Room temperature properties of semiconductors: III–V phosphides

Quantity	***Symbol***	***AlP***	***GaP***	***InP***	***(Unit)***
Crystal structure		Z	Z	Z	–
Gap: Direct (*D*) / Indirect (*I*)		*I*	*I*	*D*	–
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	μ_n =	60	110	4600	cm^2/Vs
Hole mobility	μ_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	χ =	3.98	3.8	4.5	V
Minority carrier lifetime	τ =	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	ε_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	α =	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 ($\approx 10^{15}$ 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 $B_{GaP} \approx 10^{-13}$ cm^3/s.