6.3 Elastic momentum transfer cross sections

6.3.1 Introduction

6.3.1.1 Definition in terms of the differential cross section

The momentum transfer cross section, σ_m, for electron scattering is defined as

$$\sigma_m(\varepsilon) = 2\pi \int_0^\pi \frac{d\sigma}{d\Omega}(1 - \frac{c'}{c}\cos\theta)\sin\theta d\theta \quad (1)$$

where $d\sigma/d\Omega$, the differential cross section, is defined as that fraction of a beam of electrons of energy ε which are scattered at an angle θ into the element of solid angle $d\Omega = 2\pi\sin\theta d\theta$; c and c' are the electron speeds before and after the collision respectively. The name of this cross section arises from the fact that the term $(1 - (c'/c)\cos\theta)$ is the fractional loss of directed momentum of the electron in a collision. More accurately, the speeds c and c' should be the relative speeds in the centre of mass system, g, before the collision and g' after the collision. However because of the small mass ratio m/M, where m is the electron mass and M the mass of the target particle, the replacement of g and g' by c and c' does not result in significant error.

In general electron collisions may be elastic, inelastic or superelastic. Relation (1) can thus be written as the sum of the momentum transfer cross sections for specific scattering processes, i.e.

$$\sigma_m(\varepsilon) = \sigma_m(\varepsilon)^{el} + \sum_k \sigma_m^k(\varepsilon)^{in} + \sum_k \sigma_m^k(\varepsilon)^{sup} \quad (2)$$

where $\sigma_m(\varepsilon)^{el}$ is the elastic momentum transfer cross section and $\sigma_m^k(\varepsilon)^{in}$ and $\sigma_m^k(\varepsilon)^{sup}$ are the momentum transfer cross sections for the k^{th} inelastic and superelastic scattering processes, respectively.

There are a number of special cases:

(a) if the scattering is isotropic (i.e. $d\sigma/d\Omega$ is independent of θ) then

$$\sigma_m(\varepsilon) = \sigma(\varepsilon) \quad (3)$$

where $\sigma(\varepsilon)$ is the integral elastic cross section, defined in subsect. 6.2.1.1, as

$$\sigma(\varepsilon) = 2\pi \int_0^\pi \frac{d\sigma}{d\Omega}\sin\theta \, d\theta \quad (4)$$

(b) if the scattering is elastic only, then

$$\sigma_m(\varepsilon) = \sigma_m(\varepsilon)^{el} = 2\pi \int_0^\pi \frac{d\sigma}{d\Omega}(1 - \cos\theta)\sin\theta \, d\theta \quad (5)$$

The entries in the accompanying tables of momentum transfer cross sections are values of $\sigma_m(\varepsilon)^{el}$ i.e. the elastic component of $\sigma_m(\varepsilon)$. In cases where the momentum transfer cross section is derived from crossed beam studies the elastic component should be understood as usually consisting of the sum of $\sigma_m(\varepsilon)^{el}$ and rotational excitation cross sections (suitably weighted for the relative abundances in the lower rotational state), the molecule being in its ground vibrational and electronic state. There is also a contribution from super elastic rotational de-excitation processes. In those cases where the elastic component is derived from an analysis of swarm experiments using multiterm solutions of the Boltzmann equation (see 6.3.2.1 below), the elastic component does not contain any contribution due to rotational excitation.

The momentum transfer cross section arises most often, but not exclusively, in the description of the motion of electrons in a gas at a given temperature and number density, usually in the presence of electric and/or magnetic fields. For a detailed description of the electron motion see Huxley and Crompton [74Hux1].

6.3.1.2 Definition in terms of the scattering phase shifts

The application of the phaseshift approaches described in subsect. 6.2.1.2 for elastic scattering are not, strictly speaking, appropriate in electron molecule scattering. However the technique, or variations of it, have been applied to a number of non-polar molecules which exhibit a high degree of spherical symmetry, such as the hydrocarbons.

6.3.2 Experimental determinations

6.3.2.1 From swarm experiments

The momentum transfer cross section, $\sigma_m(\varepsilon)$, can be obtained from transport coefficients measured in electron swarm experiments by using a solution of the Boltzmann equation, and an iterative procedure, to match calculated values of the transport coefficients (commonly the drift velocity, v_{dr}, and the ratio of the lateral diffusion coefficient, D_T, to the electron mobility, μ, i.e. D_T/μ) to the experimental data. Problems involving non-uniqueness of the fitted cross sections, due to the form of $\sigma_m(\varepsilon)$ or the presence of inelastic processes, have been discussed by Huxley and Crompton [74Hux1]. The energy range over which $\sigma_m(\varepsilon)$ can be derived from swarm data is limited by the range of values of E/N (E is the electric field strength and N the gas number density) for which transport coefficient data are available. This range is restricted by the onset of electric discharge.

Two types of solution of the Boltzman equation have been used:

(a) the "two term" solution:

The "two term" solution involves the assumption that the electron velocity distribution can be expanded in spherical harmonics and truncated after two terms. If the cross section for elastic scattering is very much greater than those for inelastic collisions then the angular scattering in such collisions does not significantly affect $\sigma_m(\varepsilon)$. In these circumstances the inelastic scattering may be assumed to be isotropic without significant error and thus

$$\sigma_m(\varepsilon) = \sigma_m(\varepsilon)^{el} + \sum_k \sigma^k(\varepsilon)^{in} + \sum_k \sigma^k(\varepsilon)^{sup} \qquad (6)$$

where $\sigma^k(\varepsilon)^{in}$ and $\sigma^k(\varepsilon)^{sup}$ are the integral cross sections for the k^{th} inelastic and superelastic collision processes, respectively.

(b) "multiterm" solutions

In certain cases (e.g. D_T/μ calculations for methane [91Sch1]) the two term representation of the velocity distribution function is inadequate and a more complex representation is required. In multiterm solutions the isotropic scattering assumption for all the inelastic processes is not made and the differential scattering cross sections are entered separately. In many cases however the transport coefficient calculations are not sensitive to the angular scattering for specific inelastic scattering processes and isotropic scattering may be assumed.

There is often ambiguity in the literature concerning the exact designation of the momentum transfer cross section. Unless otherwise specified, it is probable that the $\sigma^m(\varepsilon)$ derived using a "two term" solution is the cross section defined by (6), whereas the momentum transfer cross section listed in analyses using a "multiterm solution" are values of $\sigma^m(\varepsilon)^{el}$. However considerable care should be exercised to avoid confusion on this point.

6.3.2.2 From crossed beam experiments

The elastic momentum transfer cross section, $\sigma_m(\varepsilon)^{el}$, can be derived from absolute measurements of the elastic differential scattering cross section, $d\sigma/d\Omega$, via eq. (1). The main complication with this technique is that most measurements of $d\sigma/d\Omega$ cannot cover the entire range of scattering angles between 0 and π, due to the presence of the primary beam at forward angles and other geometrical constraints at backward angles. Procedures for carrying out the extrapolations to 0 and π and the uncertainties involved are discussed in subsect. 6.2.2.2. Methods for increasing the angular range of the experimental measurements are also discussed in this section. Much of the experimental data which is used in deriving the preferred elastic momentum transfer cross sections in the following section is from crossed beam measurements of differential elastic scattering. As a result of the difficulties in extracting accurate elastic momentum transfer cross sections by integrating the differential cross section, it is not uncommon for the the uncertainties on the derived $\sigma_m(\varepsilon)^{el}$ cross sections to exceed 20 %. In general swarm experiments provide the most accurate values at low electron energies (where freqently there are no beam derived values available) and are complementary to the beam-derived values at higher energies.

References for 6.3.1 and 6.3.2

74Hux1 Huxley, L.G.H., Crompton, R.W.: The Diffusion and Drift of Electrons in Gases, New York: Wiley 1974

91Sch1 Schmidt, B: J. Phys. B: At. Mol. Opt. Phys. **28** (1991) 4809

6.3.3 Determination of preferred cross sections

The preferred elastic momentum transfer cross section for each molecule in this section has been derived from a consideration of all available (published) experimental and, in some cases, theoretical work. In general, we do not consider those cases where only theoretical values exist, unless there is substantial corroboration between two or more diffferent calculations. More weight has been placed on recent measurements which have realistic and well quantified uncertainties. The uncertainty estimates on the preferred cross sections indicate the level of concurrence between the various individual measurements and calculations.

6.3.4 Units

Cross sections are given in square Ångström ($1 Å^2 = 10^{-16}$ cm^2) and electron energies in electron volt (eV).

6.3.5 Molecules

6.3.5.1 Hydrogen (H_2)

The preferred cross section is listed in Table 6.3.5.1 and shown in Fig. 6.3.5.1. From 0.001 to 2 eV the preferred cross section is taken to be that of [94Sch1]. From 2 to 4 eV the preferred cross section follows closely the *ab initio* theoretical values of [87Mor1] which agree with [94Sch1] to within 4 % over the range to 4 eV. For the remainder of the energy range to 100 eV the preferred cross section is based on the experimental beam-derived values of [81Shy1, 85Nis1, 86Kha1, 91Bru1].

The uncertainty limits are estimated to be $< \pm 5$ % for 0.001 eV $\leq \varepsilon < 4$ eV and $< \pm 15$ % for 4 eV $\leq \varepsilon \leq 100$ eV.

Table 6.3.5.1. Preferred values of the elastic momentum transfer cross section (σ_m^{el}) for electrons scattered from hydrogen (H_2).

