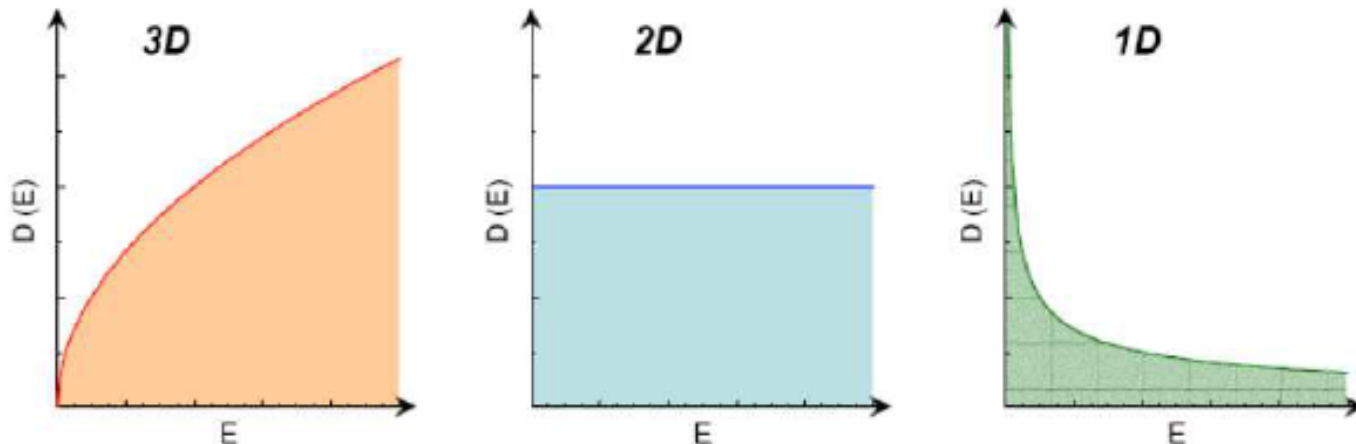


Niedrigdimensionale Elektronengase (2D, 1D, 0D)

- Elektronen wechselwirken nicht mit den Atomrümpfen
 - Elektronen wechselwirken nicht untereinander
- } Gas von nicht wechselwirkenden Teilchen

Zustandsdichten für 1-D, 2-D und 3-D Elektronengas:

