6.2 Integral elastic cross sections

6.2.1 Introduction

6.2.1.1 Definition in terms of the differential cross section

The integral elastic cross section, σ_i, for electron scattering is defined as

$$\sigma_i(\varepsilon) = 2\pi \int_0^{\pi} \frac{d\sigma}{d\Omega} \sin\theta \, d\theta \tag{1}$$

where $d\sigma/d\Omega$ differential elastic scattering 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 $d\Omega = 2\pi \sin\theta d\theta$.

6.2.1.2 Definition in terms of the scattering phase shifts

In the quantum mechanical description of elastic scattering the wave function of an electron, at a distance r from a scattering centre, after being scattered at an angle θ is given (in its simplest form) by

$$\psi = e^{ikz} + \frac{f(\theta)}{r} e^{ikr} \tag{2}$$

where $f(\theta)$ is the amplitude of the scattered wave, k is the wavevector and the z axis is in the direction of the incoming particle. The angular part of the outgoing wave may be expressed in partial waves corresponding to specific values of the angular momentum quantum number l. The differential cross section is given by

$$\frac{d\sigma}{d\Omega} = |f(\theta)|^2 \tag{3}$$

where

$$f(\theta) = \frac{1}{2ik} \sum_l (2l+1)[\exp(2i\eta_l) - 1] P_l(\cos\theta) \tag{4}$$

from which it follows that

$$\sigma_i(\varepsilon) = \frac{4\pi}{k^2} \sum_l (l+1) \sin^2(\eta_l - \eta_{l+1}) \tag{5}$$

where η_l is the additional shift introduced into the asymptotic phase of the l*th* partial wave by the scattering. $P_l(\cos\theta)$ are the Legendre polynomials.

For elastic electron scattering from targets without permanent electric dipole moments O'Malley and co-workers [62OMa1, 63OMa1] have shown that the phase shifts at low energies may be expanded in terms of the wave number (the resulting relations are known as modified effective range (MERT) formulae). These formulae have been used in fitting routines to derive the integral elastic cross section at low energies and the scattering length A. An extended version of their formulae (see for example [89Buc1, 95Pet1]) is as follows (atomic units are used):

$$\tan\eta_0 = -Ak[1 + \frac{4}{3}\alpha k^2 \ln(ka_0)] - \frac{\pi}{3}\alpha k^2 + Dk^3 + Fk^4 \tag{6}$$

$$\tan\eta_1 = \frac{\pi}{15}\alpha k^2 - A_1 k^3 \tag{7}$$

where A, A_1, D and F are fitting parameters, a_0 is the Bohr radius and α is the dipole polarizability. For higher order phaseshifts ($l \geq 2$) the Born expansion is used

$$\tan\eta_l = \frac{\pi\alpha k^2}{(2l+3)(2l+1)(2l-1)} \tag{8}$$

The scattering length is also related to the zero energy integral and momentum transfer (σ_m) cross sections via the relation

$$\sigma_i = \sigma_m = 4\pi A^2 \tag{9}$$

Whilst the application of phaseshift approaches are not, strictly speaking, appropriate in electron-molecule scattering, the above 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. Examples of these applications can be found in [92Man1, 94Lun1, 98Mer1].

6.2.2 Experimental determinations

6.2.2.1 From attenuation experiments

In some circumstances attenuation techniques, which are widely used for the measurement of grand total scattering cross sections (see section 6.1), can provide a measurement of the integral elastic cross section. Strictly speaking this is only the case where there are no inelastic scattering channels open, which in the case of the overwhelming majority of molecules, is only for very low energies below the first rotational excitation threshold. However in practice, for some molecular systems, the low energy inelastic cross sections are small compared to the elastic such that an attenuation measurement (e.g. using the Beer-Lambert law) will provide a reasonable upper limit on the total elastic cross section. However, in general, this is not the case and almost all of the experimental total elastic cross sections in the literature for electron-molecule scattering have been derived from crossed beam experiments of the differential cross section.

6.2.2.2 From crossed beam experiments

The integral elastic cross section, $\sigma_i(\varepsilon)$, can be derived from absolute measurements of $d\sigma/d\Omega$ 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. Whilst a recent technique has been developed to overcome this problem at large scattering angles [96Zub1], most of the data in the literature has been derived by the use of some extrapolation procedure to extend the differential measurements to 0 and π. Various techniques have been applied to enable this extrapolation and they, and the uncertainties involved have been discussed by various authors (e.g. [83Tra1]). One common technique which has been applied to many atomic, and some molecular species, is the so-called phaseshift analysis. In this technique, the experimental differential cross sections are fitted with expressions such as (3) and (4), where the first few (perhaps 2 - 4) phaseshifts (expressions (6) and (7)) are treated as free parameters. Higher-order phaseshifts are obtained by the use of (8). The results of the fitting process can then be used to calculate the elastic differential cross section over the entire angular range as well as the integral elastic cross section. This process has been applied, for instance, in electron-rare-gas atom colisions for energies up to the first inelastic threshold (see for example [75And1, 80Reg1, 96Gib1]). Once again, the application of

phaseshift analysis techniques to molecular systems at the differential scattering level has not been used extensively. However, several variations on this process have proved useful in a number of cases for deriving integral elastic cross sections for molecules, e.g. [91Boe1, 95Sun1, 96Boe1].