Energy [eV]	σ_m^{el} [Å^2]	Energy [eV]	σ_m^{el} [Å^2]	Energy [eV]	σ_m^{el} [Å^2]
0.0010	7.25	0.06	9.54	2.5	17.40
0.0012	7.26	0.07	9.79	3	16.28
0.0015	7.26	0.08	10.04	4	13.70
0.0018	7.27	0.09	10.25	5	11.59
0.0020	7.28	0.10	10.47	6	10.00
0.0025	7.30	0.12	10.86	7	8.59
0.0030	7.35	0.15	11.35	8	7.48
0.004	7.38	0.18	11.78	9	6.58
0.005	7.45	0.20	12.02	10	5.78
0.006	7.48	0.25	12.54	12	4.396
0.007	7.54	0.30	13.00	15	3.275
0.008	7.59	0.40	13.81	18	2.529
0.009	7.64	0.50	14.52	20	2.154
0.010	7.70	0.60	15.16	25	1.476
0.012	7.78	0.70	15.66	30	1.077
0.015	7.90	0.80	16.17	40	0.636
0.018	8.04	0.90	16.58	50	0.417
0.020	8.14	1.0	17.01	60	0.311
0.025	8.33	1.2	17.70	70	0.243
0.03	8.56	1.5	18.15	80	0.200
0.04	8.93	1.8	18.22	90	0.169
0.05	9.27	2.0	18.11	100	0.149

References for 6.3.5.1

81Shy1 Shyn, T.W., Sharp, W.E.: Phys. Rev. A **24** (1981) 1734
85Nis1 Nishimura, H., Danjo, A., Sugahara, H.J.: Phys. Soc. Jpn. **54** (1985) 1757
86Kha1 Khakoo, M.A., Trajmar, S.: Phys. Rev. A **34** (1986) 138
87Mor1 Morrison, M.A., Crompton, R.W., Saha, B.C., Petrovic, Z.Lj.: Aust. J. Phys. **40** (1987) 239
91Bru1 Brunger, M.J., Buckman, S.J., Newman, D.S., Alle, D.T.: J. Phys. B: At. Mol. Opt. Phys. **24** (1991) 1435
94Sch1 Schmidt, B., Berkhan, K., Gotz, B., Muller, M.: Phys. Scripta T **53** (1994) 30

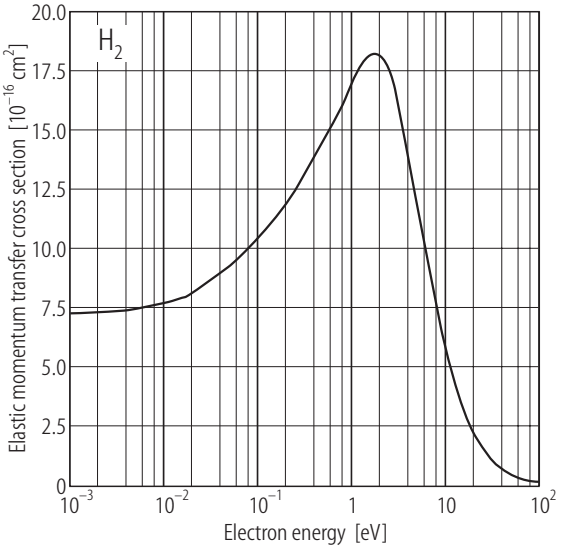

Fig. 6.3.5.1. Preferred values of the elastic momentum transfer cross section for electrons scattered from hydrogen (H_2).

6.3.5.2 Deuterium (D_2)

The preferred cross section is listed in Table 6.3.5.2 and shown in Fig. 6.3.5.2. The preferred σ_m^{el} is derived from the σ_m cross section of [89Pet1] by subtracting the v = 0 - 1 vibrational excitation cross section which they used in their calculations of transport coefficients. The [89Pet1] cross section is the same as the "reference set" cross section of [85Buc1], with minor variations and has been taken from the thesis by Z. Petrovic [87Pet1].

The uncertainty limits are estimated to be ≤ 5 % from 0.1 to 1.4 eV. No uncertainty limit is quoted for energies greater than 1.4 eV due to non-uniqueness problems.

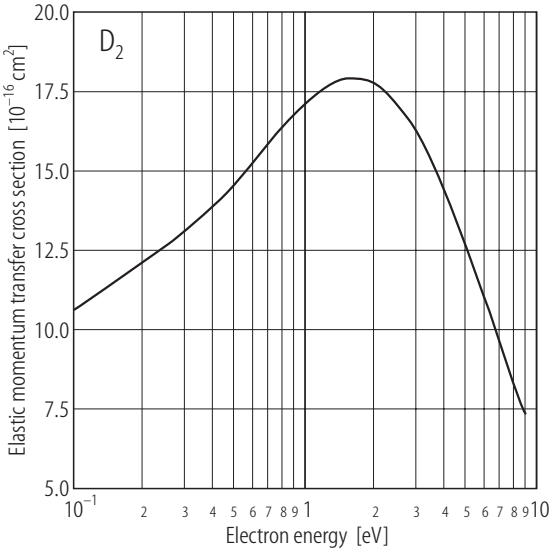

Fig. 6.3.5.2. Preferred values of the elastic momentum transfer cross section for electrons scattered from deuterium (D_2).

Table 6.3.5.2. Preferred values of the elastic momentum transfer cross section (σ_m^{el}) for electrons scattered from deuterium (D_2).

Energy [eV]	σ_m^{el} [Å^2]	Energy [eV]	σ_m^{el} [Å^2]	Energy [eV]	σ_m^{el} [Å^2]
0.1	10.6	0.6	15.2	2.5	17.3
0.12	10.9	0.7	15.8	3	16.4
0.15	11.5	0.8	16.4	4	14.5
0.18	11.9	0.9	16.8	5	12.6
0.2	12.1	1	17.1	6	10.9
0.25	12.6	1.2	17.6	7	9.50
0.3	13.0	1.5	18.0	8	8.28
0.4	13.8	1.8	18.0	9	7.34
0.5	14.5	2	17.9		

References for 6.3.5.2

85Buc1 Buckman, S.J., Phelps, A.V.: J. Chem. Phys. **82** (1985) 499l
87Pet1 Petrovic, Z.Lj.: PhD thesis (1987), Australian National University, Canberra
89Pet1 Petrovic, Z.Lj., Crompton, R.W.: Aust. J. Phys. **42** (1989) 609

6.3.5.3 Nitrogen (N_2)

The preferred cross section is listed in Table 6.3.5.3 and shown in Figs. 6.3.5.3.1 and 6.3.5.3.2. From 0.001 to 0.5 eV the preferred σ_m^{el} is taken to be that of [84Had1]. From 0.5 eV to 1.9 eV the preferred cross section is based on [95Sun1] (tabled in [97Rob1]) and from 1.8 to 3.5 eV on [95Sun1] alone.

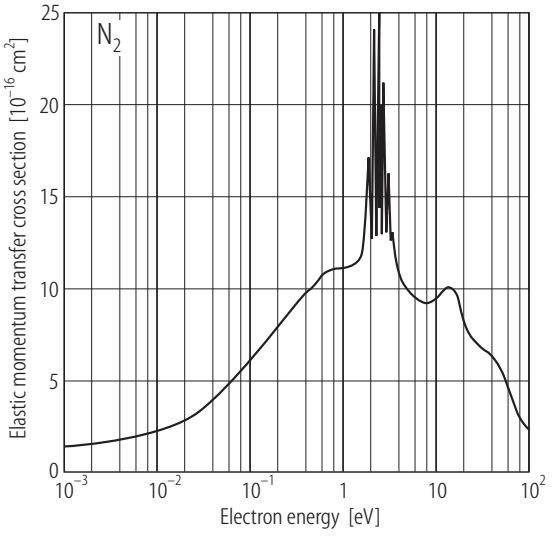

Fig. 6.3.5.3.1. Preferred values of the elastic momentum transfer cross section for electrons scattered from nitrogen (N_2).

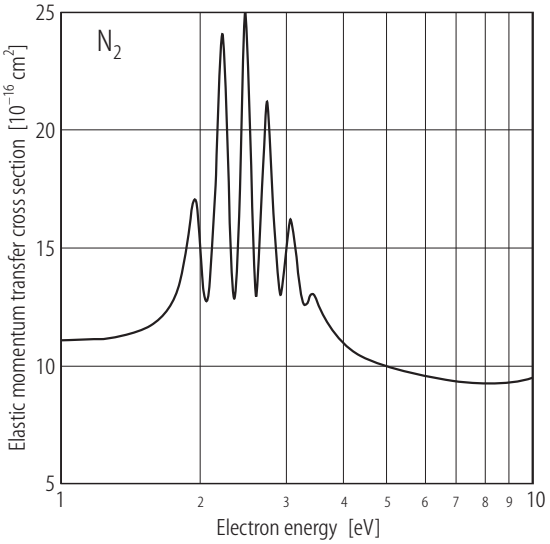

Fig. 6.3.5.3.2. Preferred values of the elastic momentum transfer cross section for electrons scattered from nitrogen (N_2), showing the region of the resonance on an expanded energy scale.

For the remainder of the energy range to 100 eV the preferred cross section is based on the beam-derived values of [95Sun1] and [76Sri1]. Fig. 6.3.5.3.2. shows details of the resonance calculated by [97Rob1] and which is generally supported by beam studies.

The uncertainty limits are estimated to be $< \pm 5$ % for $0.001 \leq \varepsilon < 0.5$ eV, $< \pm 10$ % for $0.5 \leq \varepsilon < 1.9$ eV and $< \pm 20$ % for $3.5 \leq \varepsilon < 100$ eV. No uncertainty limit is quoted for the range 1.9 to 3.5 eV.

Table 6.3.5.3. Preferred values of the elastic momentum transfer cross section (σ_m^{el}) for electrons scattered from nitrogen (N_2).

Energy [eV]	σ_m^{el} [Å^2]	Energy [eV]	σ_m^{el} [Å^2]	Energy [eV]	σ_m^{el} [Å^2]
0.001	1.357	1.5	11.52	2.85	15.59
0.0015	1.426	1.6	11.84	2.86	15.05
0.0018	1.464	1.7	12.42	2.9	13.48
0.002	1.490	1.8	13.63	2.925	13.04
0.0025	1.550	1.85	14.92	2.95	13.05
0.003	1.620	1.9	16.54	3	14.28
0.004	1.718	1.95	16.71	3.033	15.43
0.005	1.810	1.98	14.96	3.066	16.13
0.006	1.908	2	13.65	3.1	16.11
0.007	2.000	2.04	12.63	3.115	15.90
0.008	2.062	2.05	12.72	3.2	13.93
0.009	2.131	2.067	13.15	3.25	12.98
0.01	2.190	2.084	13.85	3.3	12.55
0.012	2.342	2.1	14.75	3.34	12.61
0.015	2.550	2.16	20.00	3.35	12.67
0.018	2.729	2.2	23.88	3.4	12.98
0.02	2.850	2.3	14.91	3.42	13.04
0.025	3.12	2.35	12.79	3.45	13.02
0.03	3.40	2.4	16.10	3.5	12.75
0.04	3.85	2.41	17.37	4	10.90
0.05	4.33	2.415	18.07	5	9.90
0.06	4.72	2.42	18.80	6	9.45
0.07	5.10	2.423	19.26	7	9.29
0.08	5.41	2.425	19.56	8	9.19
0.09	5.69	2.43	20.34	9	9.29
0.1	5.95	2.45	23.29	10	9.45
0.12	6.45	2.46	24.38	12	9.84
0.15	7.10	2.467	24.88	15	9.97
0.18	7.59	2.484	24.95	18	9.07
0.2	7.90	2.487	24.79	20	8.20
0.25	8.50	2.49	24.58	25	7.25
0.3	9.00	2.494	24.23	30	6.80
0.4	9.70	2.495	24.14	40	6.31
0.5	10.16	2.5	23.59	50	5.60
0.6	10.65	2.6	13.06	60	4.51
0.7	10.87	2.7	18.59	70	3.59
0.8	11.00	2.733	20.91	80	2.94
0.9	11.03	2.766	20.82	90	2.50
1	11.07	2.77	20.66	100	2.19
1.2	11.10	2.8	18.88		

