

Monogermane (GeH₄)

1. Recommended electron collision cross sections

Source: H. Soejima and Y. Nakamura, *J. Vac. Soc. Technol. A* **11** (1993) 1161-1164

The following cross section set was compiled so that it can reproduce the drift velocity and the ND_L measured in GeH₄-Ar mixtures by the two-term Boltzmann code.

(1) Elastic momentum transfer cross section

Energy (eV)	Cross section (Å ²)	Energy (eV)	Cross section (Å ²)
0.000	190.660	0.800	10.000
0.010	132.040	1.000	16.800
0.015	102.720	1.200	23.000
0.020	86.000	1.400	28.600
0.030	70.000	1.700	35.600
0.040	60.000	2.000	41.600
0.050	54.000	2.500	46.600
0.060	46.000	3.000	49.120
0.080	38.000	3.500	48.400
0.100	30.000	4.000	47.000
0.120	22.400	5.000	43.200
0.140	15.000	6.000	40.300
0.170	10.000	8.000	36.300
0.200	6.000	10.000	33.280
0.230	4.500	15.000	27.360
0.260	3.800	20.000	24.160
0.300	3.200	30.000	19.680
0.350	3.000	40.000	17.120
0.400	3.200	60.000	14.000
0.500	3.760	80.000	12.000
0.600	4.920	100.000	10.600
0.700	7.000		

(2) Vibrational excitation cross section, Q_{v24} Threshold = 0.1015 eV, Energy loss = 0.1015 eV

Energy (eV)	Cross section (Å ²)	Energy (eV)	Cross section (Å ²)
0.1015	0.000	1.5000	8.400
0.1080	0.100	1.8000	12.000
0.1140	1.200	2.0000	13.000
0.1200	10.000	2.3000	15.000
0.1250	11.500	2.7000	14.500
0.1300	11.500	3.0000	13.000
0.1400	10.000	3.5000	9.500
0.1500	8.500	4.0000	6.500
0.1700	7.500	5.0000	3.000
0.2000	5.500	6.0000	1.700
0.2500	4.000	7.2000	1.230
0.3000	3.800	9.0000	0.960
0.3800	3.500	11.0000	0.780
0.5000	3.400	14.0000	0.600
0.6000	3.350	18.0000	0.438
0.7000	3.260	24.0000	0.300
0.8000	3.420	32.0000	0.190
1.0000	4.300	46.0000	0.100
1.2000	5.800	50.0000	0.000

(3) Vibrational excitation cross section, Q_{v13} Threshold = 0.2611 eV, Energy loss = 0.2611 eV

Energy (eV)	Cross section (\AA^2)	Energy (eV)	Cross section (\AA^2)
0.2611	0.000	1.6000	3.200
0.2650	0.100	1.8000	3.800
0.2730	0.400	2.0000	4.500
0.2800	0.700	2.2000	5.000
0.2870	1.000	2.5000	5.400
0.3000	1.600	2.8000	5.200
0.3200	2.400	3.0000	4.700
0.3500	2.800	3.5000	3.200
0.3700	3.000	4.0000	2.400
0.4000	3.000	5.0000	1.550
0.4500	2.700	6.2000	1.000
0.5000	2.500	7.0000	0.730
0.6000	2.250	8.2000	0.500
0.7000	2.200	10.0000	0.327
0.8000	2.200	12.0000	0.220
1.0000	2.200	14.0000	0.152
1.2000	2.400	16.5000	0.100
1.4000	2.800	20.0000	0.000

(4) Electronic excitation cross section, Q_{exc} Threshold = 8.4 eV, Energy loss = 8.4 eV

Energy (eV)	Cross section (\AA^2)	Energy (eV)	Cross section (\AA^2)
8.4000	0.000	16.0000	5.800
8.5000	0.500	18.0000	5.940
8.6000	1.100	20.0000	6.070
8.7000	1.460	25.0000	6.270
8.8000	1.710	30.0000	6.450
9.0000	2.200	35.0000	6.630
9.2000	2.580	40.0000	6.780
9.4000	2.900	45.0000	6.930
9.6000	3.200	50.0000	7.030
9.8000	3.480	60.0000	7.230
10.0000	3.720	70.0000	6.500
10.6000	4.300	80.0000	5.780
11.0000	4.560	90.0000	5.130
12.0000	5.060	100.0000	4.570
14.0000	5.570		

