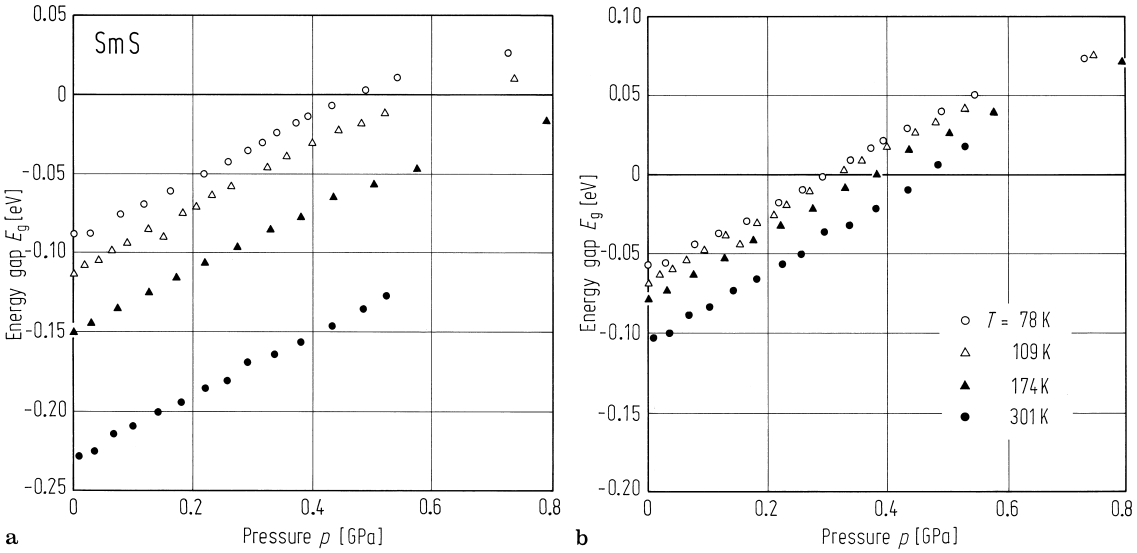


**Fig. 5**.

SmS (lattice constant $a$ = 5.9690 Å). Energy gap $E_g$ vs. pressure $p$ for **(a)** $E_g$ : $4f^6 5d^0$ - $4f^5 5d^1$, **(b)** $E_g$ from excitation from impurity levels of Sm [80M].



## Fig. 6.

$Sm_{1-x}Gd_xS$. Lattice parameters vs. composition at 298 K (open circles) and 4.2K (full circles). The parameter is independent of concentration in the range $0.15 \leq x \leq 0.22$ [73J2]. See also [75J].

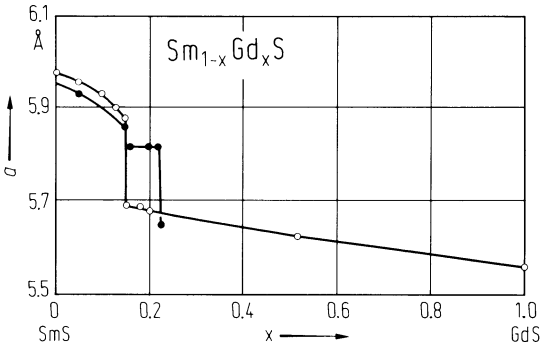
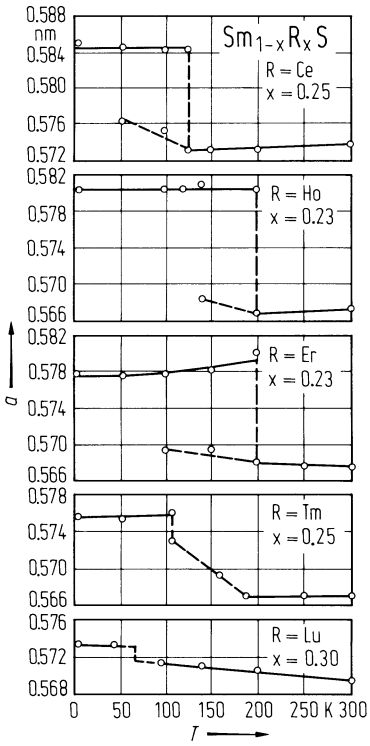


**Fig. 7.**

$Sm_{1-x}R_xS$, R =Ce, Ho, Er, Tm, Lu. Lattice parameter vs. temperature for some compounds. Vertical broken lines mark the first order transitions (semiconductor-metal) [75J]. The compositions represent the nominal atomic percent $R^{3+}$.