References for 6.3.5.3

76Sri1 Srivastava, S.K., Chutjian, A., Trajmar, S.: J. Chem. Phys. **64** (1976) 1340

84Had1 Haddad, G.N.: Aust. J. Phys. **37** (1984) 487

95Sun1 Sun, W., Morrison, M.A., Isaacs, W.A., Trail, W.K., Alle, D.T., Gulley, R.J., Brennan, M.J., Buckman, S.J.: Phys. Rev. A **52** (1995) 1229

97Rob1 Robertson, A.G., Elford, M.T., Crompton, R.W., Morrison, M.A., Sun, W., Trail, W.K.: Aust. J. Phys. **50** (1997) 441

6.3.5.4 Carbon monoxide (CO)

The preferred cross section is listed in Table 6.3.5.4 and shown in Fig. 6.3.5.4. Below 0.4 eV there appear to be no experimental values available and over the range 0.1 to 0.4 eV the preferred σ_m^{el} has been assumed to be that given by the theoretical values of [92Jai1] reduced by 15 %. The reduced values of [92Jai1] are in good agreement with the preferred cross section over the common energy range (up to 10 eV), except at the maximum. From 0.4 to 20 eV the preferred values are based on [83Had1] and [96Gib1]. It should be noted that the σ_m of [83Had1] includes both elastic and inelastic components. The σ_m^{el} cross section was obtained by subtracting the sum of the $v = 0$ to $v = 0$ - 7 vibrational excitation cross sections measured by [68Ehr1] and multiplying by a factor of 1.35, as suggested by [89Pet1]. The maximum in σ_m^{el}, which occurs at about 1.8 eV, was assumed to be that given by [83Had1] (the σ_m^{el} component) and is supported by the theoretical values of [95Mor1]. At energies greater than 30 eV the cross section is based on the beam derived values of [78Tan1].

The uncertainty is considered to be < ± 20 % except in the vicinity of the maximum at about 1.8 eV where no estimate is given. No uncertainty limit is also estimated for the range 0.1 to 0.4 eV.

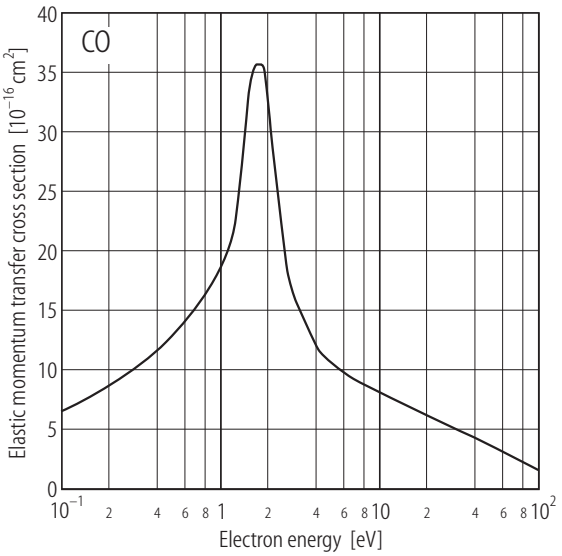

Fig. 6.3.5.4. Preferred values of the elastic momentum transfer cross section for electrons scattered from carbon monoxide (CO).

Table 6.3.5.4. Preferred values of the elastic momentum transfer cross section (σ_m^{el}) for electrons scattered from carbon monoxide (CO).

Energy [eV]	σ_m^{el} [Å^2]	Energy [eV]	σ_m^{el} [Å^2]	Energy [eV]	σ_m^{el} [Å^2]
0.1	6.51	1.4	29.1	8	8.87
0.12	6.99	1.5	33.2	9	8.53
0.15	7.64	1.6	35.2	10	8.17
0.18	8.23	1.7	35.6	12	7.64
0.2	8.60	1.8	35.5	15	7.07
0.25	9.43	1.9	34.7	18	6.50
0.3	10.16	2	32.1	20	6.27
0.4	11.58	2.1	28.9	25	5.59
0.5	12.90	2.2	26.5	30	5.11
0.6	14.03	2.3	24.4	40	4.27
0.7	15.16	2.4	22.3	50	3.66
0.8	16.24	2.5	20.3	60	3.17
0.9	17.31	3	15.8	70	2.69
1	18.55	4	12.1	80	2.31
1.1	19.79	5	10.7	90	1.97
1.2	21.6	6	9.79	100	1.69
1.3	25.0	7	9.25		

References for 6.3.5.4

68Ehr1 Ehrhardt, H., Langhans, L., Linder, F., Taylor, H.S.: Phys. Rev. **173** (1968) 222
78Tan1 Tanaka, H., Srivastava, S.K., Chutjian, A.: J. Chem. Phys. **69** (1978) 5329
83Had1 Haddad, G.N., Milloy, H.B.: Aust. J. Phys. **36** (1983) 473
89Pet1 Petrovic, Z.Lj., Crompton, R.W.: Aust. J. Phys. **42** (1989) 609
92Jai1 Jain, A., Norcross, D.W.: Phys. Rev. A **45** (1992) 1644
95Mor1 Morgan, L.A.: Private communication to S.J. Buckman, 1995
96Gib1 Gibson, J.C., Morgan, L.A., Gulley, R.J., Brunger, M.J., Bundschu, C.T., Buckman, S.J.: J. Phys. B: At. Mol. Opt. Phys. **29** (1996) 3197

6.3.5.5 Nitric oxide (NO)

The preferred cross section is listed in Table 6.3.5.5 and shown in Fig. 6.3.5.5. The preferred cross section for NO is based on that of [95Moj1] and covers the energy range 1.5 to 40 eV.

The uncertainty is estimated to be < ± 20 % for 5 eV ≤ ε ≤30 eV and < ± 30 % for values at energies outside this range.

Table 6.3.5.5. Preferred values of the elastic momentum transfer cross section (σ_m^{el}) for electrons scattered from nitric oxide (NO).

Energy [eV]	σ_m^{el} [Å^2]	Energy [eV]	σ_m^{el} [Å^2]
1.5	7.03	9	4.69
1.8	6.82	10	4.5
2	6.67	12	4.24
2.5	6.37	15	3.85
3	6.15	18	3.55
4	5.78	20	3.33
5	5.51	25	2.9
6	5.27	30	2.52
7	5.03	40	1.8
8	4.84		

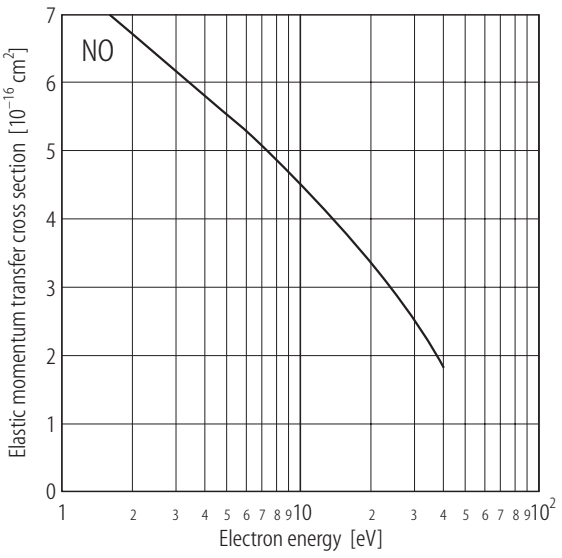

Fig. 6.3.5.5. Preferred values of the elastic momentum transfer cross section for electrons scattered from nitric oxide (NO).

References for 6.3.5.5

95Moj1 Mojarrabi, B., Gulley, R.J., Middleton, A.G., Cartwright, D.C., Teubner, P.J.O., Buckman, S.J., Brunger, M.J.: J. Phys. B: At. Mol. Opt. Phys. **28** (1995) 487

6.3.5.6 Oxygen (O_2)

The preferred cross section is listed in Table 6.3.5.6 and shown in Fig. 6.3.5.6. Values of σ_m^{el} in the low energy range (< 0.3 eV) are based on the analysis of electron transport coefficient data by [87You1]. At higher energies the preferred cross section follows that derived by [89Iti1] from beam data but has been modified in the energy range 2 to 20 eV to take into account the more recent experimental values obtained by [95Sul1]. The modifications were within the stated uncertainty of these beam measurements.

The uncertainty is estimated to be ≤ ± 20 %.

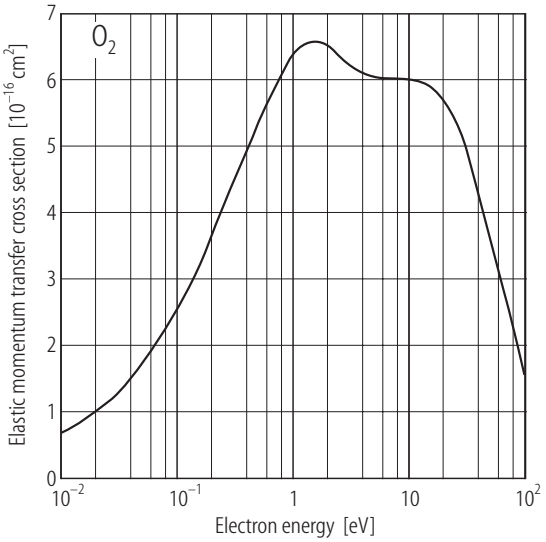

Fig. 6.3.5.6. Preferred values of the elastic momentum transfer cross section for electrons scattered from oxygen (O_2).

Table 6.3.5.6. Preferred values of the elastic momentum transfer cross section (σ_m^{el}) for electrons scattered from oxygen (O_2).

Energy [eV]	σ_m^{el} [Å^2]	Energy [eV]	σ_m^{el} [Å^2]	Energy [eV]	σ_m^{el} [Å^2]
0.01	0.69	0.25	4.02	7	6.01
0.012	0.75	0.3	4.37	8	6.01
0.015	0.86	0.4	4.91	9	6.01
0.018	0.92	0.5	5.36	10	6.01
0.02	0.96	0.6	5.7	12	6.01
0.025	1.1	0.7	5.98	15	6.01
0.03	1.23	0.8	6.17	18	5.97
0.04	1.42	0.9	6.32	20	5.91
0.05	1.63	1	6.49	25	5.60
0.06	1.85	1.2	6.71	30	5.17
0.07	2.04	1.5	6.82	40	4.37
0.08	2.19	1.8	6.69	50	3.66
0.09	2.38	2	6.58	60	3.05
0.1	2.51	2.5	6.32	70	2.58
0.12	2.77	3	6.14	80	2.22
0.15	3.1	4	6.01	90	1.91
0.18	3.42	5	6.01	100	1.44
0.2	3.61	6	6.01		

References for 6.3.5.6

87You1 Yousfi, M., Azzi, N., Segur, P., Gallimberti, I., Stangherlin, S.: Personal communication, 1987

89Iti1 Itikawa, Y., Ichimura, K., Onda, K., Sakimoto, K., Takayanagi, K., Hatano, Y., Hayashi, M., Nishimura, H., Tsurubuchi, S.: J. Phys. Chem. Ref. Data **18** (1989) 23

95Sul1 Sullivan, J.P., Gibson, J.C., Gulley, R.J., Buckman, S.J.: J. Phys. B: At. Mol. Opt. Phys. **28** (1995) 4319

6.3.5.7 Methane (CH_4)

The preferred cross section is listed in Table 6.3.5.7 and shown in Fig. 6.3.5.7. The preferred values of σ_m^{el} in the low energy range 0.01 to 0.2 eV are based on the analysis of electron transport coefficient data by [91Sch1]. Between 0.2 and 0.6 eV the preferred cross section is based on the shape of the cross section of [86Soh1] but is about 25 % larger. At energies greater than 0.6 eV the preferred cross section is based on those of [97Bun1] and [91Boe1].

