Ethane (C_2H_6)

1. Recommended electron collision cross sections[1]

Source: Y. Nakamura, *J. Phys.D* **30** (1997)1610-1615

The following cross section set was compiled so that it can reproduce the drift velocity and the ND_L measured in C_2H_6-Ar mixtures and the drift velocity, ND_L and the Townsend's ionization coefficient measured in pure C_2H_6 gas by the multi-term Boltzmann code (Robson and Ness, *Phys. Rev. A* **26** (1986)2068).

(1) Elastic momentum transfer cross section

Energy (eV)	Cross section (Å^2)	Energy (eV)	Cross section (Å^2)
0.001	88.000	0.500	6.150
0.002	60.000	0.600	7.000
0.003	48.000	0.700	7.400
0.005	35.000	0.800	7.700
0.007	27.800	1.000	8.000
0.010	21.500	1.500	8.500
0.015	16.000	2.000	9.100
0.020	12.400	2.500	10.250
0.025	10.200	3.000	11.100
0.030	8.800	4.000	13.730
0.040	6.600	5.000	16.170
0.050	4.700	6.000	17.750
0.060	3.400	7.000	18.050
0.070	2.600	8.000	17.100
0.080	2.000	10.000	14.660
0.090	1.500	12.000	12.110
0.100	1.220	15.000	9.220
0.110	1.125	20.000	6.250
0.120	1.180	25.000	4.660
0.130	1.260	30.000	3.700
0.150	1.450	40.000	2.630
0.170	1.660	50.000	2.070
0.200	2.000	60.000	1.750
0.250	2.700	80.000	1.330
0.300	3.500	100.000	1.070
0.350	4.250	200.000	0.530
0.400	4.900	500.000	0.250

(2) Vibrational excitation cross section (bending, v3) Threshold = 0.112eV, Energy loss = 0.112eV

Energy (eV)	Cross section (Å^2)	Energy (eV)	Cross section (Å^2)
0.112	0.0000	0.220	0.0365
0.115	0.0700	0.250	0.0325
0.120	0.1130	0.280	0.0308
0.125	0.1230	0.300	0.0300
0.130	0.1250	0.330	0.0300
0.140	0.1270	0.350	0.0300
0.150	0.1200	0.400	0.0317
0.160	0.0990	0.500	0.0380
0.180	0.0640	0.600	0.0450
0.200	0.0420	0.800	0.0600

1.000	0.0750	8.000	1.2000
1.200	0.0910	9.000	1.1800
1.500	0.1170	10.000	1.1500
2.000	0.1600	12.000	1.0200
2.500	0.2100	15.000	0.7800
3.000	0.2750	20.000	0.4500
4.000	0.4500	25.000	0.2750
5.000	0.7200	30.000	0.1750
6.000	0.9700	40.000	0.0850
6.500	1.0800	50.000	0.0460
7.000	1.1800	60.000	0.0300
7.500	1.2000	100.000	0.0000

(3) Vibrational excitation cross section (bending,v2) Threshold = 0.167eV, Energy loss = 0.167eV

Energy (eV)	Cross section ($Å^2$)	Energy (eV)	Cross section ($Å^2$)
0.167	0.0000	3.000	0.6000
0.170	0.0450	4.000	0.8000
0.180	0.1100	5.000	1.2000
0.190	0.2300	6.000	1.8100
0.200	0.3600	6.500	2.1.000
0.220	0.5500	7.000	2.3100
0.250	0.7000	7.500	2.4200
0.270	0.7200	8.000	2.4100
0.300	0.6900	9.000	2.2300
0.320	0.6200	10.000	2.0200
0.350	0.5300	12.000	1.7300
0.400	0.4550	13.000	1.6000
0.500	0.3900	15.000	1.4100
0.600	0.3550	20.000	0.8100
0.800	0.3400	25.000	0.4350
1.000	0.3500	30.000	0.2600
1.200	0.3620	40.000	0.1130
1.500	0.3750	50.000	0.0550
1.700	0.4000	60.000	0.0300
2.000	0.4350	100.000	0.0000
2.500	0.5150		

(3) Vibrational excitation cross section (bending,v1) Threshold = 0.36eV, Energy loss = 0.36eV