## Fig. 8.

SmS. The $p - T$ phase diagram. Solid line determined from thermopower data. Dashed line gives the pressure at which reverse transformation (semiconductor-metal) takes place. The intersection of the two lines gives the critical point (825ºC) [78S1].

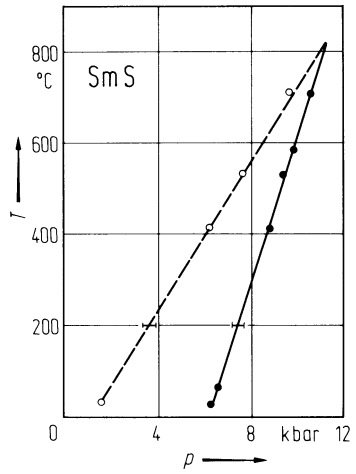
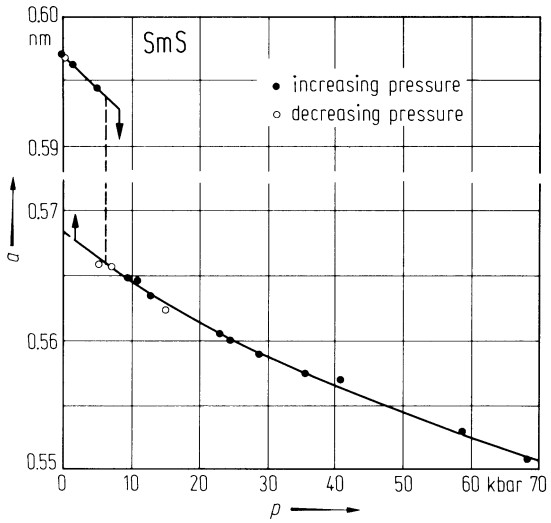


**Fig. 9.**

SmS. Lattice parameter vs. hydrostatic pressure. Metallic phase for $p > 6.5$ kbar [79K].



## Fig. 10.

SmS, SmTe. Calculated band structure for semiconducting SmS (top) and SmTe (bottom). Note the absence of 4f states in the case of the telluride [76C, 71D].