The uncertainty is estimated to be $\leq \pm$ 20 % except in the region of the Ramsauer-Townsend minimum (0.2 to 0.6 eV) where no estimate is given.

Table 6.3.5.7. Preferred values of the elastic momentum transfer cross section (σ_m^{el}) for electrons scattered from methane (CH_4).

Energy [eV]	σ_m^{el} [Å^2]	Energy [eV]	σ_m^{el} [Å^2]	Energy [eV]	σ_m^{el} [Å^2]
0.01	15.6	0.25	0.535	7	21.80
0.012	14.5	0.3	0.504	8	22.01
0.015	13.3	0.4	0.579	9	21.69
0.018	12.2	0.5	0.769	10	20.43
0.02	11.5	0.6	0.985	12	15.94
0.025	10.0	0.7	1.172	15	10.88
0.03	8.79	0.8	1.429	18	8.20
0.04	6.93	0.9	1.675	20	6.93
0.05	5.62	1	1.916	25	4.99
0.06	4.70	1.2	2.40	30	3.92
0.07	3.90	1.5	3.24	40	2.81
0.08	3.31	1.8	4.11	50	2.21
0.09	2.77	2	4.77	60	1.81
0.1	2.30	2.5	6.34	70	1.55
0.12	1.74	3	8.12	80	1.35
0.15	1.21	4	11.78	90	1.20
0.18	0.919	5	15.86	100	1.07
0.2	0.750	6	20.03		

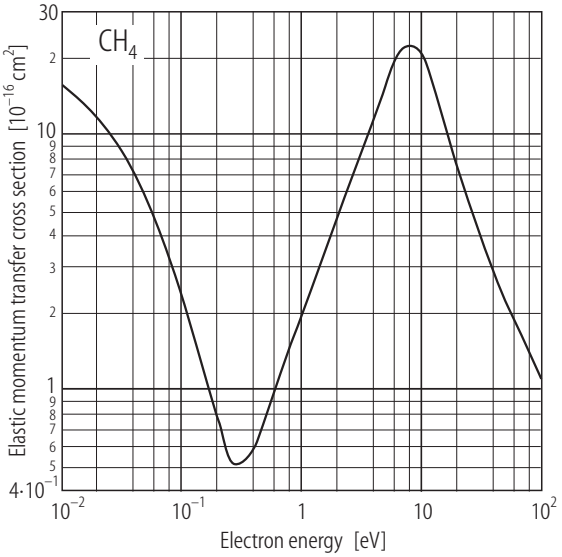

Fig. 6.3.5.7. Preferred values of the elastic momentum transfer cross section for electrons scattered from methane (CH_4).

References for 6.3.5.7

86Soh1 Sohn, W., Kochem, K-H., Scheurlein, K.M., Jung, K., Ehrhardt, H.: J. Phys. B: At. Mol. Phys. **19** (1986) 3625

91Boe1 Boesten, L., Tanaka, H.: J. Phys. B: At. Mol. Opt. Phys. **24** (1991) 821

91Sch1 Schmidt, B.: J. Phys. B: At. Mol. Opt. Phys. **28** (1991) 4809

97Bun1 Bundschu, C.T., Gibson, J.C., Gulley, R.J., Brunger, M.J., Buckman, S.J., Sanna, N., Gianturco, F.A.: J. Phys. B: At. Mol. Opt. Phys. **30** (1997) 2239

6.3.5.8 Ammonia (NH_3)

The preferred cross section is listed in Table 6.3.5.8 and shown in Fig. 6.3.5.8. The preferred cross section is based on the beam-derived values of [92All1] and takes into account the theoretical cross section of [91Gia1].

The estimated uncertainty is < ± 20 %.

Table 6.3.5.8. Preferred values of the elastic momentum transfer cross section (σ_m^{el}) for electrons scattered from ammonia (NH_3).

Energy [eV]	σ_m^{el} [Å^2]	Energy [eV]	σ_m^{el} [Å^2]
2	1.73	9	10
2.5	2.63	10	10.1
3	3.69	12	9.90
4	5.91	15	9.15
5	7.88	18	8.16
6	8.97	20	7.46
7	9.56	25	6.00
8	9.90	30	4.89

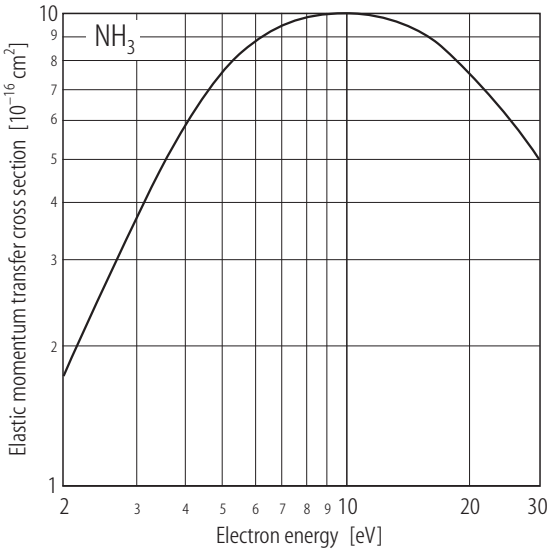

Fig. 6.3.5.8. Preferred values of the elastic momentum transfer cross section for electrons scattered from ammonia (NH_3).

References for 6.3.5.8

91Gia1 Gianturco, F.A.: J. Phys. B: At. Mol. Opt. Phys. **24** (1991) 4627

92All1 Alle, D.T., Gulley, R.J., Buckman, S.J., Brunger, M.J.: J. Phys. B: At. Mol. Opt. Phys. **25** (1992) 1533

6.3.5.9 Water vapour (H_2O)

The preferred cross section is listed in Table 6.3.5.9 and shown in Fig. 6.3.5.9. The preferred values of σ_m^{el} over the energy range 0.01 to 1eV are based on the swarm derived cross section of [87You1]. For energies greater than 1eV the preferred cross section is based on the beam derived cross sections of [79Sen1, 87Shy1, 91Joh1]. No data point from each of these three sets of data differs from the preferred values by more than 20 %.

Below 1 eV no estimate of the uncertainty is given, but at higher energies the uncertainty is estimated to be $< \pm 20$ %.

References for 6.3.5.9

79Sen1 Seng, G., Linder, F.: quoted by Gianturco, F.A, Thompson, D.G.: J. Phys. B: At. Mol. Phys. **13** (1980) 613

87Shy1 Shyn, T.W., Cho, S.Y.: Phys. Rev. A **36** (1987) 5138

87You1 Yousfi, M., Azzi, N., Segur, P., Gallimberti, I., Stangherlin, S.: Private communication, 1987

91Joh1 Johnstone, W.M., Newell, W.R.: J. Phys. B: At. Mol. Opt. Phys. **24** (1991) 3633

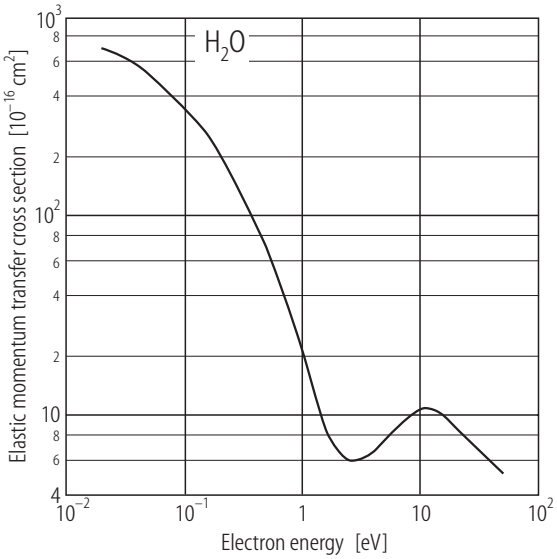

Fig. 6.3.5.9. Preferred values of the elastic momentum transfer cross section for electrons scattered from water vapour (H_2O).

Table 6.3.5.9. Preferred values of the elastic momentum transfer cross section (σ_m^{el}) for electrons scattered from water vapour (H_2O).

Energy [eV]	σ_m^{el} [Å^2]	Energy [eV]	σ_m^{el} [Å^2]	Energy [eV]	σ_m^{el} [Å^2]
0.02	700	0.9	25	8	9.56
0.03	640	1	21	9	10.15
0.05	505	1.2	13.73	10	10.50
0.07	430	1.5	9.38	12	10.77
0.1	350	1.8	7.39	15	10.00
0.14	280	2	6.66	18	9.01
0.2	200	2.5	5.91	20	8.45
0.3	130	3	5.95	25	7.54
0.5	66	4	6.56	30	6.80
0.6	50	5	7.43	40	5.83
0.7	40	6	8.24	50	5.07
0.8	32	7	8.92		

6.3.5.10 Ethane (C_2H_6)

The preferred cross section is listed in Table 6.3.5.10 and shown in Fig. 6.3.5.10. The preferred cross section σ_m^{el} for C_2H_6 is based primarily on the swarm-derived cross sections of [97Shi1] and [97Sch1] but includes consideration of the beam-derived cross sections of [88Tan1] and [98Mer1].

The estimated uncertainty is < ± 10 % at energies < 10 eV with the exception of values at energies in the vicinity of the minimum where no estimate is given. For energies of 10 eV and higher the estimated uncertainty is < ± 15 %.

Fig. 6.3.5.10. Preferred values of the elastic momentum transfer cross section for electrons scattered from ethane (C_2H_6).