Most of the experimental data which is used in deriving the preferred integral elastic cross sections in the following section is from crossed beam measurements of differential elastic scattering. As a result of the difficulties, outlined above, in extracting accurate integral cross sections by integrating the differential cross section, it is not uncommon for the the uncertainties on the derived integral cross sections to exceed 20 %. This is particularly true for polar molecules where strong forward scattering, as a result of the long-range dipole interaction, can dominate the differential cross section.

References for 6.2.1 and 6.2.2

62OMa1 O'Malley, T.F., Rosenberg, L., Spruch, L.: Phys. Rev. **125** (1962) 1300

63OMa1 O'Malley, T.F.: Phys. Rev. **130** (1963) 1020

75And1 Andrick, D. and Bitsch, A.: J. Phys. B: At. Mol. Phys. **8** (1975) 393

80Reg1 Register, D.F., Trajmar, S., Srivastava, S.K.: Phys. Rev. A **21** (1980) 1134

83Tra1 Trajmar, S., Register, D.F., Chutjian, A.: Phys. Rep. **97** (1983) 219

89Buc1 Buckman, S.J., Mitroy, J.: J. Phys. B: At. Mol. Opt. Phys. **22** (1989) 1365

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

92Man1 Mann, A., Linder, F.: J. Phys. B: At. Mol. Opt. Phys. **25** (1992) 533

94Lun1 Lunt, S.L., Randell, J., Ziesel, J.P., Mrotzek, G., Field, D.: J. Phys. B: At. Mol. Opt. Phys. **27** (1994) 1407

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

95Pet1 Petrovic, Z.Lj., O'Malley, T.F., Crompton, R.W.: J. Phys. B: At. Mol. Opt. Phys. **28** (1995) 3309

96Gib1 Gibson, J.C., Gulley, R.J., Sullivan, J.P., Buckman, S.J., Chan, V., Burrow, P.D.: J. Phys. B: At. Mol. Opt. Phys. **29** (1996) 3177

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

96Zub1 Zubek, M., Gulley, N., King, G.C., Read, F.H. J. Phys. B: At. Mol. Opt. Phys. **29** (1996) L239

98Mer1 Merz, R., Linder, F.: J. Phys. B: At. Mol. Opt. Phys. **31** (1998) 4663

6.2.3 Determination of preferred cross sections

The preferred integral elastic 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. In some cases it is also possible to exclude certain data sets on the basis that the integral elastic cross sections are *larger* than reliable, and more accurate, grand total cross section determinations. The uncertainty estimates on the preferred cross sections indicate the level of concurrence between the various individual measurements and calculations.

6.2.4 Units

Cross sections are given in square Ångström (1 $Å^2 = 10^{-16}$ cm^2) and electron energies in electron volt (eV). Where applicable, scattering lengths are given in atomic units (1 a.u. = $5.2918 \cdot 10^{-9}$ cm) as is customary.

6.2.5 Diatomic molecules

6.2.5.1 Hydrogen (H_2)

The preferred cross sections, listed in Table 6.2.5.1 and shown in Fig. 6.2.5.1, are obtained using the data of [71Lin1, 75Sri1, 80Fer1, 85Nis1, 86Kha1, 91Bru1]. With the exception of [80Fer1], which are grand total cross section measurements but are equivalent to the integral elastic cross section below 50 meV, all of the above cross sections were derived from differential scattering measurements. These experimental values are in reasonable agreement with a vibrational close coupling calculation of [90Sni1].

Table 6.2.5.1. Preferred values of the integral elastic cross section (σ_i) for electrons scattered from hydrogen. The estimated uncertainty is ± 20 % across the entire energy range.

Energy [eV]	σ_i [$Å^2$]	Energy [eV]	σ_i [$Å^2$]	Energy [eV]	σ_i [$Å^2$]
0.020	7.41	0.50	10.95	12	7.61
0.030	7.77	0.60	11.28	14	6.92
0.040	8.08	0.70	11.59	16	6.32
0.050	8.32	0.80	11.88	18	5.78
0.060	8.51	0.90	12.16	20	5.26
0.070	8.69	1.0	12.36	25	4.23
0.080	8.84	1.25	13.0	30	3.40
0.090	8.99	1.50	13.55	35	2.81
0.10	9.13	2.0	14.11	40	2.36
0.12	9.33	3.0	14.12	50	1.73
0.15	9.55	4.0	13.2	60	1.31
0.20	9.83	5.0	12.51	70	1.06
0.25	10.04	6.0	11.45	80	0.89
0.30	10.24	8.0	9.85	90	0.81
0.40	10.61	10	8.58	100	0.74