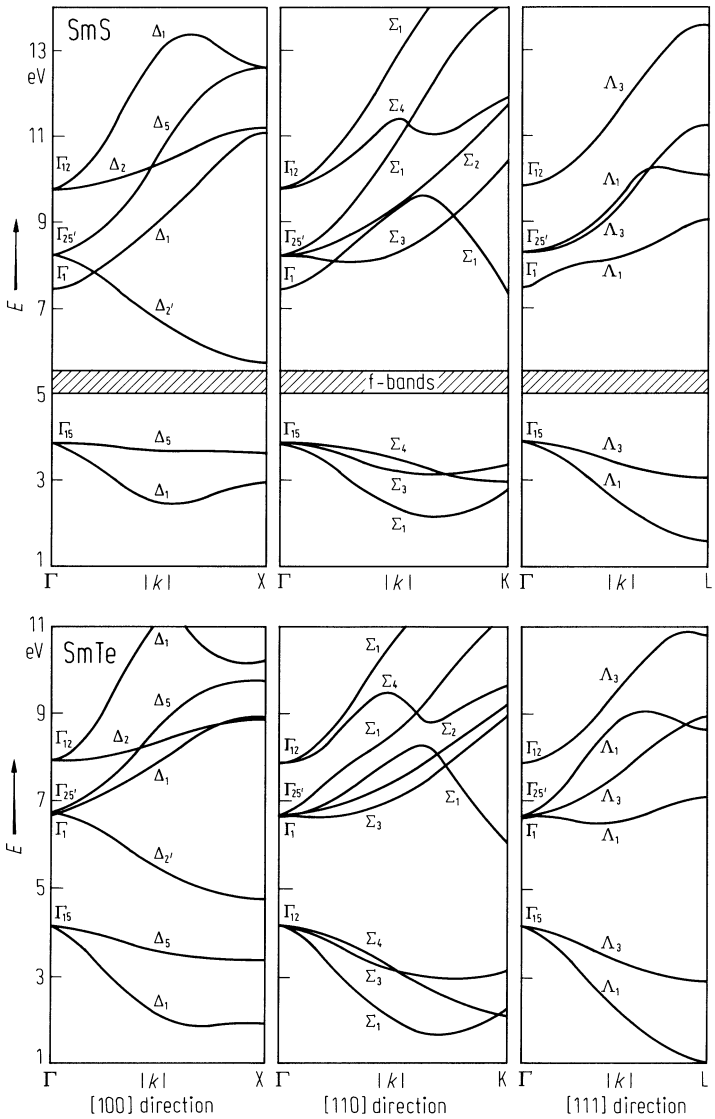


**Fig. 11.**

SmS, $Sm_{1-x}Y_xS$. Schematic representation of the density of states of (a) semiconducting SmS, (b) black phase of $Sm_{1-x}Y_xS$ [76G].

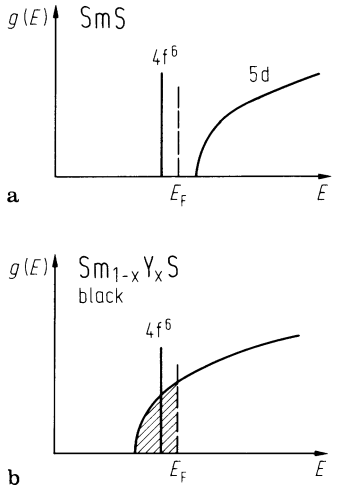


**Fig. 12.**

SmS. (a): band structure in the semiconducting phase. (b): band structure in the metallic high pressure phase [81F].