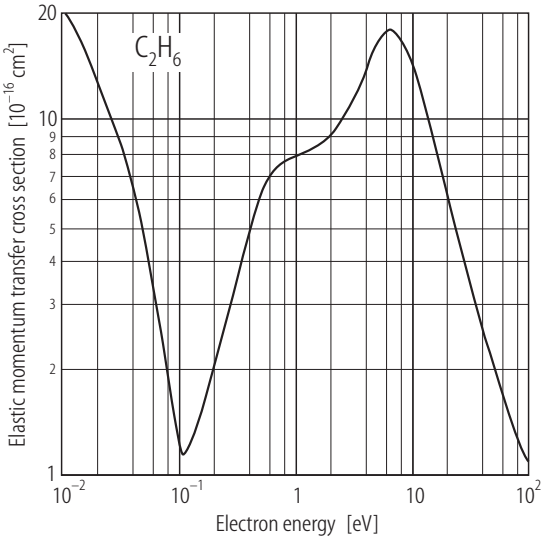

Table 6.3.5.10. Preferred values of the elastic momentum transfer cross section (σ_m^{el}) for electrons scattered from ethane (C_2H_6).

Energy [eV]	σ_m^{el} [Å^2]	Energy [eV]	σ_m^{el} [Å^2]	Energy [eV]	σ_m^{el} [Å^2]
0.01	20.65	0.25	2.66	7	17.83
0.012	18.91	0.3	3.24	8	16.97
0.015	16.00	0.4	4.82	9	15.77
0.018	14.01	0.5	6.04	10	14.58
0.02	12.65	0.6	6.89	12	12.05
0.025	10.61	0.7	7.35	15	9.20
0.03	9.10	0.8	7.56	18	7.17
0.04	6.76	0.9	7.79	20	6.13
0.05	4.80	1	7.90	25	4.61
0.06	3.42	1.2	8.18	30	3.63
0.07	2.56	1.5	8.34	40	2.57
0.08	1.96	1.8	8.76	50	2.01
0.09	1.48	2	9.07	60	1.68
0.1	1.204	2.5	10.02	70	1.451
0.12	1.204	3	11.03	80	1.296
0.15	1.444	4	13.55	90	1.164
0.18	1.783	5	16.08	100	1.076
0.2	1.99	6	17.65		

References for 6.3.5.10

88Tan1 Tanaka, H., Boesten, L., Matsunaga, D., Kudo, T.: J. Phys. B: At. Mol. Opt. Phys. **21** (1988) 1255
97Sch1 Schmidt, B.: Private communication (1997) to [98Mer1]
97Shi1 Shisikura, Y., Asano, K., Nakamura, Y.: J. Phys. D **30** (1997) 1610
98Mer1 Merz, R., Linder, F.: J. Phys. B: At. Mol. Opt. Phys. **31** (1998) 4663

6.3.5.11 Silane (SiH_4)

The preferred cross section for silane is listed in Table 6.3.5.11 and shown in Fig. 6.3.5.11. The preferred cross section for SiH_4 at energies less than 1 eV is based on that derived by [94Nag1] from the analysis of electron swarm data. At energies between 1.8 and 20 eV the preferred cross section is a smooth fit to the beam-derived values of [90Tan1] and follows closely the swarm-derived cross section of [87Mat1]. No cross section is suggested for energies greater than 20 eV as beam and swarm-derived cross sections diverge significantly.

No uncertainty is estimated for $\varepsilon < 1.8$ eV. The uncertainty in the region for 1.8 eV $\leq \varepsilon \leq 20$ eV is estimated to be < ± 25 %.

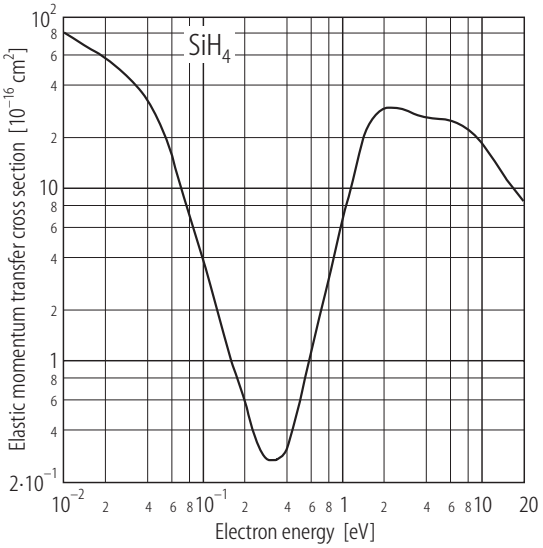

Fig. 6.3.5.11. Preferred values of the elastic momentum transfer cross section for electrons scattered from silane (SiH_4).

Table 6.3.5.11. Preferred values of the elastic momentum transfer cross section (σ_m^{el}) for electrons scattered from silane (SiH_4).

Energy [eV]	σ_m^{el} [Å^2]	Energy [eV]	σ_m^{el} [Å^2]	Energy [eV]	σ_m^{el} [Å^2]
0.01	80.8	0.15	1.17	1.8	27.38
0.012	73.5	0.18	0.739	2	28.78
0.015	64.9	0.2	0.554	2.5	29.50
0.018	59.7	0.25	0.310	3	28.07
0.02	56.2	0.3	0.268	4	26.06
0.025	48.7	0.35	0.271	5	25.42
0.03	42.7	0.4	0.319	6	24.80
0.04	32.4	0.5	0.633	7	23.83
0.05	23.1	0.6	1.161	8	22.34
0.06	15.7	0.7	1.983	9	20.23
0.07	10.00	0.8	3.07	10	18.14
0.08	6.89	0.9	4.66	12	14.95
0.09	5.01	1	6.49	15	11.32
0.1	3.76	1.2	11.21	18	9.28
0.12	2.30	1.5	21.37	20	8.24

References for 6.3.5.11

87Mat1 Mathieson, K.J., Millican, P.G., Walker, I.C., Curtis, M.G.: J. Chem. Soc. Faraday Trans. II **83** (1987) 1041
90Tan1 Tanaka, H., Boesten, L., Sato, H., Kimura, M., Dillon, M.A., Spence, D.: J. Phys. B: At. Mol. Opt. Phys. **23** (1990) 577
94 Nag1 Nagpal, R., Garscadden, A.: J. Appl. Phys.**75** (1994) 703

6.3.5.12 Hydrogen sulphide (H_2S)

The preferred cross section is listed in Table 6.3.5.12 and shown in Fig. 6.3.5.12. The preferred values of σ_m^{el} are based on the beam-derived values of [93Gul1] and take into account the form of the theoretical cross sections of [92Len1] and [99Var1].

The estimated uncertainty is < ± 20 %.

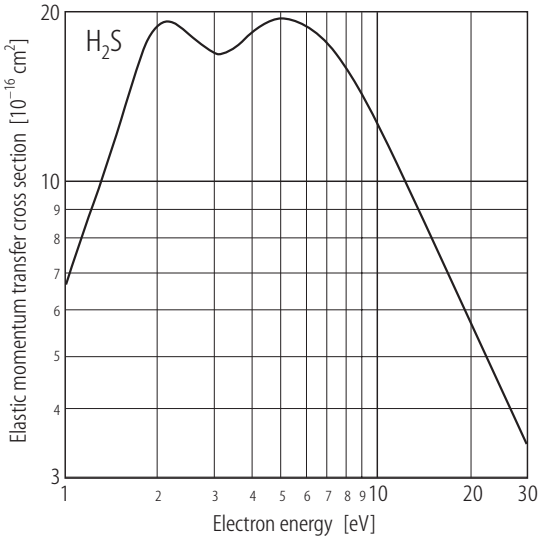

Fig. 6.3.5.12. Preferred values of the elastic momentum transfer cross section for electrons scattered from hydrogen sulphide (H_2S).

Table 6.3.5.12. Preferred values of the elastic momentum transfer cross section (σ_m^{el}) for electrons scattered from hydrogen sulphide (H_2S).

Energy [eV]	σ_m^{el} [Å^2]	Energy [eV]	σ_m^{el} [Å^2]
1.2	8.83	8	15.79
1.5	12.69	9	14.22
1.8	17.34	10	12.75
2	18.87	12	10.25
2.5	18.14	15	7.92
3	16.84	18	6.33
4	18.41	20	5.57
5	19.35	25	4.28
6	18.69	30	3.44
7	17.35		

References for 6.3.5.12

92Len1 Lengsfield, B.H., Rescigno, T.N., McCurdy, C.W., Parker, S.: cited by [93Gul1] as private communication
93Gul1 Gulley, R.J., Brunger, M.J., Buckman, S.J.: J. Phys. B: At. Mol. Opt. Phys. **26** (1993) 2913
99Var1 Varella, M.T.do N., Bettega, M.H.F., Lima, M.A.P., Ferreira, L.G.: J. Chem. Phys. **111** (1999) 6396

6.3.5.13 Carbon dioxide (CO_2)

The preferred cross section is listed in Table 6.3.5.13 and shown in Fig. 6.3.5.13. Below 1 eV there are no beam derived data and the preferred σ_m^{el} cross section is taken to be that of [95Nak1] derived from an analysis of swarm data. In the range 1 to 20 eV the preferred cross section follows the general form of the [95Nak1] cross section but with some modifications in the region of the 3.8 eV resonance and at values in the region of 15 eV. The beam derived cross section values of [99Gib1] generally agree with the preferred cross section to within 10 % over their energy range of 1 to 10 eV. There is also good agreement with values of [98Tan1] at energies greater than 7 eV and at energies from 20 to 100 eV the preferred curve values follow a smooth curve through their data points. Other beam derived values [80Reg1] (with the exception of their lowest energy point) and [99Iga1] agree with the preferred curve to within their stated uncertainties.

The uncertainty limits are estimated to be $< \pm 5$ % for $0.04 \leq \varepsilon < 0.5$ eV, $< \pm 10$ % for $0.5 \leq \varepsilon < 20$ and $< \pm 20$ % for $20 \leq \varepsilon \leq 100$ eV.

References for 6.3.5.13

80Reg1 Register, D.F., Nishimura, H., Trajmar, S.J.: J. Phys. B: At. Mol. Opt. Phys. **13** (1980) 1651
95Nak1 Nakamura, Y.: Aust. J. Phys. **48** (1995) 357
98Tan1 Tanaka, H., Ishikawa, T., Masai, T., Sagara, T., Boesten, L., Takekawa, M., Itikawa, Y., Kimura, M.: Phys. Rev. A **57** (1998) 1798
99Gib1 Gibson, J.C., Green, M.A., Trantham, K.W., Buckman, S.J., Teubner, P.J.O., Brunger, M.J.: J. Phys. B: At. Mol. Opt. Phys. **32** (1999) 213
99Iga1 Iga, I., Homem, M.G.P., Mazon, K.T., Lee. M-T.: J. Phys. B: At. Mol. Opt. Phys. **32** (1999) 4373

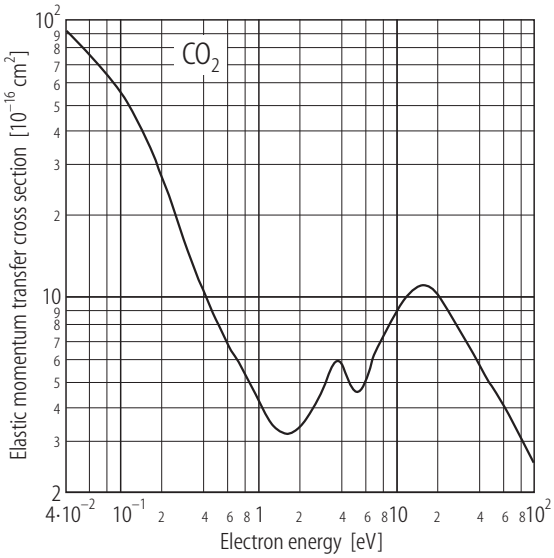

Fig. 6.3.5.13. Preferred values of the elastic momentum transfer cross section for electrons scattered from carbon dioxide (CO_2).