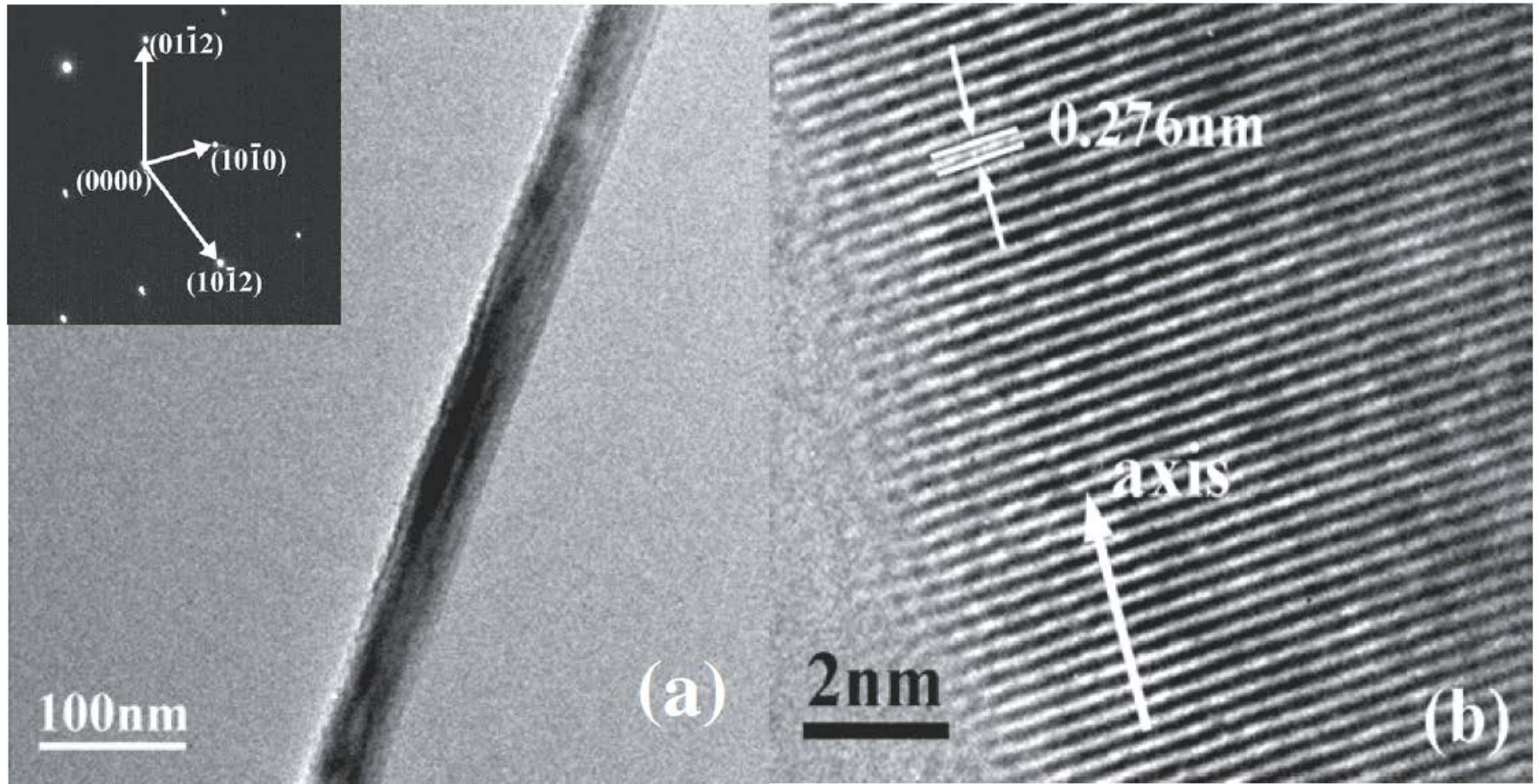


$$D(E) = \frac{V}{2\pi^2} \left(\frac{2m}{\hbar^2} \right)^{3/2} E^{1/2} \quad (3\text{D-Elektronengas})$$

