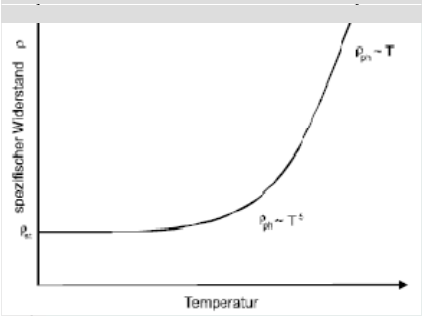
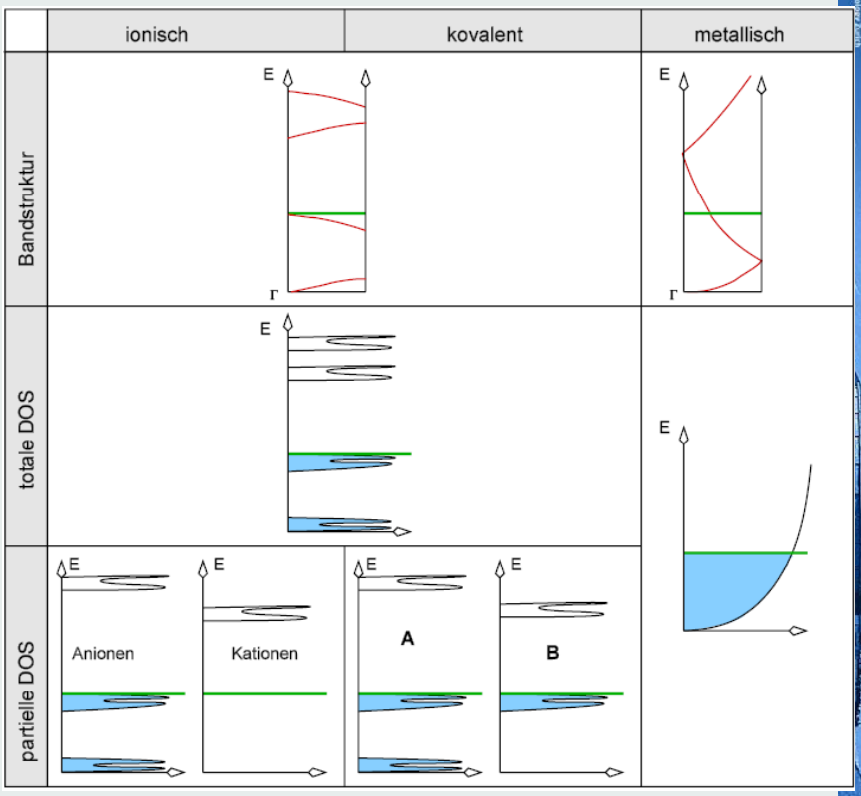
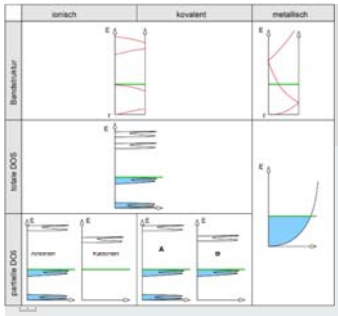
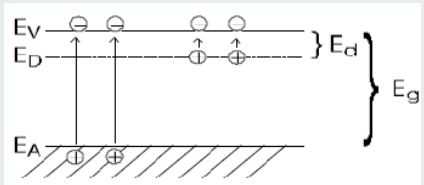
Metals, Semiconductors, Insulators



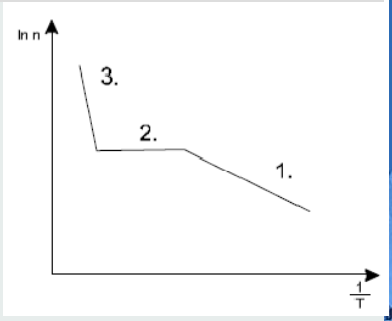


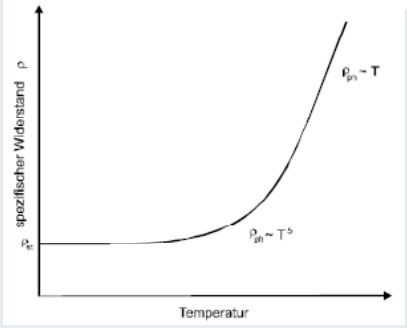
Metals, Semiconductors, Insulators





$$\sigma = n e \mu_n + p e \mu_p$$





1. *Impurity reserve* (E_d » kT):
Thermal energy is too low to promote electrons from donatorniveaus into conduction band

$$n \propto e^{\frac{-E_d}{2kT}}$$

2. *Impurity depletion* (E_d « kT « E_g):
All donator centers are ionised, but thermal energie still to promote electrons via the intrinsic band gap.