Table 6.3.5.13. Preferred values of the elastic momentum transfer cross section (σ_m^{el}) for electrons scattered from carbon dioxide (CO_2).

Energy [eV]	σ_m^{el} [Å^2]	Energy [eV]	σ_m^{el} [Å^2]	Energy [eV]	σ_m^{el} [Å^2]
0.04	90.0	0.7	5.69	8	7.40
0.05	80.6	0.8	5.18	9	8.09
0.06	73.2	0.9	4.69	10	9.02
0.07	66.8	1	4.25	12	10.00
0.08	61.9	1.2	3.59	15	10.86
0.09	56.8	1.5	3.24	18	10.76
0.1	53.6	1.8	3.24	20	10.17
0.12	46.4	2	3.39	25	8.74
0.15	37.2	2.5	3.91	30	7.51
0.18	30.1	3	4.67	40	5.84
0.2	26.2	3.5	5.64	50	4.79
0.25	19.8	4	5.79	60	4.15
0.3	15.05	4.5	5.02	70	3.61
0.4	10.48	5	4.58	80	3.19
0.5	8.09	6	4.91	90	2.83
0.6	6.77	7	6.08	100	2.53

6.3.5.14 Propane (C_3H_8)

The preferred cross section for propane is listed in Table 6.3.5.14 and shown in Fig. 6.3.5.14. The preferred cross section σ_m^{el} is based on that of [94Boe1].

The uncertainty is estimated to be < ± 30 %.

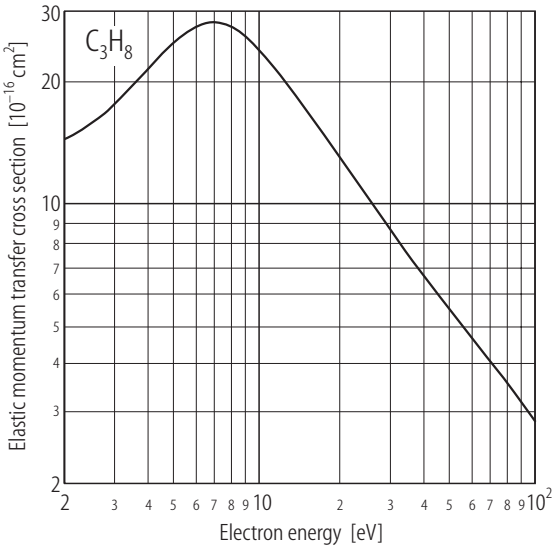

Fig. 6.3.5.14. Preferred values of the elastic momentum transfer cross section for electrons scattered from propane (C_3H_8).

Table 6.3.5.14. Preferred values of the elastic momentum transfer cross section (σ_m^{el}) for electrons scattered from propane (C_3H_8).

Energy [eV]	σ_m^{el} [Å^2]	Energy [eV]	σ_m^{el} [Å^2]	Energy [eV]	σ_m^{el} [Å^2]
2.5	15.9	10	24.4	50	5.25
3	17.6	12	20.43	60	4.52
4	21.9	15	16.66	70	3.93
5	25.4	18	13.74	80	3.53
6	28.6	20	12.44	90	3.16
7	29.2	25	10.00	100	2.86
8	28.4	30	8.45		
9	26.5	40	6.40		

Reference for 6.3.5.14

94Boe1 Boesten, L., Dillon, M.A., Tanaka, H., Kimura, M., Sato, H.: J. Phys. B: At. Mol. Opt. Phys. **27** (1994) 1845

6.3.5.15 Nitrous oxide (N_2O)

The preferred cross section is listed in Table 6.3.5.15 and shown in Fig. 6.3.5.15. The preferred cross section for N_2O is based on the beam-derived values of [86Mar1, 93Joh1, 00Kit1].

The uncertainty is estimated to be < ± 25 % over the whole energy range 2 to 80 eV.

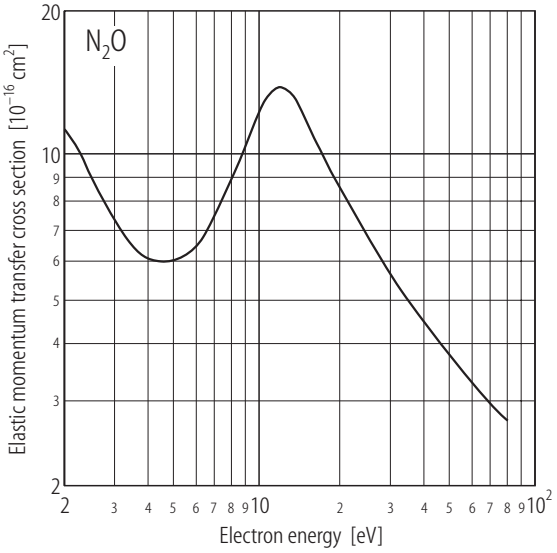

Fig. 6.3.5.15. Preferred values of the elastic momentum transfer cross section for electrons scattered from nitrous oxide (N_2O).

Table 6.3.5.15. The preferred values of the elastic momentum transfer cross section (σ_m^{el}) for electrons scattered from nitrous oxide (N_2O).

Energy [eV]	σ_m^{el} [Å^2]	Energy [eV]	σ_m^{el} [Å^2]	Energy [eV]	σ_m^{el} [Å^2]
2	11.18	8	8.88	25	6.62
2.5	8.81	9	10.4	30	5.60
3	7.22	10	12.13	40	4.36
4	5.97	12	13.74	50	3.71
5	5.97	15	11.18	60	3.29
6	6.41	18	9.31	70	2.97
7	7.57	20	8.33	80	2.73

References for 6.3.5.15

86Mar1 Marinkovic, B., Szmytkowski, Cz., Pejcev, V., Filipovic, D., Vuskovic, L.: J. Phys. B: At. Mol. Phys. **19** (1986) 2365

93Joh1 Johnstone, W.M., Newell, W.R.: J. Phys. B: At. Mol. Opt. Phys. **26** (1993) 129

00Kit1 Kitajima, M., Sakamoto, Y., Gulley, R.J., Hoshino, M., Gibson, J.C., Tanaka, H., Buckman, S.J.: Private communication, 2000

6.3.5.16 Disilane (Si_2H_6)

The preferred cross section for disilane is listed in Table 6.3.5.16 and shown in Fig. 6.3.5.16. The preferred cross section for disilane is taken to be a curve of best fit to the beam derived values of [94Dil1].

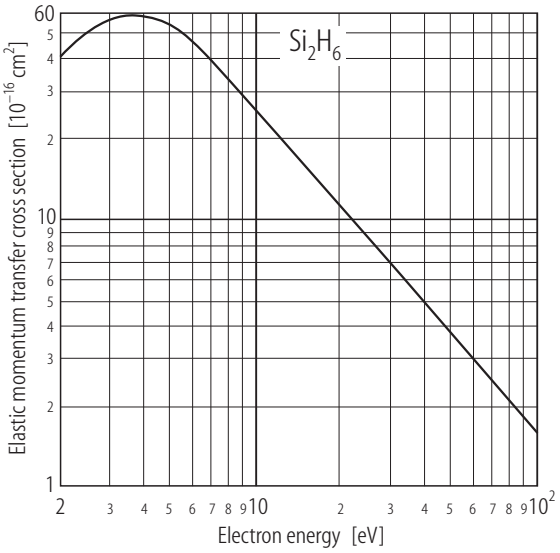

Fig. 6.3.5.16. Preferred values of the elastic momentum transfer cross section for electrons scattered from disilane (Si_2H_6).

Table 6.3.5.216. Preferred values of the elastic momentum transfer cross section (σ_m^{el}) for electrons scattered from disilane (Si_2H_6).

Energy [eV]	σ_m^{el} [Å^2]	Energy [eV]	σ_m^{el} [Å^2]	Energy [eV]	σ_m^{el} [Å^2]
2	40.1	9	28.3	40	4.77
2.5	50.8	10	24.9	50	3.64
3	57.1	12	19.75	60	2.95
4	59.7	15	15.17	70	2.44
5	54.5	18	12.22	80	2.08
6	45.6	20	10.94	90	1.81
7	38.3	25	8.35	100	1.60
8	32.6	30	6.70		

Reference for 6.3.5.16

94Dil1 Dillon, M.A., Boesten, L., Tanaka, H., Kimura, M., Sato, H.: J. Phys. B: At. Mol. Opt. Phys. **27** (1994) 1209

6.3.5.17 Sulphur dioxide (SO_2)

The preferred cross section is listed in Table 6.3.5.17 and shown in Fig. 6.3.5.17. The preferred values of σ_m^{el} are based on the beam-derived values of [89Tra1] and [94Gul1].

The estimated uncertainty is < ± 30 %.

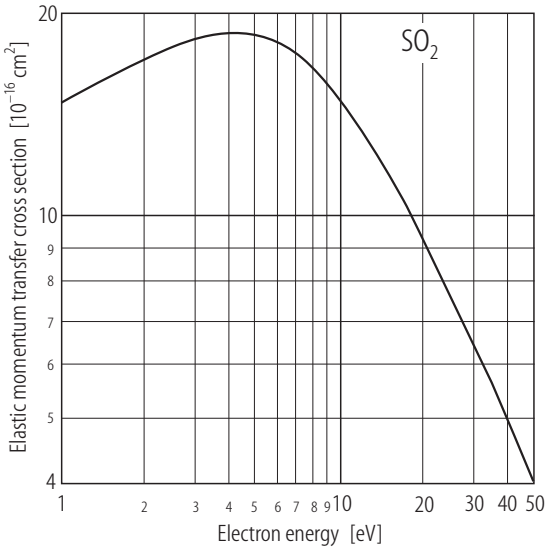

Fig. 6.3.5.17. Preferred values of the elastic momentum transfer cross section for electrons scattered from sulphur dioxide (SO_2).

Table 6.3.5.17. Preferred values of the elastic momentum transfer cross section (σ_m^{el}) for electrons scattered from sulphur dioxide (SO_2).

