

Room temperature properties of semiconductors

Quantity	Symbol	AlP	GaP	InP	(Unit)
Crystal structure		Z	Z	Z	–
Gap: Direct (<i>D</i>) / Indirect (<i>I</i>)		<i>I</i>	<i>I</i>	<i>D</i>	–
Lattice constant	$a_0 =$	5.4635	5.4512	5.8686	Å
Bandgap energy	$E_g =$	2.45	2.26	1.35	eV
Intrinsic carrier concentration	$n_i =$	0.044	1.6×10^0	1×10^7	cm^{-3}
Effective DOS at CB edge	$N_c =$	2.0×10^{19}	1.9×10^{19}	5.2×10^{17}	cm^{-3}
Effective DOS at VB edge	$N_v =$	1.5×10^{19}	1.2×10^{19}	1.1×10^{19}	cm^{-3}
Electron mobility	$\mu_n =$	60	110	4600	cm^2/Vs
Hole mobility	$\mu_p =$	450	75	150	cm^2/Vs
Electron diffusion constant	$D_n =$	1.6	2.8	120	cm^2 / s
Hole diffusion constant	$D_p =$	11.6	1.9	3.9	cm^2 / s
Electron affinity	$\chi =$	3.98	3.8	4.5	V
Minority carrier lifetime	$\tau =$	10^{-6}	10^{-6}	10^{-8}	s
Electron effective mass	$m_e^* =$	$0.83 m_e$	$0.82 m_e$	$0.08 m_e$	–
Heavy hole effective mass	$m_{hh}^* =$	$0.70 m_e$	$0.60 m_e$	$0.56 m_e$	–
Relative dielectric constant	$\epsilon_r =$	9.8	11.1	12.4	–
Refractive index near E_g	$\bar{n} =$	3.0	3.0	3.4	–
Absorption coefficient near E_g	$\alpha =$	10^3	10^3	10^4	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: $D = \mu (k T / e)$
- 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 $B_{\text{GaP}} \approx 10^{-13} \text{ cm}^3/\text{s}$.