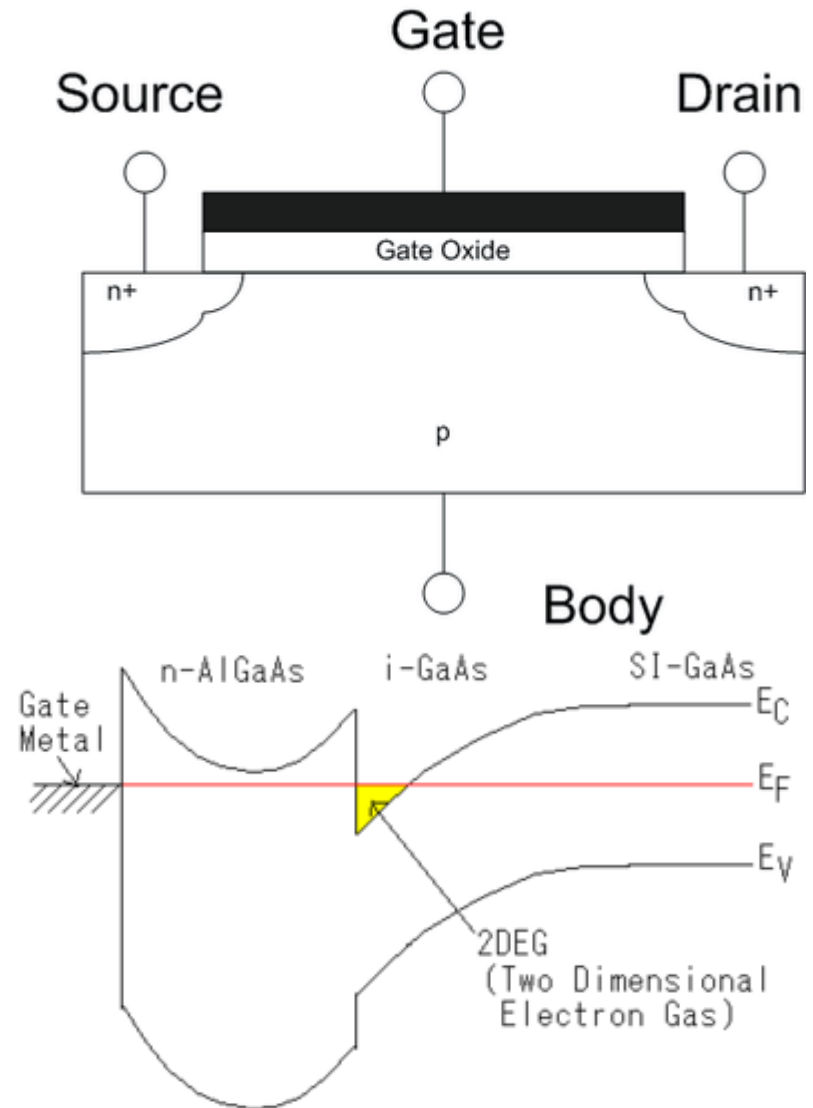
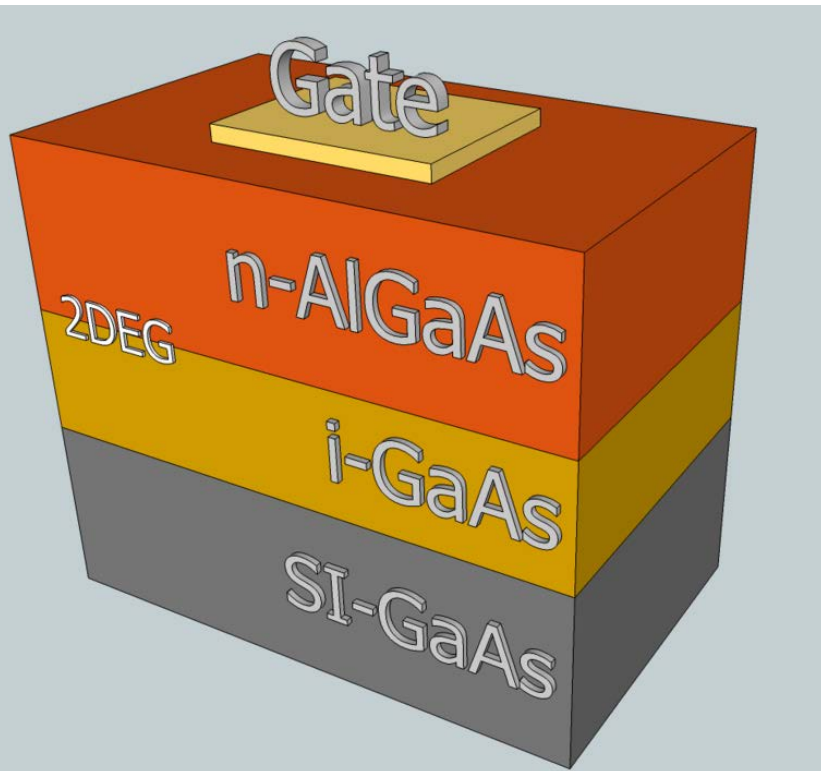
$$D(E) = \frac{A}{2\pi} \left(\frac{2m}{\hbar^2} \right) E^0 = \text{const} \quad (2\text{D-Elektronengas})$$

$$D(E) = \frac{L}{2\pi} \left(\frac{2m}{\hbar^2} \right)^{1/2} E^{-1/2} \quad (1\text{D-Elektronengas})$$