(5) Ionization cross section, Q_{exc} Threshold = 12.3 eV, Energy loss = 12.3 eV

Energy (eV)	Cross section (\AA^2)	Energy (eV)	Cross section (\AA^2)
12.3000	0.000	30.0000	4.500
12.5000	0.100	35.0000	4.850
13.3000	0.290	40.0000	5.080
13.7000	0.471	45.0000	5.250
14.0000	0.910	50.0000	5.360
15.0000	1.370	60.0000	5.410
16.6000	2.000	68.6000	5.450
18.3000	2.500	80.0000	5.410
20.0000	2.920	100.0000	5.300
25.0000	3.700		

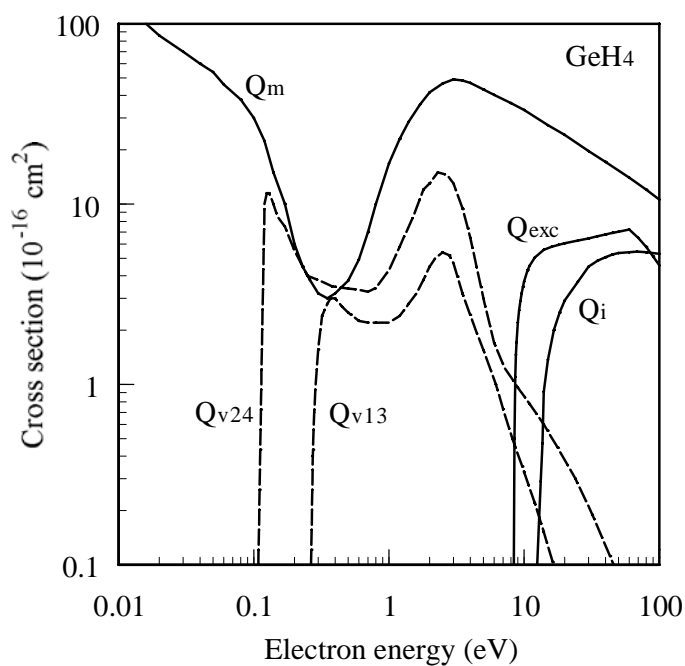


Fig. 1 The recommended cross sections for GeH₄.

2. Related electron swarm data

(1) Electron drift velocity, W , in GeH₄-Ar mixtures

0.210% GeH₄-Ar mixture

E/N (Td)	W (10 ⁶ cm/s)	E/N (Td)	W (10 ⁶ cm/s)
0.04	0.529	0.7	1.517
0.05	0.727	0.8	1.475
0.06	0.957	1	1.432
0.07	1.166	1.2	1.396
0.08	1.390	1.4	1.382
0.1	1.791	1.7	1.345
0.12	2.075	2	1.297
0.14	2.270	2.5	1.210
0.17	2.410	3	1.115
0.2	2.423	3.5	1.065
0.25	2.313	4	1.021
0.3	2.163	5	1.001
0.35	2.003	7	1.053
0.4	1.884	8	1.165
0.5	1.702	10	1.286
0.6	1.592	12	1.430

0.980% GeH₄-Ar mixture

E/N (Td)	W (10 ⁶ cm/s)	E/N (Td)	W (10 ⁶ cm/s)
0.04	0.2913	0.14	1.298
0.05	0.3679	0.17	1.711
0.06	0.4498	0.2	2.142
0.07	0.5373	0.25	2.839
0.08	0.6286	0.3	3.405
0.1	0.8355	0.35	3.848
0.12	1.045	0.4	4.149

0.5	4.363	6	2.344
0.6	4.329	7	2.230
0.7	4.172	8	2.155
0.8	3.989	10	2.137
1	3.686	12	2.189
1.2	3.444	14	2.305
1.4	3.262	17	2.550
1.7	3.099	20	2.694
2	2.990	25	3.017
2.5	2.889	30	3.350
3	2.836	35	3.812
3.5	2.780	40	4.222
4	2.709	50	4.586
5	2.527		

