

Room temperature properties of Si, Ge, GaAs, and GaN

Quantity	Symbol	Si	Ge	GaAs	GaN	(Unit)
Crystal structure		D	D	Z	W	—
Gap: Direct (<i>D</i>) / Indirect (<i>I</i>)		<i>I</i>	<i>I</i>	<i>D</i>	<i>D</i>	—
Lattice constant	$a_0 =$	5.431	5.646	5.653	5.185 (c_0)	Å
Bandgap energy	$E_g =$	1.12	0.66	1.42	3.425	eV
Intrinsic carrier concentration	$n_i =$	1.0×10^{10}	2.0×10^{13}	2.0×10^6	1.9×10^{-10}	cm^{-3}
Effective DOS at CB edge	$N_c =$	2.8×10^{19}	1.0×10^{19}	4.4×10^{17}	2.3×10^{18}	cm^{-3}
Effective DOS at VB edge	$N_v =$	1.0×10^{19}	6.0×10^{18}	7.7×10^{18}	1.8×10^{19}	cm^{-3}
Electron mobility	$\mu_n =$	1500	3900	8500	1500	$\text{cm}^2/(\text{Vs})$
Hole mobility	$\mu_p =$	450	1900	400	30	$\text{cm}^2/(\text{Vs})$
Electron diffusion constant	$D_n =$	39	101	220	39	cm^2/s
Hole diffusion constant	$D_p =$	12	49	10	0.75	cm^2/s
Electron affinity	$\chi =$	4.05	4.0	4.07	4.1	V
Minority carrier lifetime	$\tau =$	10^{-6}	10^{-6}	10^{-8}	10^{-8}	s
Electron effective mass	$m_e^* =$	0.98 m_e	1.64 m_e	0.067 m_e	0.20 m_e	—
Heavy hole effective mass	$m_{hh}^* =$	0.49 m_e	0.28 m_e	0.45 m_e	0.80 m_e	—
Relative dielectric constant	$\epsilon_r =$	11.9	16.0	13.1	8.9	—
Refractive index near E_g	$\bar{n} =$	3.3	4.0	3.4	2.5	—
Absorption coefficient near E_g	$\alpha =$	10^3	10^3	10^4	10^5	cm^{-1}

- D = Diamond; Z = Zincblende; W = Wurtzite; DOS = Density of states; VB = Valence band; CB = Conduction band.
- The Einstein relation relates the diffusion constant and mobility in a non-degenerately doped semiconductor: $D = \mu (kT/e)$
- Minority carrier diffusion lengths are given by $L_n = (D_n \tau_n)^{1/2}$ and $L_p = (D_p \tau_p)^{1/2}$
- The mobilities and diffusion constants apply to low doping concentrations ($\approx 10^{15} \text{ cm}^{-3}$). As the doping concentration increases, mobilities and diffusion constants decrease.
- The minority carrier lifetime τ applies to doping concentrations of 10^{18} cm^{-3} . For other doping concentrations, the lifetime is given by $\tau = B^{-1} (n + p)^{-1}$, where $B_{\text{Si}} \approx 5 \times 10^{-14} \text{ cm}^3/\text{s}$, $B_{\text{Ge}} \approx 5 \times 10^{-13} \text{ cm}^3/\text{s}$, $B_{\text{GaAs}} \approx 10^{-10} \text{ cm}^3/\text{s}$, and $B_{\text{GaN}} \approx 10^{-10} \text{ cm}^3/\text{s}$.