Energy (eV)	Cross section ($Å^2$)	Energy (eV)	Cross section ($Å^2$)
0.360	0.0000	2.000	0.2000
0.370	0.0600	2.500	0.2650
0.380	0.0800	3.000	0.3550
0.390	0.1100	4.000	0.5700
0.400	0.1200	5.000	0.8600
0.450	0.1950	6.000	1.3100
0.500	0.2500	6.500	1.6000
0.600	0.3250	7.000	1.8000
0.700	0.3650	7.500	1.8500
0.800	0.3650	8.000	1.8000
0.900	0.3500	9.000	1.5000
1.000	0.3300	10.000	1.1970
1.200	0.2600	12.000	0.9100
1.500	0.2120	15.000	0.6700
1.700	0.2010	20.000	0.3000

30.000	0.1100	100.000	0.0000
50.000	0.0300		

(4) Attachment cross section Threshold = 7.05eV

Energy (eV)	Cross section (Å^2)	Energy (eV)	Cross section (Å^2)
7.050	0.0000[2]	11.000	0.0072
7.520	0.0020	11.500	0.0050
8.000	0.0040	12.000	0.0035
8.600	0.0110	12.600	0.0020
9.700	0.0150	13.500	0.0000
10.500	0.0100		

(5) Electronic excitation cross section Threshold = 9.185eV, Energy loss = 9.185eV

Energy (eV)	Cross section (Å^2)	Energy (eV)	Cross section (Å^2)
9.185	0.0000	25.000	2.5000
9.200	0.1000	30.000	2.6000
10.000	0.4200	35.000	2.7000
11.000	0.8300	40.000	2.7000
12.000	1.1200	50.000	2.6500
13.000	1.3500	70.000	2.3000
15.000	1.7700	100.000	1.6000
17.000	2.0000	200.000	0.7800
20.000	2.2500	500.000	0.3800

(6) Neutral dissociation cross section Threshold = 10.2eV, Energy loss = 10.2eV

Energy (eV)	Cross section (Å^2)	Energy (eV)	Cross section (Å^2)
10.200	0.0000[3]	40.000	1.3500
11.000	0.2900	50.000	1.3750
11.500	0.4200	60.000	1.3900
12.000	0.5000	80.000	1.4000
13.000	0.6000	100.000	1.4000
14.000	0.6800	120.000	1.4000
15.000	0.7500	150.000	1.3900
17.000	0.8700	200.000	1.3500
20.000	1.0000	250.000	1.3200
25.000	1.1300	300.000	1.2700
30.000	1.2500	400.000	1.2200
35.000	1.3000	600.000	1.1500

(7) Ionization cross section Threshold = 11.8eV, Energy loss = 11.8eV

11.800	0.0000[2]	30.000	4.2200
12.000	0.0600	40.000	5.2500
13.000	0.2100	50.000	5.7500
14.000	0.5000	70.000	6.0500
15.000	0.7800	100.000	6.0400
16.000	1.0300	150.000	5.9500
17.000	1.7000	200.000	5.4800
20.000	2.2500	300.000	4.5000
25.000	3.3500	500.000	3.6500

[1] Y. Nakamura, *J. Phys.D* **30** (1997)1610-1615

[2] M. Hayashi, in "*Swarm Studies and Inelastic Electron-Molecule Collisions*", ed. by L. C. Pitchford *et al*., Springer-Verlag (New York) 1987