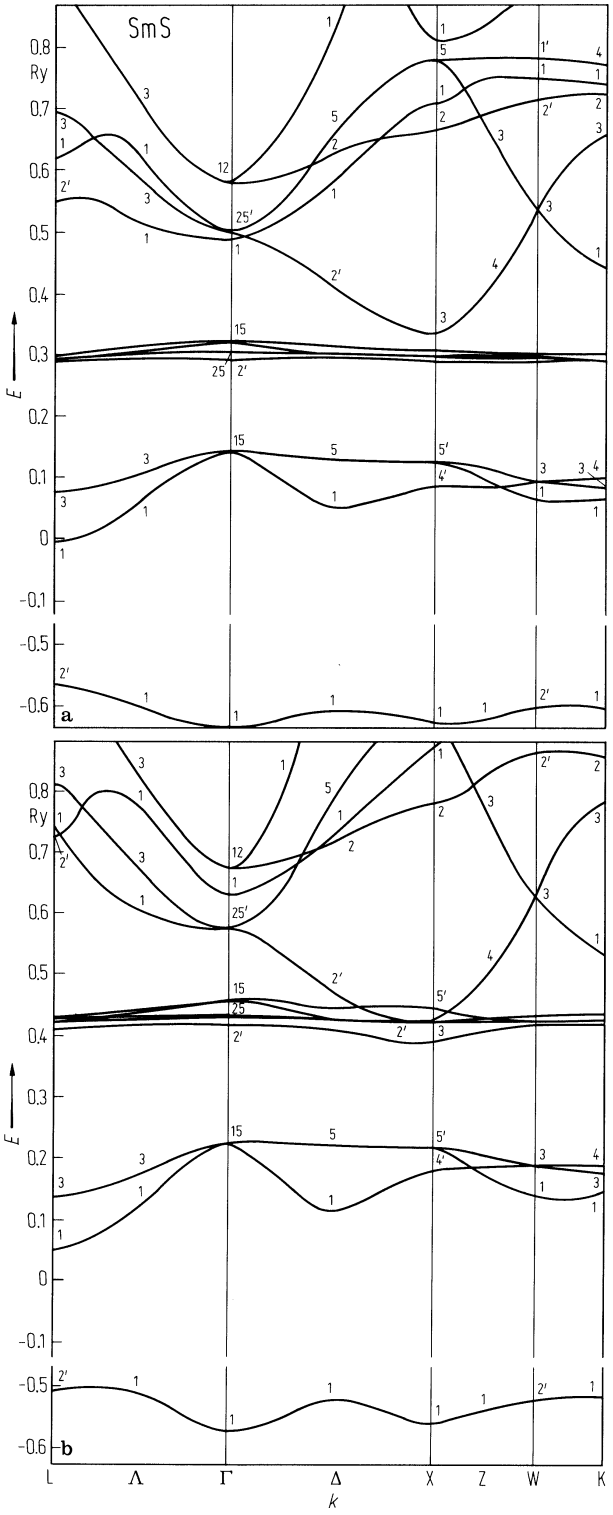


**Fig. 13.**

SmS, SmSe. Reflectivity vs. photon energy for cleaved single crystals at 300 K. (—) 5d ($t_{2g}$) and (---) 5d ($e_g$) final states [76G].

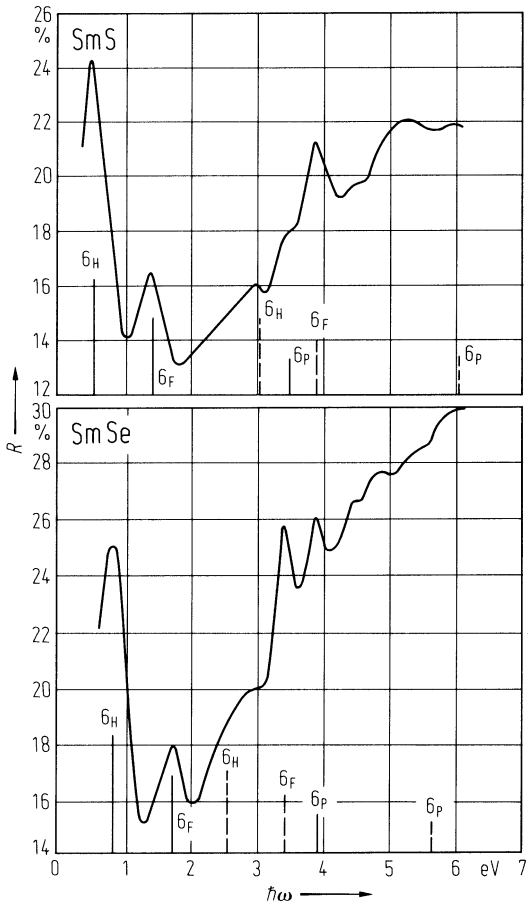


**Fig. 14.**

SmS. Optical spectrum (imaginary part of dielectric constant vs. photon energy) and terms of excited $f^5$ configuration [81F].