GaN Nanodraht



2DEG : GaAs/AlGaAs MOSFET



2DEG vs Graphene

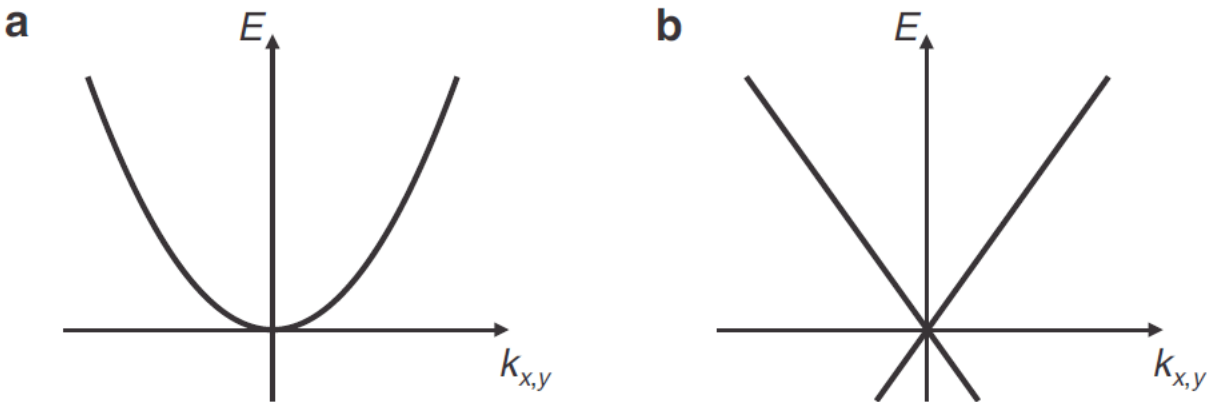


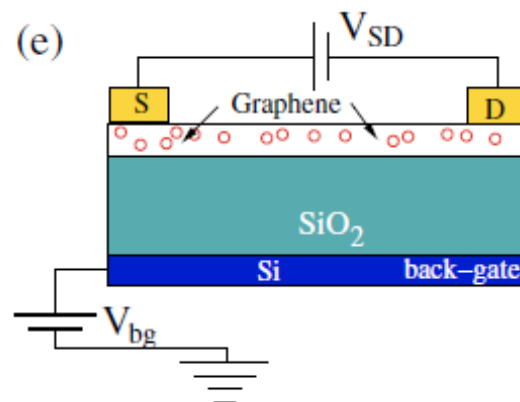
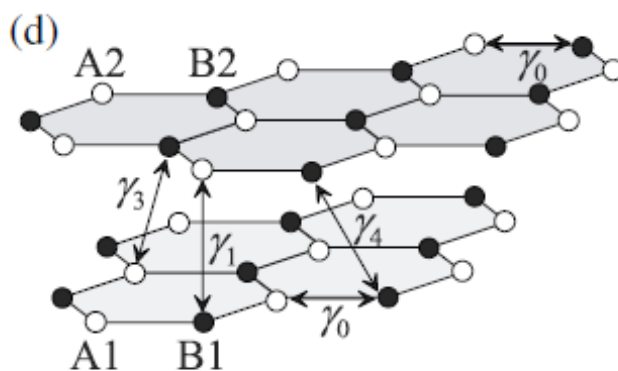
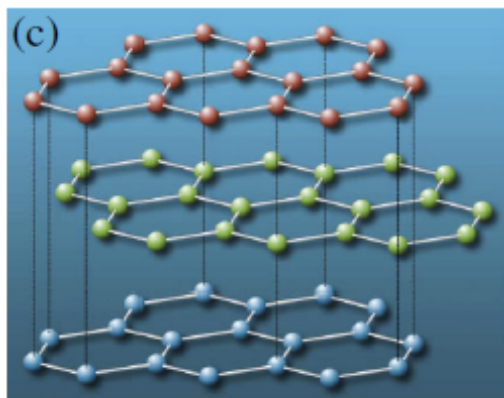
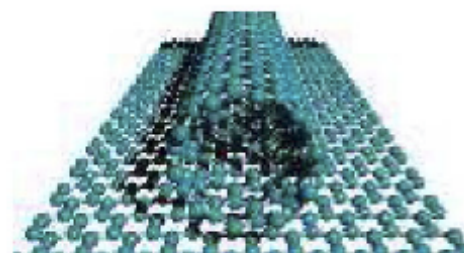
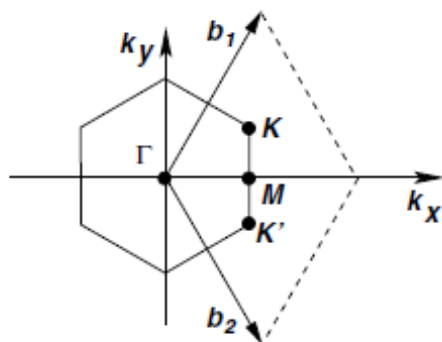
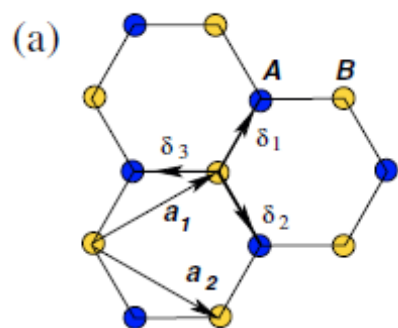
Figure 1.3: **a**, Simplified 2D band structure of GaAs/AlGaAs 2DEG near Γ point. **b**, Simplified 2D band structure of monolayer graphene near a Dirac point (K or K').

