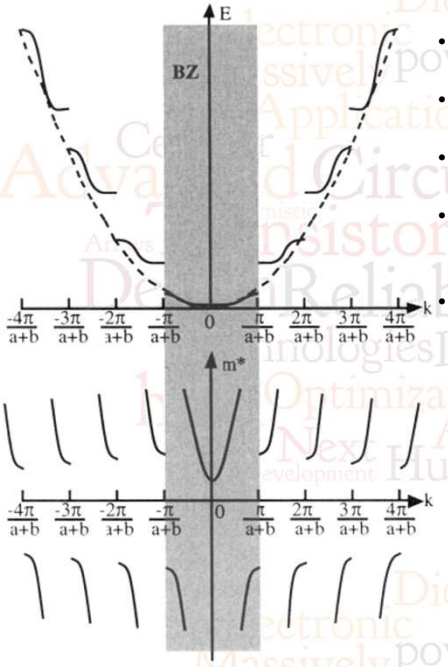
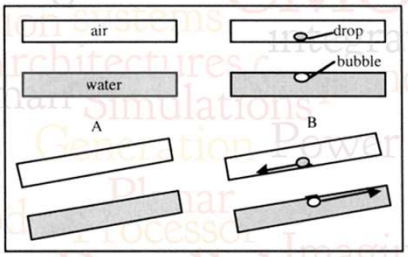
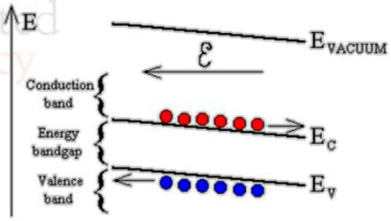
Effective Mass



- Effective mass in a crystal varies as a function of k
- Effective mass will be different for different energy bands.
- Upper half of an energy band, effective mass < 0 (holes)
- Lower half of energy band, effective mass > 0 (conduction electrons)
- Middle of an energy band, effective mass $\rightarrow \infty$ (core electrons)

$$m^* = \left(\frac{1}{\hbar^2}\frac{\mathrm{d}^2E}{\mathrm{d}k^2}\right)^{-1}$$





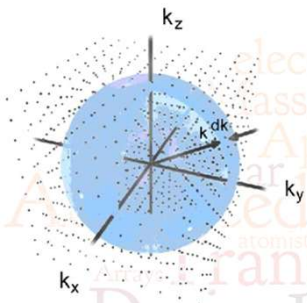
40

Electronic Properties

	Material	Transition	Gap energy E_g[eV] 0 K	300 K	Room-temp. conductivity $\sigma\left[\frac{1}{\Omega\cdot\mathrm{m}}\right]$	Mobility of electrons $\mu_e\left[\frac{\mathrm{m}^2}{\mathrm{V}\cdot\mathrm{s}}\right]$	Mobility of holes $\mu_h\left[\frac{\mathrm{m}^2}{\mathrm{V}\cdot\mathrm{s}}\right]$	Work function (photoelectric) ϕ [eV]	Effective mass ratio at 4 K $\frac{m_e^*}{m_0}$	$\frac{m_h^*}{m_0}$
Element	C (diamond)	I	5.48	5.47	10^{-12}	0.18	0.12	4.8	0.2	0.25
	Ge	I	0.74	0.66	2.2	0.39	0.19	4.6	1.64[a] 0.08[b]	0.04[c] 0.28[d]
	Si	I	1.17	1.12	9×10^{-4}	0.15	0.045	3.6	0.98[a] 0.19[b]	0.16[c] 0.49[d]
	Sn (gray)	D	0.09	0.08	10^6	0.14	0.12	4.4		0.3[d]
III–V	GaAs	D	1.52	1.42	10^{-6}	0.85	0.04		0.067	0.082
	InAs	D	0.42	0.36	10^4	3.30	0.046	4.9	0.023	0.40
	InSb	D	0.23	0.17		8.00	0.125		0.014	0.40
	GaP	I	2.34	2.26		0.01	0.007		0.82	0.60
	GaN	D	3.50	3.36		0.04	0.01		0.19	0.60
	InN	D		0.7						
	InP	D	1.42	1.35		0.46	0.015		0.077	0.64

41

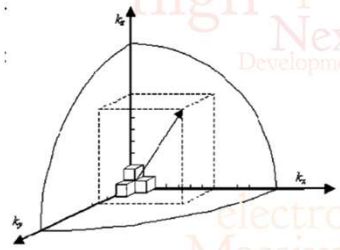
Density of States



The Density of States (DOS) is essentially the number of different states at a particular energy level that electrons are allowed to occupy, i.e. the number of electron states per unit volume per unit energy.

Bulk properties such as specific heat, paramagnetic susceptibility, and other transport phenomena of conductive solids depend on this function.

DOS calculations allow one to determine the general distribution of states as a function of energy and can also determine the spacing between energy bands in semiconductors



$$g_C(E)_{3D} = \frac{1}{2\pi^2}\left(\frac{2m_e^*}{\hbar^2}\right)^{\frac{3}{2}}(E - E_C)^{\frac{1}{2}}$$

47