$$n = \text{const.}$$

3. *Intrinsic conductivity* (E_g « kT):
Thermal energy is large enough, to promote intrinsic charge carriers over the band gap. Now the donor carriers become the minority carriers and conductivity raises strongly

$$n \propto e^{\frac{-E_g}{2kT}}$$

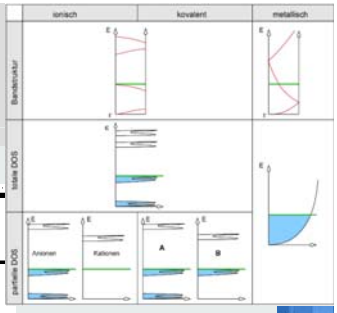
$T << \Theta_D$: $\rho_{Ph} \propto T^5$ (Kleinwinkelstreuung)

und

$T >> \Theta_D$: $\rho_{Ph} \propto T$

wobei Θ_D die Debye-Frequenz des Festkörpers ist.

Metals, Semiconductors, Insulators



I–VII compounds		II–VI compounds		III–V compounds	
LiF	11	ZnO	3.4	AlP	3.0
LiCl	9.5	ZnS	3.8	AlAs	2.3
NaF	11.5	ZnSe	2.8	AlSb	1.5
NaCl	8.5	ZnTe	2.4	GaP	2.3
NaBr	7.5	CdO	2.3	GaAs	1.4
KF	11	CdS	2.45	GaSb	0.7
KCl	8.5	CdSe	1.8	InP	1.3
KBr	7.5	CdTe	1.45	InAs	0.3
KI	5.8	PbS	0.37	InSb	0.2
		PbSe	0.27	β-SiC	2.2
		PbTe	0.33	α-SiC	3.1

Some of these values, especially for the alkali halides, are only approximate.

Nitrides, Carbides ??

Color in Semiconductors II
Bandgap–Tuning by Quanten–Size-Effect

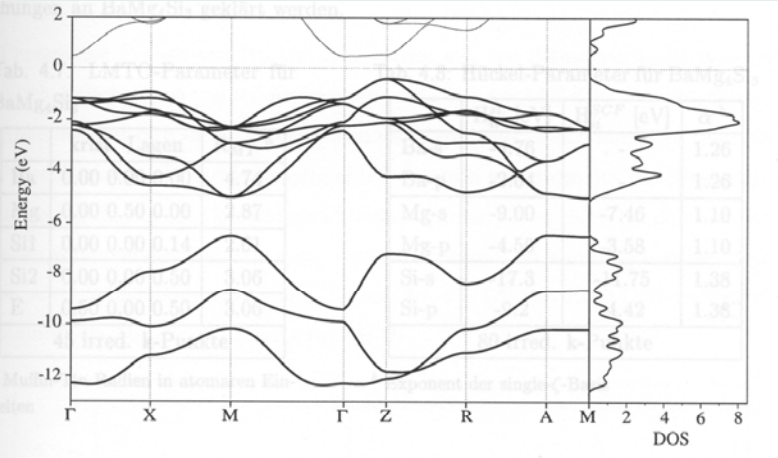
CdTe

Growing particle diametre from 2 auf 5 nm results in color change from green to red → bandgap becomes smaller

Photoelectron spectra (ESCA)

UPS: E_{rad} = UV radiation =>

valence states (bonds, etc)



binding energy

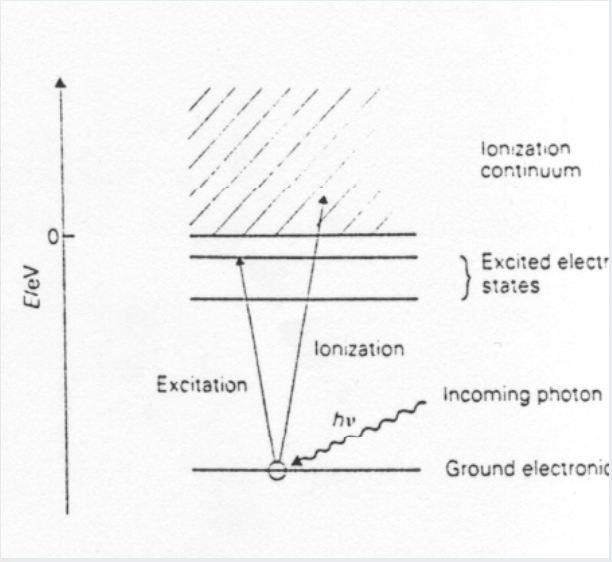
Band structure DOS

Photoelectron spectra (ESCA)