[3] H. F. Winters, *Chem. Phys.* **36** (1979) 353-364

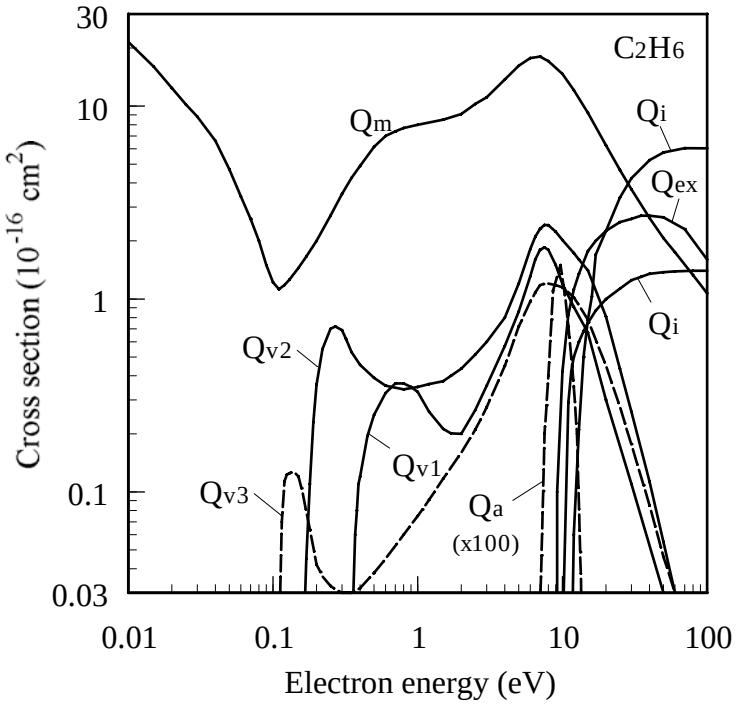

Fig. 1 Recommended cross sections for C_2H_6

2. Related electron swarm data

(1) Electron drift velocity, W, in pure C_2H_6

E/N (Td)	W (10^6 cm/s)		E/N (Td)	W (10^6 cm/s)	
0.03	0.1097[1]		1.6		4.330
0.035	0.1284		1.7	4.476	
0.04	0.1470		1.8		4.500
0.05	0.1853		2	4.715	4.640
0.06	0.2222		2.5	4.985	4.890
0.07	0.2592		3	5.116	5.060
0.08	0.2971	0.289[4]	3.5	5.243	5.180
0.1	0.3755	0.366	4	5.332	5.270
0.12	0.4558	0.445	4.5		5.330
0.14	0.5375	0.526	5	5.440	5.380
0.16		0.609	6	5.525	5.440
0.17	0.6624		7	5.526	5.470
0.18		0.693	8	5.537	5.480
0.2	0.7883	0.777	10	5.506	
0.25	1.005	0.988	12	5.483	
0.3	1.223	1.190	14	5.416	
0.35	1.435	1.410	17	5.333	
0.4	1.643	1.620	20	5.252	
0.5	2.034	2.000	25	5.180	
0.6	2.4	2.360	30	5.146	
0.7	2.73	2.680	35	5.170	
0.8	3.03	2.980	40	5.220	
1	3.51	3.470	50	5.340	
1.2	3.87	3.830	60	5.456	
1.4	4.15	4.110	70	5.650	

80	5.938	170	9.737
100	6.615	200	11.436
120	7.290	250	13.841
140	8.355	300	16.894

[4] B. Schmidt and M. Roncossek, *Aust. J. Phys.* **45** (1992) 351-363
[5] I. C. Walker (1984)

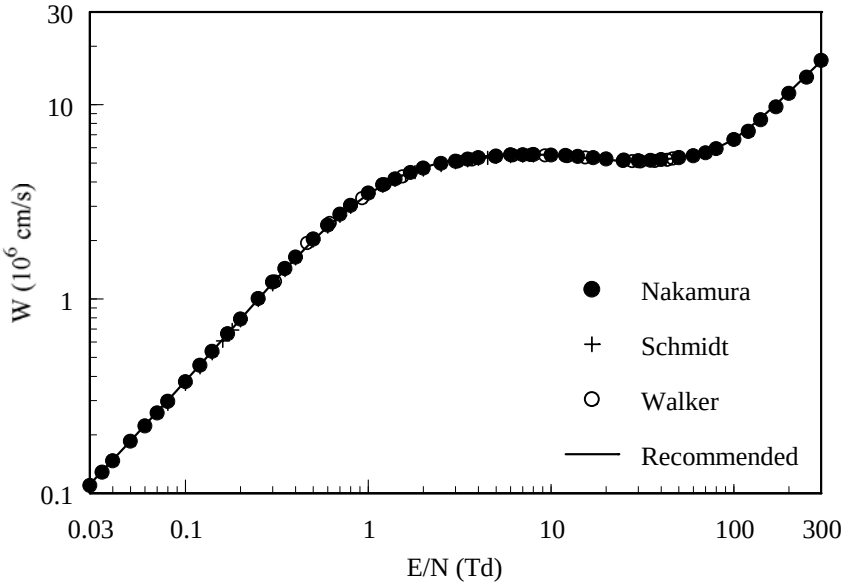

Fig. 2 Electron drift velocity in pure C_2H_6

(2) Product of longitudinal diffusion coefficient and gas number density, ND_L, in pure C_2H_6