Figure 1.1: E_F , k_F , v_F , and $D(E)$ for 2DEG, graphene, and 3D metal (free electron model) at $T = 0$ K. g is the spin and valley degeneracy ($g = 2$ for GaAs/AlGaAs 2DEG; $g = 4$ for graphene; $g = 2$ for 3D metal).

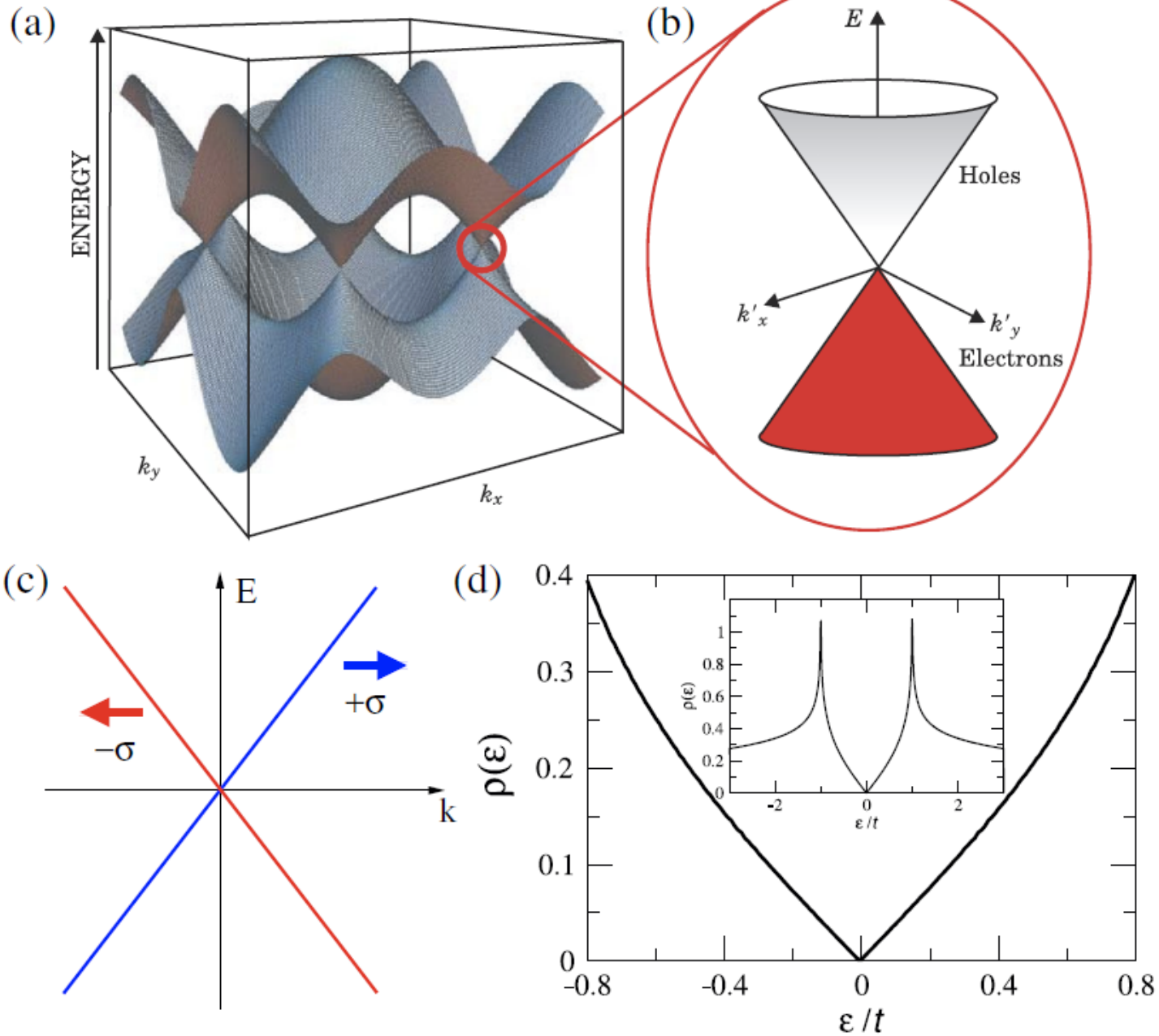
Table 1.1: E_F , k_F , v_F , and $D(E)$ for 2DEG, graphene, and 3D metal (free electron model) at $T = 0$ K. g is the spin and valley degeneracy ($g = 2$ for GaAs/AlGaAs 2DEG; $g = 4$ for graphene; $g = 2$ for 3D metal).

	E_F	k_F	v_F	$D(E)$
2DEG	$\frac{\hbar^2 k_F^2}{2m^*}$	$\left(\frac{4\pi n_0}{g}\right)^{1/2}$	$\frac{\hbar k_F}{m^*}$	$\frac{gm^*}{2\pi\hbar^2}$
Graphene	$\hbar v_F k_F$	$\left(\frac{4\pi n_0}{g}\right)^{1/2}$	v_F	$\frac{gE}{2\pi(\hbar v_F)^2}$
3D metal	$\frac{\hbar^2 k_F^2}{2m^*}$	$\left(\frac{6\pi^2 n_{3D}}{g}\right)^{1/3}$	$\frac{\hbar k_F}{m^*}$	$\frac{gm^*}{2\pi^2\hbar^2} \sqrt{\frac{2m^*E}{\hbar^2}}$

Graphene



Graphene E(k) Bandstruktur



Effektive Masse in Graphene

Structure	Effective mass (m^*/m_e)	Velocity ($10^6 m/s$)
Graphite	0.043 (0.045) ^[8,17]	0.94 (0.91) ^[19]
Monolayer graphene ' <i>electrons</i> '	0.0	1.11 (1.093-1.10) ^[3,26]
Monolayer graphene ' <i>holes</i> '	0.0	1.04
Bilayer graphene	0.022	1.10 (1.07) ^[28]
Multilayer graphene	0.031	1.00 (1.03) ^[29]

TABLE 1: Electron and hole effective masses and velocities in monolayer graphene, bilayer graphene, multilayer graphene, and graphite. Available experimentally measured results are presented in parentheses.