Energy [eV]	σ_m^{el} [Å^2]	Energy [eV]	σ_m^{el} [Å^2]	Energy [eV]	σ_m^{el} [Å^2]
1	14.7	5	18.8	18	10.0
1.2	15.4	6	18.2	20	9.15
1.5	16.2	7	17.4	25	7.61
1.8	16.8	8	16.6	30	6.46
2	17.2	9	15.8	40	4.97
2.5	17.9	10	15.0	50	4.05
3	18.3	12	13.5		
4	18.8	15	11.5		

References for 6.3.5.17

89Tra1 Trajmar, S., Shyn, T.W.: J. Phys. B: At. Mol. Opt. Phys. **22** (1989) 2911
94Gul1 Gulley, R.J., Buckman, S.J.: J. Phys. B: At. Mol. Opt. Phys. **27** (1994) 1833

6.3.5.18 Trifluoromethane (CHF_3)

The preferred cross section is listed in Table 6.3.5.18 and shown in Fig. 6.3.5.18. The preferred cross section, σ_m^{el}, is that calculated by [99Nat1].

No uncertainty is estimated.

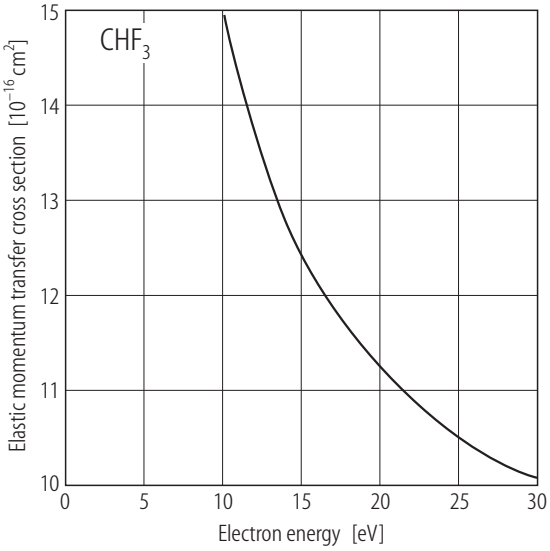

Fig. 6.3.5.18. Preferred values of the elastic momentum transfer cross section for electrons scattered from trifluoromethane (CHF_3).

Table 6.3.5.18. Preferred values of the elastic momentum transfer cross section (σ_m^{el}) for electrons scattered from trifluoroethane (CHF_3).

Energy [eV]	σ_m^{el} [Å^2]
10	14.9
12	13.7
15	12.4
18	11.6
20	11.2
25	10.5
30	10.1

References for 6.3.5.18

99Nat1 Natalense, A.P.P., Bettega, M.H.F., Ferreira, L.G., Lima, M.A.P.: Phys. Rev. A **59** (1999) 879

6.3.5.19 Nitrogen trifluoride (NF_3)

The preferred cross section for nitrogen trifluoride is listed in Table 6.3.5.19 and shown in Fig. 6.3.5.19. The preferred cross section is based on a curve of best fit to the only set of data available for this gas. These data are those of [96Boe1] and cover the energy range 1.5 to 100 eV.

No estimate of the uncertainty is made.

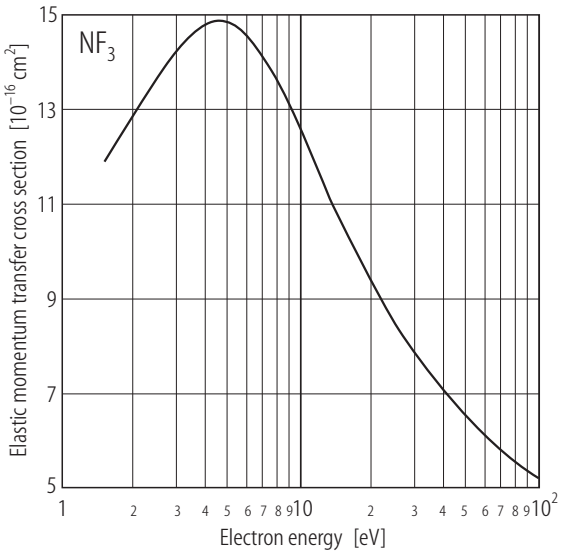

Fig. 6.3.5.19. Preferred values of the elastic momentum transfer cross section for electrons scattered from nitrogen trifluoride (NF_3).

Table 6.3.5.19. Preferred values of the elastic momentum transfer cross section (σ_m^{el}) for electrons scattered from nitrogen trifluoride (NF_3).

Energy [eV]	σ_m^{el} [Å^2]	Energy [eV]	σ_m^{el} [Å^2]	Energy [eV]	σ_m^{el} [Å^2]
1.5	11.90	8	13.62	40	6.98
1.8	12.57	9	12.99	50	6.45
2	12.93	10	12.46	60	6.08
2.5	13.71	12	11.57	70	5.78
3	14.27	15	10.45	80	5.56
4	14.94	18	9.72	90	5.39
5	14.94	20	9.29	100	5.22
6	14.61	25	8.41		
7	14.22	30	7.80		

Reference for 6.3.5.19

96Boe1 Boesten, L., Tachibana, Y., Nakano, Y., Shinohara, T., Tanaka, H., Dillon, M.A.: J. Phys. B: At. Mol. Opt. Phys. **29** (1996) 5475

6.3.5.20 Benzene (C_6H_6)

The preferred cross section is listed in Table 6.3.5.20 and shown in Fig. 6 3.5.20. There appears to be only two sets of beam-derived elastic momentum transfer cross section values, those of [99Gul1] and [00Cho1]. The preferred cross section has been taken as the best fit curve to these two data sets.

The uncertainty is estimated to be < ± 25 %.

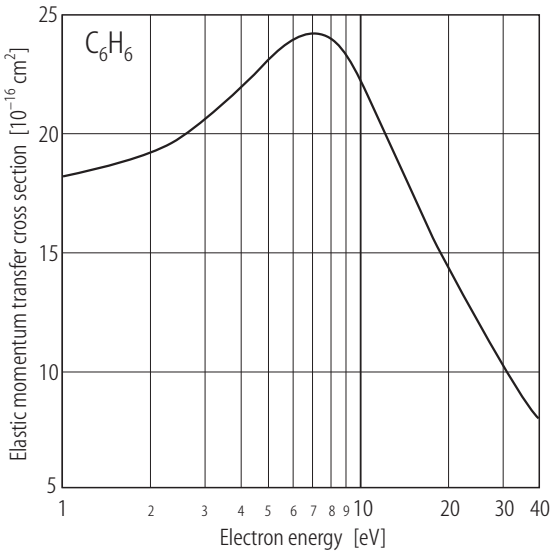

Fig. 6.3.5.20. Preferred values of the elastic momentum transfer cross section for electrons scattered from benzene (C_6H_6).

Table 6.3.5.20. Preferred values of the elastic momentum transfer cross section (σ_m^{el}) for electrons scattered from benzene (C_6H_6).

Energy [eV]	σ_m^{el} [Å^2]	Energy [eV]	σ_m^{el} [Å^2]
1	18.19	8	24.483
1.2	18.362	9	23.879
1.5	18.621	10	22.413
1.8	18.966	12	20.258
2	19.138	15	17.414
2.5	19.741	18	15.345
3	20.517	20	14.052
4	21.897	25	11.948
5	23.19	30	10.172
6	24.138	40	7.931
7	24.482		

References for 6.3.5.20

99Gul1 Gulley, R.J., Buckman, S.J.: J. Phys. B: At. Mol. Opt. Phys. **32** (1999) L405

00Ch01 Cho, H., Gulley, R.J., Sunohara, K., Kitajima, M., Uhlmann, L.J., Tanaka, H., Buckman, S.J.: Private communication, 2000

6.3.5.21 Carbon tetrafluoride (CF_4)

The preferred cross section is listed in Table 6.3.5.21 and shown in Fig. 6.3.5.21. The preferred values of σ_m^{el} are those determined by [99Chr1] after an extensive review of the literature up to 1999.

No uncertainty limits are quoted.

Table 6.3.5.21. Preferred values of the elastic momentum transfer cross section (σ_m^{el}) for electrons scattered from carbon tetrafluoride (CF_4).

Energy [eV]	σ_m^{el} [Å^2]	Energy [eV]	σ_m^{el} [Å^2]	Energy [eV]	σ_m^{el} [Å^2]
0.001	13.03	0.1	0.26	8	8.96
0.0015	12.30	0.125	0.14	9	10.06
0.002	11.76	0.15	0.13	10	11.23
0.0025	11.30	0.175	0.18	15	13.41
0.003	10.92	0.2	0.27	20	14.10
0.0035	10.55	0.25	0.48	25	12.50
0.004	10.22	0.3	0.76	30	10.38
0.0045	9.93	0.35	1.05	35	8.80
0.005	9.65	0.4	1.39	40	7.80
0.006	9.14	0.45	1.76	45	7.24
0.007	8.67	0.5	2.13	50	6.66
0.008	8.25	0.6	2.82	60	5.80
0.009	7.85	0.7	3.45	70	5.28
0.01	7.52	0.8	4.01	80	4.77
0.015	6.15	0.9	4.48	90	4.37
0.02	5.06	1	4.92	100	4.03
0.025	4.16	1.5	6.26	150	2.74
0.03	3.44	2	6.92	200	1.92
0.035	2.82	2.5	7.3	250	1.46
0.04	2.29	3	7.53	300	1.17
0.045	1.90	3.5	7.72	350	0.97
0.05	1.54	4	7.89	400	0.82
0.06	1.10	4.5	8.04	450	0.71
0.07	0.78	5	8.21	500	0.62
0.08	0.55	6	8.55	600	0.5
0.09	0.39	7	8.68	700	0.41

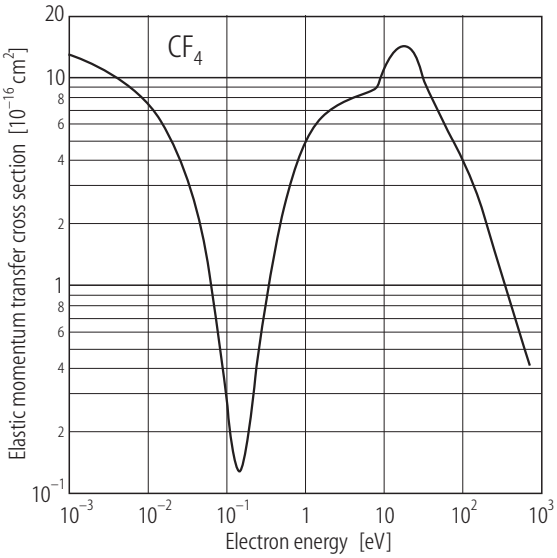

Fig. 6.3.5.21. Preferred values of the elastic momentum transfer cross section for electrons scattered from carbon tetrafluoride (CF_4).

Reference for 6.3.5.21

99Chr1 Christophorou, L.G.: J. Phys. Chem. Ref. Data **28** (1999) 1

6.3.5.22 Perfluoroethane (C_2F_6)

The preferred cross section is listed in Table 6.3.5.22 and shown in Fig. 6.3.5.22. The preferred cross section σ_m^{el}, is that determined by [98Chr1] from an assessment of the literature to 1997.

