InAs - Indium Arsenide

Electrical properties

Basic Parameters
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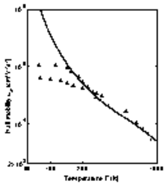
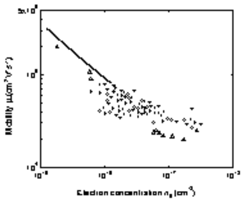
Basic Parameters

Breakdown field	$\approx 4\cdot 10^4$ V cm^{-1}
Mobility of electrons	$\leq 4\cdot 10^4$ cm^{2}V^{-1}s^{-1}
Mobility of holes	$\leq 5\cdot 10^2$ cm^2 V^{-1}s^{-1}
Diffusion coefficient of electrons	$\leq 10^3$ cm^{2}s^{-1}
Diffusion coefficient of holes	≤ 13 cm^2 s^{-1}
Electron thermal velocity	$7.7\cdot 10^5$ m s^{-1}
Hole thermal velocity	$2\cdot 10^5$ m s^{-1}

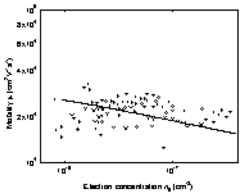
Mobility and Hall Effect



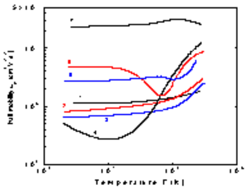
Electron Hall mobility versus temperature for different electron concentration:
full triangles $n_o = 4\cdot 10^{15}$ cm^{-3},
circles $n_o = 4\cdot 10^{16}$cm^{-3},
open triangles $n_o = 1.7\cdot 10^{16}$cm^{-3}.
Solid curve-calculation for pure InAs.
(Rode [1975])



Electron Hall mobility versus electron concentration. T = 77 K.
(Karataev et al. [1977]).



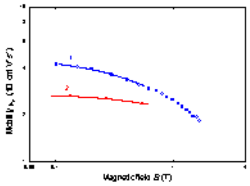
Electron Hall mobility versus electron concentration T = 300 K
(Karataev et al. [1977]).



Electron Hall mobility (R·σ) in compensated material

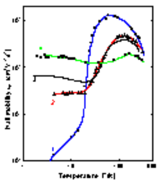
Curve	n cm^{-3}	N_a+N_d cm^{-3}	$\theta=N_a/N_d$
1	$8.2\cdot 10^{16}$	$3\cdot 10^{17}$	0.58
2	$3.2\cdot 10^{17}$	$6.1\cdot 10^{18}$	0.9
3	$5.1\cdot 10^{16}$	$3.2\cdot 10^{18}$	0.96
4	$3.3\cdot 10^{16}$	$7.5\cdot 10^{17}$	0.91
5	$7.6\cdot 10^{15}$	$3.4\cdot 10^{17}$	0.95
6	$6.4\cdot 10^{15}$	$3.8\cdot 10^{17}$	0.96
7	$3.3\cdot 10^{15}$	$3.9\cdot 10^{17}$	0.98

(Garyagdyev et al. [1974]).

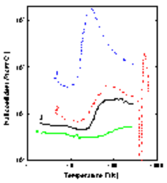


Electron Hall mobility versus transverse magnetic field, T = 77 K.
N_d (cm^{-3}):
1. $1.7\cdot 10^{16}$;
2. $5.8\cdot 10^{16}$.
(Kamakura et al. [1975]).

At T = 300 K the electron Hall factor in pure *n*-InAs r_H ~1.3.

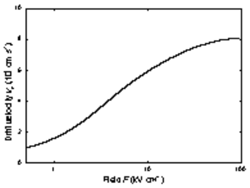


Hole Hall mobility (R·σ) versus temperature for different acceptor densities.
Hole concentration at 300 K p_o (cm^{-3}): **1**. $5.7\cdot10^{16}$; **2**. $2.6\cdot10^{17}$; **3**. $4.2\cdot10^{17}$; **4**. $1.3\cdot10^{18}$.
(Kasamanly et al. [1968]).