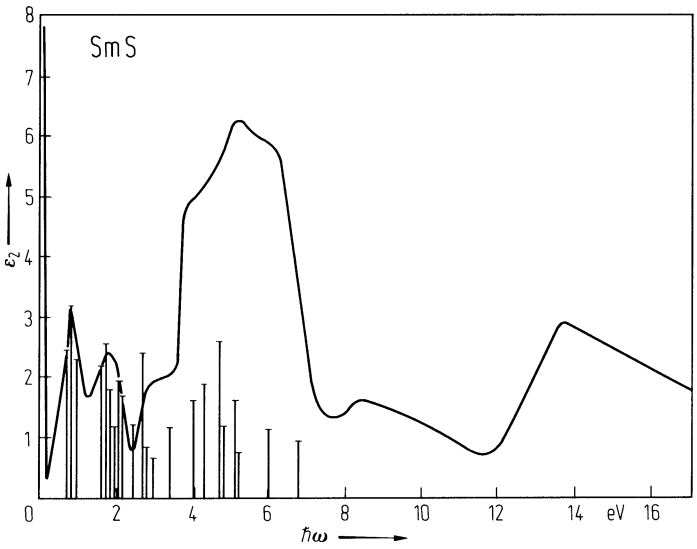


**Fig. 15.**

SmS, SmSe, SmTe. XPS spectra of the valence band and the 4f region (electron intensity vs. binding energy) [76C].

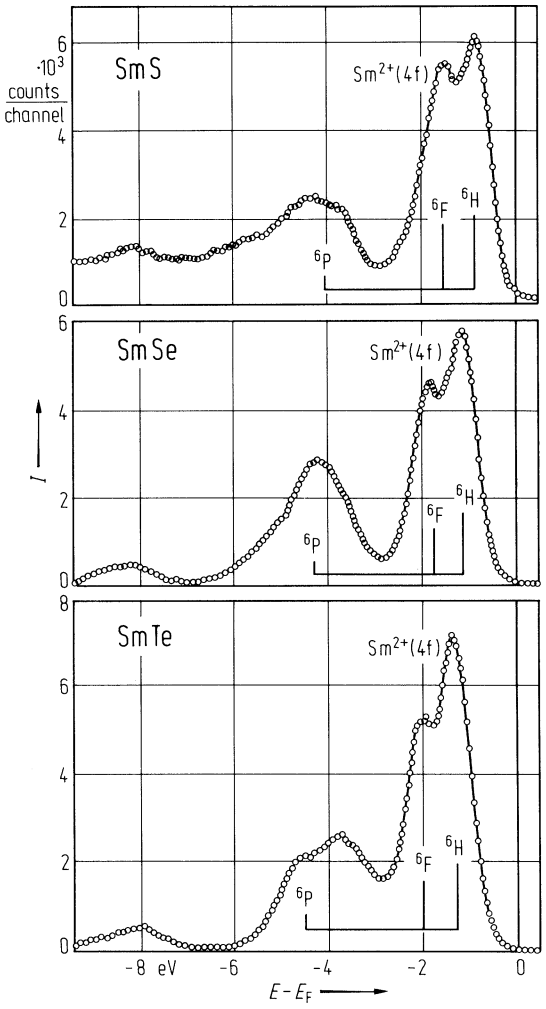


**Fig. 16.**

SmS. Phonon dispersion (frequency vs. reduced wavevector coordinate). Solid points: measurements at normal pressure. Open points: measurments at 0.7 GPa [82M2].

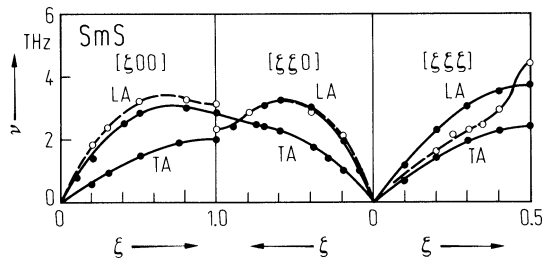


**Fig. 17.**

SmS, SmSe, SmTe. Normalized resistivity vs. pressure for SmS. The actual resistivity at pressures greater than 6.5 kbar is ≈ 3...4·10$^{-4}$ Ω cm. The data for SmSe and SmTe are shown in the inset [70J].