E/N (Td)	ND_L (10^{20} $cm^{-1}.s^{-1}$)		E/N (Td)	ND_L (10^{20} $cm^{-1}.s^{-1}$)	
0.03	99.34[1]		1	166.9	162.0
0.035	105.5		1.2	159.3	149.7
0.04	106.0		1.4	147.8	138.6
0.05	112.5		1.6		130.2
0.06	111.4		1.7	127.4	
0.07	118.6		1.8		124.0
0.08	127.9	114.5[4]	2	128.5	119.7
0.1	137.4	121.9	2.5	119.4	113.8
0.12	130.0	129.0	3	106.0	108.6
0.14	128.2	136.0	3.5	102.5	102.9
0.16		143.0	4	98.6	96.3
0.17	136.6		4.5		91.4
0.18		150.0	5	88.5	87.4
0.2	152.0	157.0	6	83.4	78.2
0.25	165.4	170.0	7	76.3	71.1
0.3	175.6	175.7	8	71.3	65.4
0.35	181.7	180.9	10	67.0	
0.4	192.0	183.0	12	65.8	
0.5	192.9	181.6	14	61.2	
0.6	187.9	178.6	17	61.8	
0.7	185.4	174.6	20	60.5	
0.8	185.5	171.4	25	62.6	

30	60.8	100	88.0
35	60.9	120	96.3
40	59.4	140	123.3
50	59.4	170	137.3
60	58.7	200	149.1
70	59.2	250	166.8
80	67.4	300	202.1

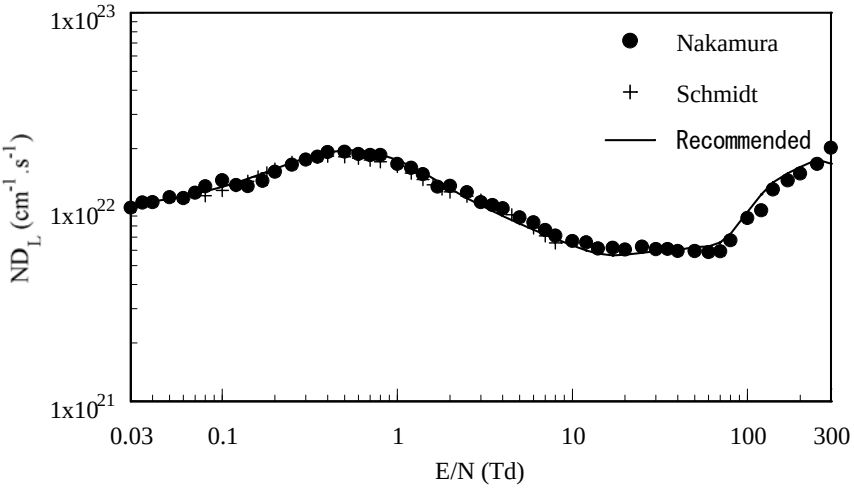

Fig. 3 ND_L in pure C_2H_6

(3) Ionization coefficient in pure C_2H_6

E/N (Td)	$\alpha/N(10^{-17}cm^2)$	E/N (Td)	$\alpha/N(10^{-17}cm^2)$
82.0	0.0037[6]	254.6	2.32
84.9	0.0051	282.9	3.05
90.5	0.0091	311.1	3.88
96.2	0.0158	339.4	4.58
101.8	0.0255	367.7	5.37
110.3	0.0481	424.3	6.82
118.8	0.0849	480.9	8.49
127.3	0.136	565.7	10.7
135.8	0.209	707.2	15.3
147.1	0.322	848.6	19.0
158.4	0.453	1131	26.0
169.7	0.594	1414	32.2
183.9	0.820	1697	38.2
198.0	1.07	2263	48.1
212.1	1.39	2829	53.7
226.3	1.70	4243	62.2
240.4	1.98		