The uncertainty is estimated to be < ± 35 %.

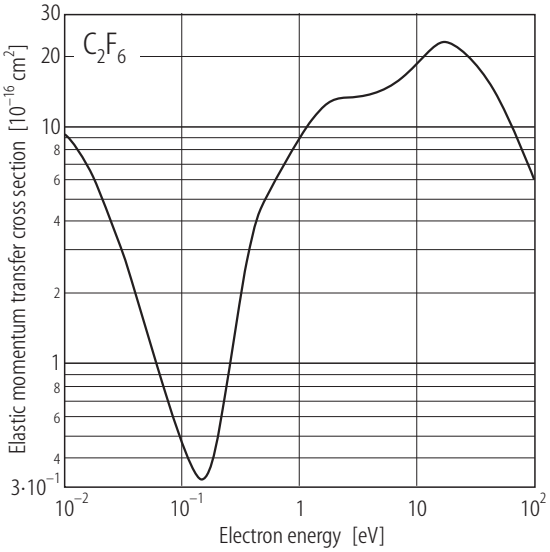

Fig. 6.3.5.22. Preferred values of the elastic momentum transfer cross section for electrons scattered from perfluoroethane (C_2F_6).

Table 6.3.5.22. Preferred values of the elastic momentum transfer cross section (σ_m^{el}) for electrons scattered from perfluoroethane (C_2F_6).

Energy [eV]	σ_m^{el} [Å^2]	Energy [eV]	σ_m^{el} [Å^2]	Energy [eV]	σ_m^{el} [Å^2]
0.01	9.47	0.4	3.45	8	17.9
0.02	5.08	0.45	4.24	9	18.4
0.03	3.06	0.5	4.82	10	18.8
0.04	1.99	0.6	5.71	15	22.7
0.05	1.38	0.7	6.55	20	22.5
0.06	1.01	0.8	7.39	30	18.9
0.07	0.78	0.9	8.21	40	15.5
0.08	0.63	1	8.98	50	12.8
0.09	0.53	1.5	11.8	60	10.6
0.1	0.46	2	13	70	8.96
0.15	0.32	3	13.2	80	7.66
0.2	0.47	4	14.1	90	6.66
0.25	0.93	5	14.6	100	5.86
0.3	1.66	6	15.2		
0.35	2.55	7	16.4		

References for 6.3.5.22

98Chr1 Christophorou, L.G. and Olthoff, J.K.: J. Phys. Chem. Ref. Data **27** (1998) 1

6.3.5.23 Sulphur hexafluoride (SF_6)

The preferred cross section is listed in Table 6.3.5.23 and shown in Fig. 6.3.5.23. The preferred values of σ_m^{el} are those of [00Chr1] which cover the energy range 2.75 to 700 eV. This cross section agrees to within the stated error limits with the beam derived values of [83Tra1, 89Sak1 91Joh1, 00Cho1].

The uncertainty is estimated to be < ± 20 %.

References for 6.3.5.23

83Tra1 Trajmar, S., Register, D.F., Chutjian, A.: Phys. Rep. **97** (1983) 216
89Sak1 Sakae, T., Sumiyoshi, S., Murakami, E., Matsumoto, Y., Ishibashi, K., Katase, A.: J. Phys. B: At. Mol. Opt. Phys.: **22** (1989) 1385
91Joh1 Johnstone, W.M., Newell, W.R.: J. Phys. B: At. Mol. Opt. Phys. **24** (1991) 473
00Cho1 Cho, H., Gulley, R.J., Buckman, S.J.: J. Phys. B: At. Mol. Opt. Phys. **33** (2000) L309
00Chr1 Christophorou, L.G., Olthoff, J.K.: J. Phys. Chem. Ref. Data **29** (20009 267

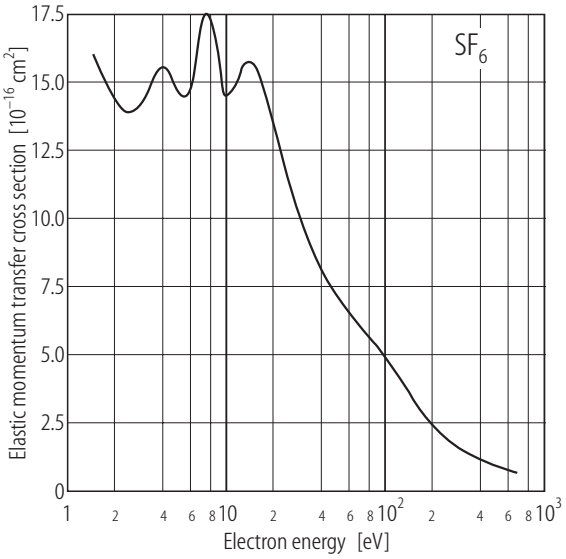

Fig. 6.3.5.23. Preferred values of the elastic momentum transfer cross section for electrons scattered from sulphur hexafluoride (SF_6).

Table 6.3.5.23. Preferred values of the elastic momentum transfer cross section (σ_m^{el}) for electrons scattered from sulphur hexafluoride (SF_6).

Energy [eV]	σ_m [Å^2]	Energy [eV]	σ_m [Å^2]
2.75	16	30	13.2
3	15.4	35	11.4
3.5	14.5	40	10.3
4	14.00	45	9.37
4.5	13.9	50	8.65
5	14.1	60	7.69
6	15.1	70	7.06
7	15.5	75	6.74
8	14.8	80	6.46
9	14.4	90	6.03
10	15.1	100	5.70
11	16.7	125	4.92
12	17.6	150	4.16
13	17.1	200	2.98
14	15.8	250	2.23
15	14.9	300	1.76
16	14.5	350	1.47
17	14.7	400	1.28
18	15.00	450	1.13
19	15.4	500	1.02
20	15.7	600	0.82
22	15.7	700	0.66
25	15.00		

6.3.5.24 Hexafluorobenzene (C_6F_6)

The preferred cross section is listed in Table 6.3.5.24 and shown in Fig. 6.3.5.24.
The preferred cross section is a best fit curve to the only available data, the beam-derived values of [00Cho1].

The uncertainty is estimated to be < ± 25 %.

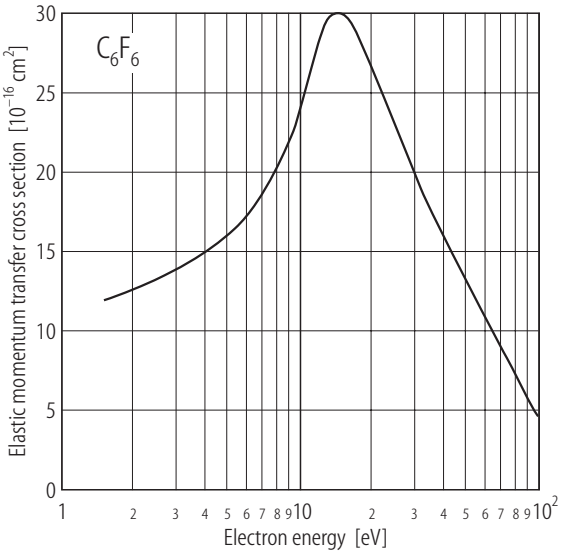

Fig. 6.3.5.24. Preferred values of the elastic momentum transfer cross section for electrons scattered from hexafluorobenzene (C_6F_6).

Table 6.3.5.24. Preferred values of the elastic momentum transfer cross section (σ_m^{el}) for electrons scattered from hexafluorobenzene (C_6F_6).

Energy [eV]	σ_m^{el} [Å^2]	Energy [eV]	σ_m^{el} [Å^2]	Energy [eV]	σ_m^{el} [Å^2]
1.5	11.9	8	20.34	40	15.86
1.8	12.33	9	21.98	50	12.93
2	12.59	10	23.97	60	10.603
2.5	13.28	12	28.36	70	8.879
3	13.79	15	29.91	80	7.155
4	14.914	18	28.05	90	5.69
5	16.12	20	26.38	100	4.569
6	17.41	25	22.5		
7	18.79	30	19.74		

References for 6.3.5.24

00Cho1 Cho, H., Gulley, R.J., Sunohara, K., Kitajima, M., Uhlmann, L.J., Tanaka, H., Buckman, S.J.: Private communication, 2000

6.3.5.25 Perfluoropropane (C_3F_8)

The preferred cross section is listed in Table 6.3.5.25 and shown in Fig. 6.3.5.25. The preferred cross section, σ_m^{el} is based on that determined by [99Tan1] (erroneously tabled in this paper as being for C_3H_8).

The uncertainty is estimated to be < ± 30 %.

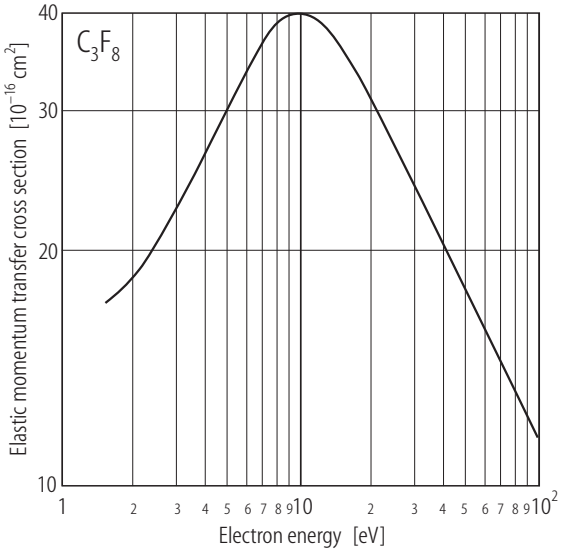

Fig. 6.3.5.25. Preferred values of the elastic momentum transfer cross section for electrons scattered from perfluoropropane (C_3F_8).

Table 6.3.5.25. Preferred values of the elastic momentum transfer cross section (σ_m^{el}) for electrons scattered from perfluoropropane (C_3F_8).

Energy [eV]	σ_m^{el} [Å^2]	Energy [eV]	σ_m^{el} [Å^2]	Energy [eV]	σ_m^{el} [Å^2]
1.5	17.1	8	39.7	40	19.8
1.8	17.9	9	40.7	50	17.3
2	18.4	10	41.1	60	15.5
2.5	20.1	12	39.5	70	14.2
3	22.2	15	35.9	80	13.1
4	26.7	18	32.3	90	12.2
5	30.4	20	30.2	100	11.5
6	33.9	25	26.6		
7	37.3	30	23.6		

References for 6.3.5.25

99Tan1 Tanaka, H., Tachibana, Y., Kitajima, M., Sueoka, O., Takaki, H., Hamada, A., Kimura, M.: Phys. Rev. A **59** (1999) 2006