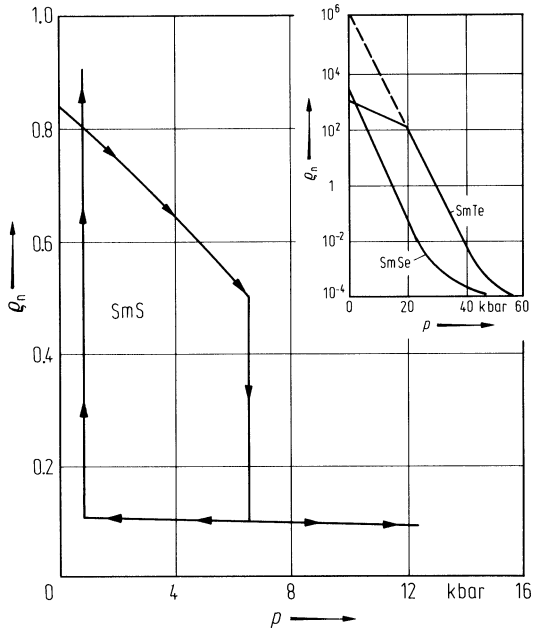


**Fig. 18.**

SmS. Resistivity vs. temperature at different pressures [81L1]. Inset shows $\rho$ vs. $1/T$ at $p$ = 14 kbar.

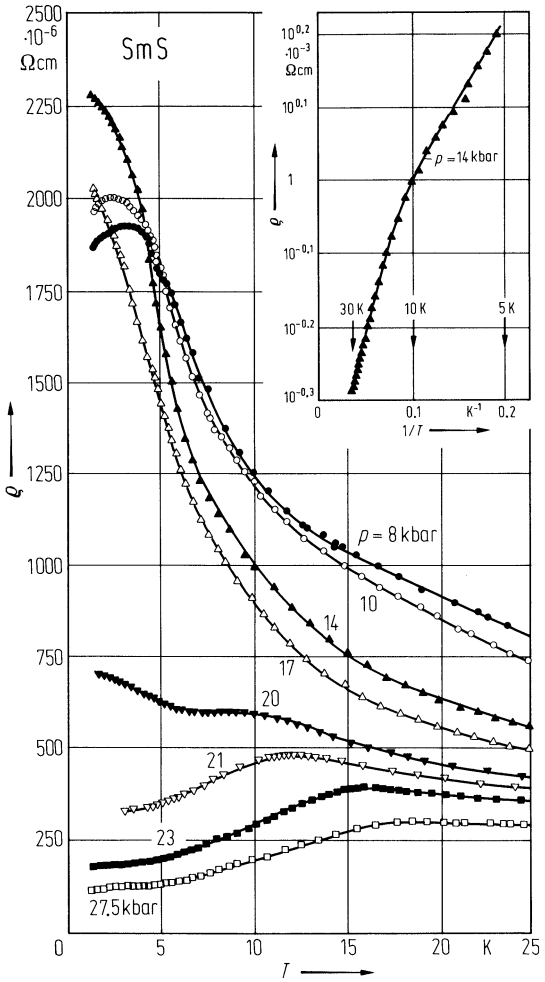


**Fig. 19.**

SmS. Hall coefficient vs. temperature (log scale) at different hydrostatic pressures. Insert: Hall coefficient at 4 K vs. pressure, full triangles and squares: other samples [81K1].

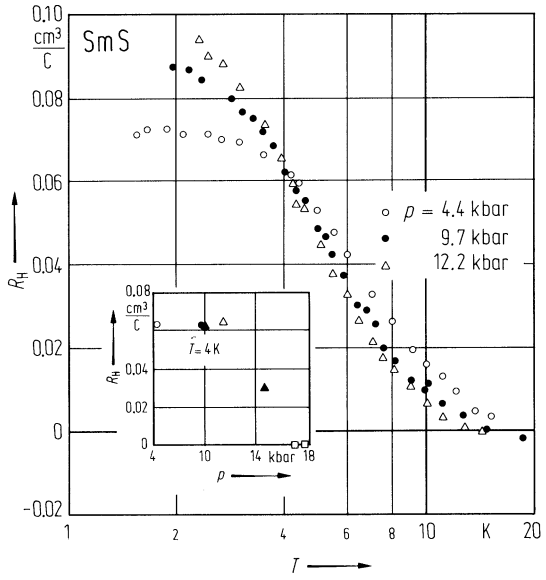


**Fig. 20.**

SmS. Hall mobility vs. temperature at different pressures [81K1].