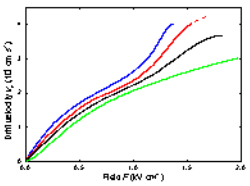


Hall coefficient versus temperature for different acceptor densities.
Hole concentration at 300 K p_o (cm^{-3}): **1**. $5.7\cdot10^{16}$; **2**. $2.6\cdot10^{17}$; **3**. $4.2\cdot10^{17}$; **4**. $1.3\cdot10^{18}$.
(Kasamanly et al. [1968]).

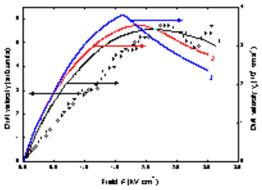
Transport Properties in High Electric Fields



Steady state field dependence of the electron drift velocity, 300 K,
F ‖ (100). Theoretical calculation
(Brennan and Hess[1984]).

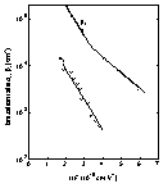


Field dependence of the electron drift velocity at different transverse magnetic fields for long (microsecond) pulses.
Experimental results, 77 K
Magnetic field B(T): **1**. 0.0; **2**. 0.3; **3**. 0.9; **4**. 1.5.
(Kamakura et al. [1975]).



Field dependence of the electron drift velocity, 77 K.
Solid lines show results of theoretical calculation for different non-parabolicity
α (eV^{-1}): **1**. 2.85; **2**. 2.0; **3**. 1.5. *(Kuchar et al. [1973])*.
Points show experimental results for very short (pico-second pulses)
(Krotkus and Dobrovolskis[1988]).

Impact Ionization



The dependence of ionization rates for electrons α_i and holes β_i versus 1/F, T =77K
(Mikhailova et al. [1976]).

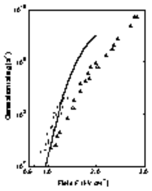
For electrons:

$\alpha_i = \alpha_o \exp(-F_{no}/F)$
$\alpha_o = 1.8\cdot10^5$ cm^{-1};
$F_{no} = 1.6\cdot10^5$ V cm^{-1} (77 K)

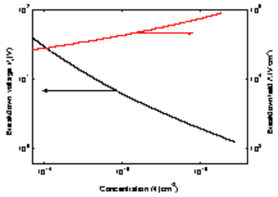
For holes:

$\beta_i = \beta_o \exp(-F_{po}/F)$
At 77 K

$1.5\cdot10^4$ V cm^{-1} < F < $3\cdot10^4$ V cm^{-1}	$3\cdot10^4$ V cm^{-1} < F < $6\cdot10^4$ V cm^{-1}
$\beta_o = 4.7\cdot10^5$ cm^{-1};	$\beta_o = 4.5\cdot10^6$ cm^{-1};
$F_{po} = 0.85\cdot10^5$ V cm^{-1}.	$F_{po} = 1.54\cdot10^5$ V cm^{-1}



Generation rate g versus electric field for relatively low fields, T = 77 K.
Solid line shows result of calculation.
Experimental results: open and full circles -undoped InAs,
open triangles - compensated InAs.
(Krotkus and Dobrovolskis[1988]).



Breakdown voltage and breakdown field versus doping density for an abrupt *p-n* junction, 77 K.

Recombination Parameters

Pure *n*-type material ($n_o = 2\cdot10^{-15}$ cm^{-3})

The longest lifetime of holes	$\tau_p \sim 3\cdot10^{-6}$ s
Diffusion length L_p	$L_p \sim 10 - 20$ µm.

Pure *p*-type material

The longest lifetime of electrons	$\tau_n \sim 3\cdot10^{-8}$ s
Diffusion length L_n	$L_n \sim 30 - 60$ µm

Characteristic surface recombination rates (cm s^{-1}) $10^2 - 10^4$.

Radiative recombination coefficient

77 K	$1.2\cdot10^{-9}$ cm^{3}s^{-1}
298 K	$1.1\cdot10^{-10}$ cm^{3}s^{-1}

Auger coefficient

300 K	$2.2\cdot10^{-27}$cm^{3}s^{-1}

(Gel'mont et al. [1982]).