E_{kin} (electron) = E_{rad} - E_{bind}

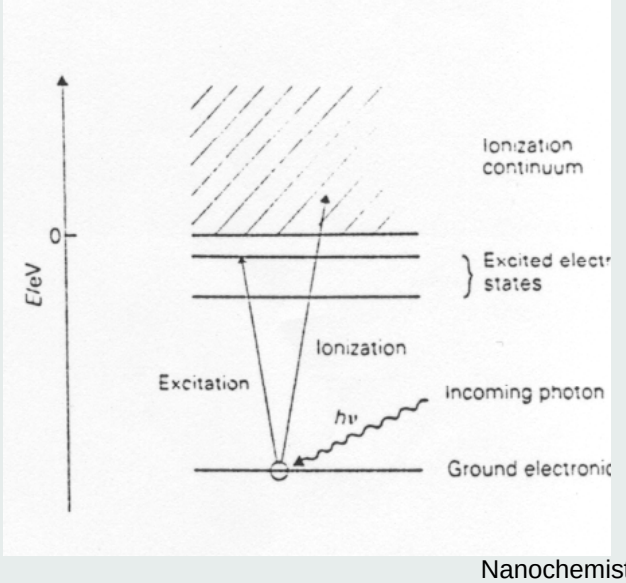
Surface method

2-3nm depth



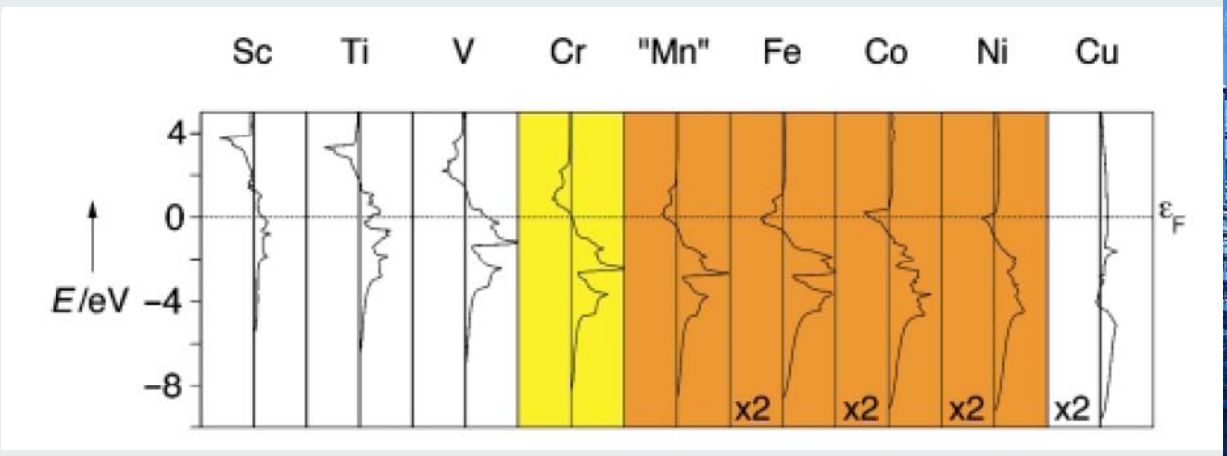
Photoelectron spectra (ESCA)

UPS: E_{rad} = UV radiation =>	valence states (bonds, etc)
XPS: E_{rad} = X radiation =>	core states (oxidation states)



Magnetism in Transition Metals

Angew. Chem. Int. Ed. **2000**, *39*, 1560–1585



Magnetism – Spin Polarized Band Structures

Angew. Chem. Int. Ed. **2000**, *39*, 1560 – 1585

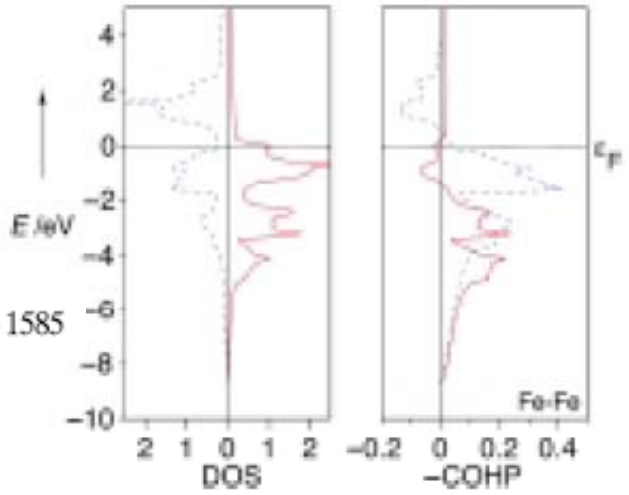


Figure 17. DOS and Fe-Fe COHP curves for ferromagnetic α-Fe. In each plot, the solid red/dashed blue line corresponds to the α/β spins. All curves have been shifted in energy so that ε_F, indicated with a horizontal dotted line, lies at 0.0 eV.