

**Room temperature properties of semiconductors: III–V arsenides**

<b>Quantity</b>	<b>Symbol</b>	<b>AlAs</b>	<b>GaAs</b>	<b>InAs</b>	<b>(Unit)</b>
Crystal structure		Z	Z	Z	–
Gap: Direct ( <i>D</i> ) / Indirect ( <i>I</i> )		<i>I</i>	<i>D</i>	<i>D</i>	–
Lattice constant	$a_0 =$	5.6611	5.6533	6.0584	Å
Bandgap energy	$E_g =$	2.168	1.42	0.354	eV
Intrinsic carrier concentration	$n_i =$	10	$2 \times 10^6$	$7.8 \times 10^{14}$	$\text{cm}^{-3}$
Effective DOS at CB edge	$N_c =$	$1.5 \times 10^{19}$	$4.4 \times 10^{17}$	$8.3 \times 10^{16}$	$\text{cm}^{-3}$
Effective DOS at VB edge	$N_v =$	$1.7 \times 10^{19}$	$7.7 \times 10^{18}$	$6.4 \times 10^{18}$	$\text{cm}^{-3}$
Electron mobility	$\mu_n =$	200	8500	33,000	$\text{cm}^2/\text{Vs}$
Hole mobility	$\mu_p =$	100	400	450	$\text{cm}^2/\text{Vs}$
Electron diffusion constant	$D_n =$	5.2	220	858	$\text{cm}^2/\text{s}$
Hole diffusion constant	$D_p =$	2.6	10	12	$\text{cm}^2/\text{s}$
Electron affinity	$\chi =$	3.50	4.07	4.9	V
Minority carrier lifetime	$\tau =$	$10^{-7}$	$10^{-8}$	$10^{-8}$	s
Electron effective mass	$m_e^* =$	$0.146 m_e$	$0.067 m_e$	$0.022 m_e$	–
Heavy hole effective mass	$m_{hh}^* =$	$0.76 m_e$	$0.45 m_e$	$0.40 m_e$	–
Relative dielectric constant	$\epsilon_r =$	10.1	13.1	15.1	–
Refractive index near $E_g$	$\bar{n} =$	3.2	3.4	3.5	–
Absorption coefficient near $E_g$	$\alpha =$	$10^3$	$10^4$	$10^4$	$\text{cm}^{-1}$

- 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  $\tau$  applies to doping concentrations of  $10^{18} \text{ cm}^{-3}$ . For other doping concentrations, the lifetime is given by  $\tau = B^{-1} (n + p)^{-1}$ , where  $B_{\text{GaAs}} = 10^{-10} \text{ cm}^3/\text{s}$ .