[6] A. E. D. Heylen, *Int. J. Electronics* **39** (1975) 653-660

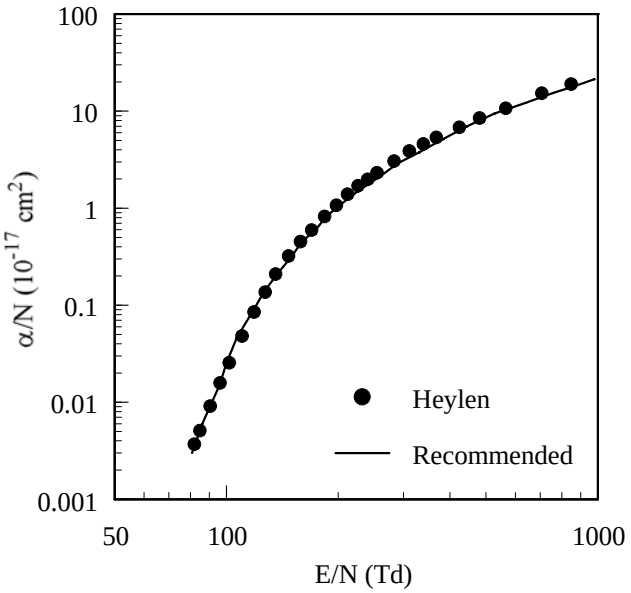

Fig.4 α/N in pure C_2H_6

(4) Electron drift velocity, W, in C_2H_6-Ar mixtures

0.206% C_2H_6-Ar mixture

E/N (Td)	W (10^6 cm/s)	E/N (Td)	W (10^6 cm/s)
0.03	0.709[1]	0.35	0.599
0.035	0.777	0.4	0.577
0.04	0.839	0.5	0.545
0.05	0.903	0.6	0.520
0.06	0.930	0.7	0.513
0.07	0.935	0.8	0.507
0.08	0.928	1	0.494
0.1	0.897	1.2	0.490
0.12	0.860	1.4	0.491
0.14	0.823	1.7	0.499
0.17	0.771	2	0.509
0.2	0.728	2.5	0.522
0.25	0.672	3	0.531
0.3	0.640		

1.98% C_2H_6-Ar mixture

E/N (Td)	W (10^6 cm/s)	E/N (Td)	W (10^6 cm/s)
0.03	0.486[1]	0.2	2.559
0.035	0.602	0.25	2.582
0.04	0.725	0.3	2.544
0.05	0.976	0.35	2.479
0.06	1.216	0.4	2.404
0.07	1.437	0.5	2.251
0.08	1.639	0.6	2.118
0.1	1.964	0.7	1.993
0.12	2.200	0.8	1.890
0.14	2.352	1	1.729
0.17	2.494	1.2	1.605

1.4	1.517	7	1.304
1.7	1.428	8	1.327
2	1.362	10	1.384
2.5	1.304	12	1.474
3	1.272	14	1.597
3.5	1.254	17	1.801
4	1.255	20	2.026
5	1.256	25	2.411
6	1.279		