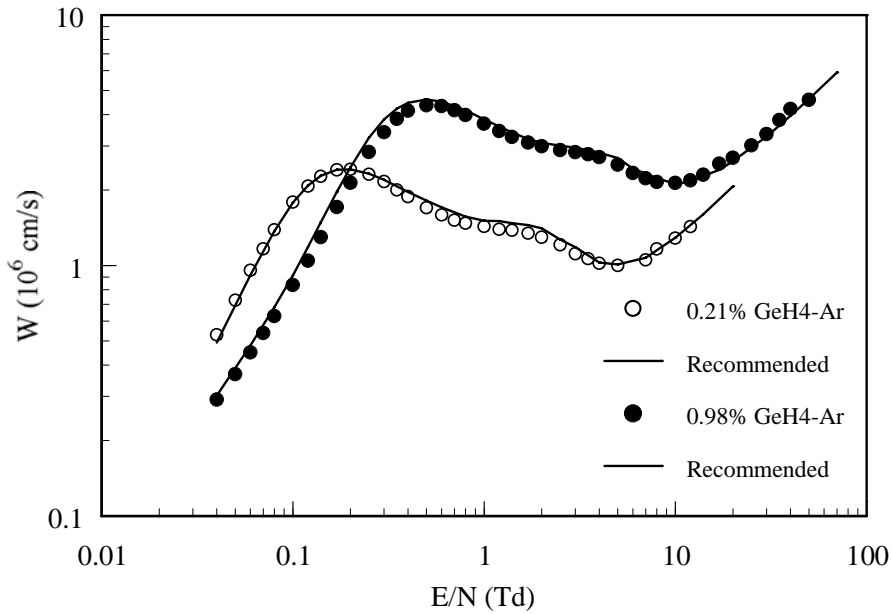


Fig. 2 Electron drift velocity in GeH₄-Ar mixtures.

(2) Product of longitudinal diffusion coefficient and gas number density, ND_L, in GeH₄-Ar mixtures

0.210% GeH₄-Ar mixture

E/N (Td)	ND _L (10 ²³ cm/s)	E/N (Td)	ND _L (10 ²³ cm/s)
0.04	0.821	0.35	0.5517
0.05	1.041	0.4	0.4770
0.06	1.420	0.5	0.4009
0.07	1.627	0.6	0.3349
0.08	1.754	0.7	0.3019
0.1	1.835	0.8	0.3164
0.12	1.687	1.2	0.2600
0.14	1.507	1.4	0.2600
0.17	1.261	1.7	0.197
0.2	1.004	2	0.170
0.25	0.7906	2.5	0.095
0.3	0.7082	3	0.091

0.980% GeH₄-Ar mixture

E/N (Td)	ND _L (10 ²³ cm/s)	E/N (Td)	ND _L (10 ²³ cm/s)
0.04	0.2468	1.7	0.2769
0.05	0.2879	2	0.2496
0.06	0.2922	2.5	0.2316
0.07	0.3041	3	0.2160
0.1	0.4754	3.5	0.1860
0.12	0.6770	4	0.1510
0.14	0.6079	5	0.1150
0.17	1.135	6	0.1100
0.2	1.015	7	0.1240
0.25	1.121	8	0.1418
0.3	1.140	10	0.1920
0.35	1.058	12	0.2220
0.4	0.9627	14	0.2402
0.5	0.7227	17	0.2705
0.6	0.6624	20	0.2571
0.7	0.4835	25	0.2787
0.8	0.4372	30	0.3045
1	0.3861	35	0.3066
1.2	0.3225	50	0.2887
1.4	0.2870		

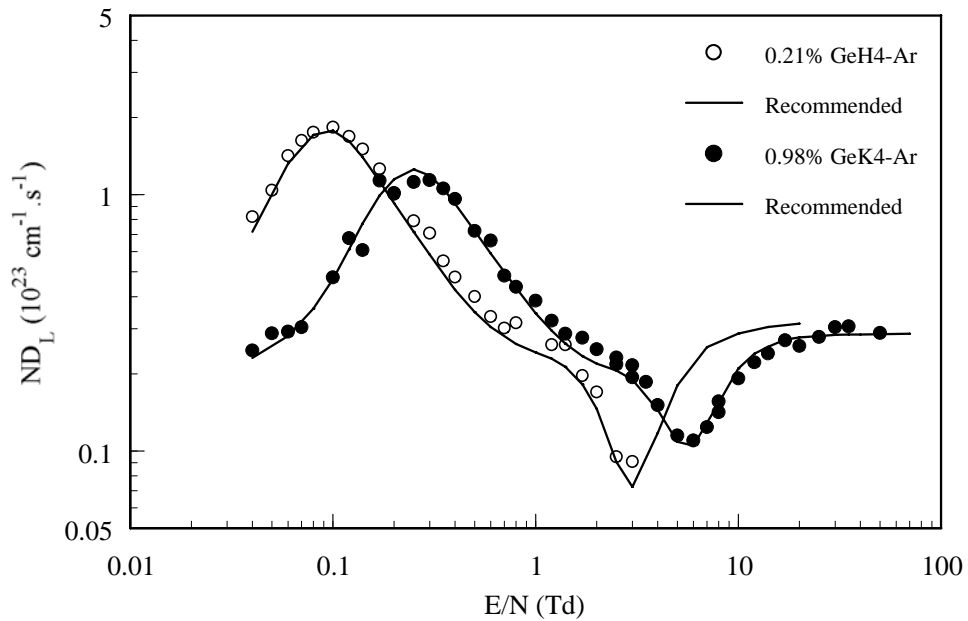


Fig. 3 ND_L in GeH₄-Ar mixtures