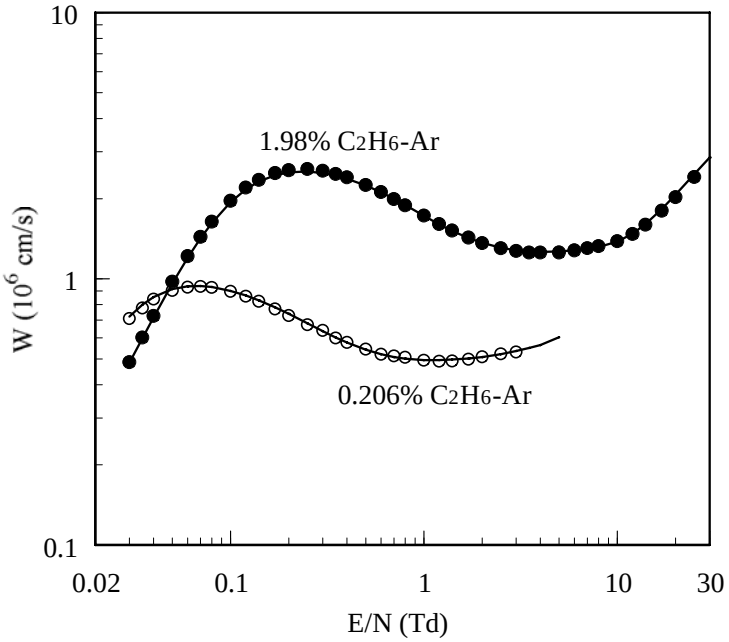

Fig.5 Electron drift velocity in C_2H_6-Ar mixtures. Solid curves: calculated with the recommended cross sections.

(5) Product of longitudinal diffusion coefficient and gas number density, ND_L, in C_2H_6-Ar mixtures

0.206% C_2H_6-Ar mixture

E/N (Td)	ND_L (10^{22} cm^{-1}.s^{-1})	E/N (Td)	ND_L (10^{22} cm^{-1}.s^{-1})
0.03	24.61[1]	0.3	2.53
0.035	22.45	0.35	2.59
0.04	20.82	0.4	2.38
0.05	17.03	0.5	2.15
0.06	13.67	0.6	1.61
0.07	11.85	0.8	1.57
0.08	10.95	1	1.53
0.1	8.64	1.2	1.39
0.12	7.07	1.4	1.33
0.14	6.16	1.7	1.36
0.17	4.74	2	1.18
0.2	4.29	2.5	1.12
0.25	3.10	3	1.08

0.206% C_2H_6-Ar mixture

E/N (Td)	ND_L (10^{22} $cm^{-1}.s^{-1}$)	E/N (Td)	ND_L (10^{22} $cm^{-1}.s^{-1}$)
0.03	11.00[1]	1	2.24
0.035	12.01	1.2	1.92
0.04	13.99	1.4	1.70
0.05	17.18	1.7	1.61
0.06	19.76	2	1.55
0.07	19.97	2.5	1.51
0.08	19.75	3	1.30
0.1	18.20	3.5	1.39
0.12	16.23	4	1.26
0.14	13.88	5	1.24
0.17	12.43	6	1.13
0.2	11.61	7	1.12
0.25	9.46	8	1.10
0.3	7.60	10	1.23
0.35	6.98	12	1.30
0.4	6.14	14	1.51
0.5	4.94	17	1.75
0.6	3.80	20	1.89
0.7	3.34	25	2.36
0.8	2.85		

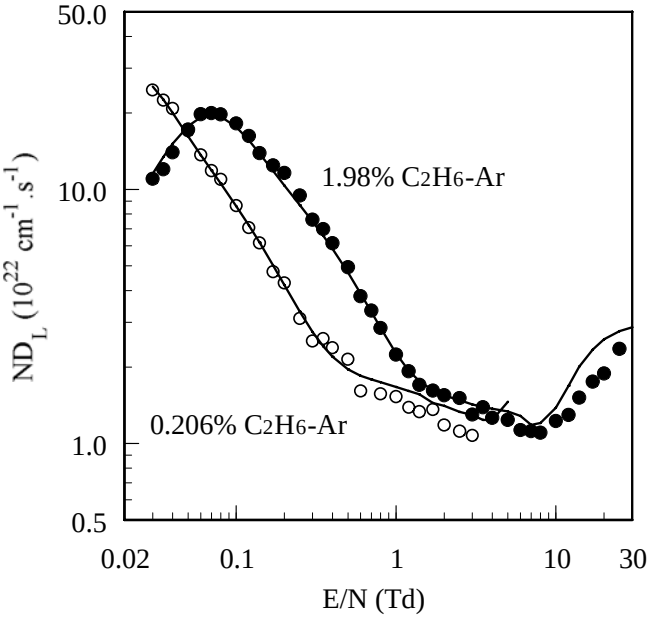

Fig. 6 NDL in C_2H_6-Ar mixtures. Solid curves: calculated with the recommended cross sections.