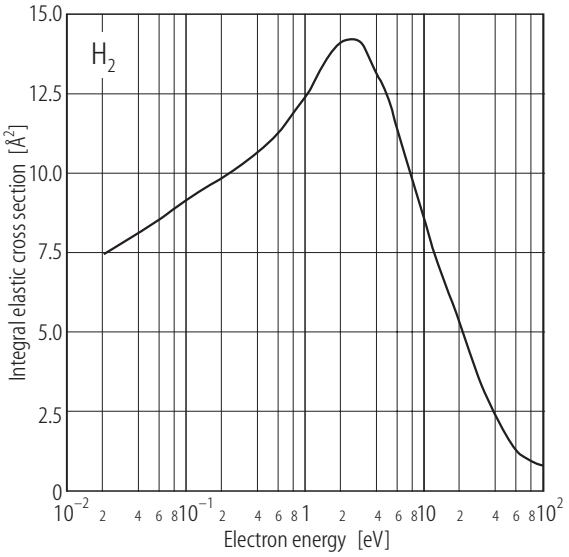

Fig. 6.2.5.1. Integral elastic scattering cross section for H_2 for energies below 100 eV.

References for 6.2.5.1

71Lin1 Linder, F., Schmidt, H.: Z. Naturforsch. **26** A (1971) 1603

75Sri1 Srivastava, S., Chutjian, A., Trajmar, S.: J. Chem. Phys. **63** (1975) 2659

80Fer1 Ferch, J., Raith, W. and Schroder, K.: J. Phys. B: At. Mol. Phys. **13** (1980) 148

85Nis1 Nishimura, H., Danjo, A., Sugahara, H.: J. Phys. Soc. Jpn. **54** (1985) 1757

86Kha1 Khakoo, M., Trajmar, S.: Phys. Rev. A **34** (1986) 138

90Sni1 Snitchler, G., Alston, S., Norcross, D., Saha, B., Danby, G., Trail, W., Morrison, M.A.: Private communication, shown in [91Bru1]

91Bru1 Brunger, M.J., Buckman, S.J., Newman, D.S., Alle, D.T.: J. Phys. B: At. Mol. Opt. Phys. **24** (1991) 1435

6.2.5.2 Nitrogen (N_2)

The preferred cross section, listed in Table 6.2.5.2 and shown in Fig. 6.2.5.2, was obtained using the data of [76Sri1, 80Shy1, 86Soh1, 92Bre1, 93Shi1, 95Sun1]. All of these cross sections were derived from differential scattering measurements. A previous cross section compilation has been presented by [86Iti1]. Note that at low energies, in the region of the dominant $^2\Pi$ resonance, the level of detail in the DCS measurements does not permit the fine details of the resonance profile to be extracted. A broad envelope of the resonance enhanced cross section is thus provided. There is good general agreement between the preferred cross section and the calculations of (for example) [76Cha1, 95Sun1].

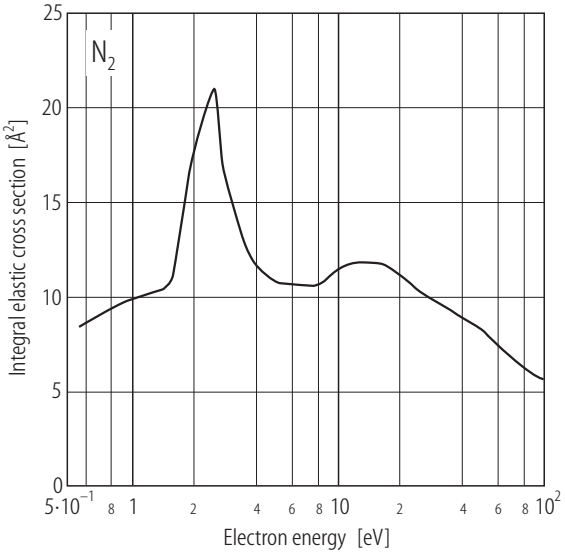

Fig. 6.2.5.2. Integral elastic scattering cross section for N_2 for energies below 100 eV.

Table 6.2.5.2. Preferred values of the integral elastic cross section (σ_i) for electrons scattered from nitrogen. The uncertainty in the cross section is estimated to be of the order of ± 20 %.

Energy [eV]	σ_i [Å^2]	Energy [eV]	σ_i [Å^2]	Energy [eV]	σ_i [Å^2]
0.55	8.39	2.7	17.5	25	10.25
0.70	9.03	3.0	15.0	30	9.65
0.90	9.62	4.0	11.6	40	8.85
1.0	9.83	5.0	10.75	50	8.2
1.5	10.53	6.0	10.6	60	7.4
2.0	17.93	8.0	10.6	80	6.25
2.2	19.5	10	11.4	100	5.6
2.35	20.5	15	11.8		
2.5	21.0	20	11.15		

References for 6.2.5.2

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

76Cha1 Chandra, N., Temkin, A.: Phys. Rev. A **13** (1976) 188

80Shy1 Shyn, T.W., Carignan, G.R.: Phys. Rev. A **22** (1980) 923

86Soh1 Sohn, W., Kochem, K-H., Scheuerlein, K-M., Jung, K., Ehrhardt, H.: J. Phys. B: At. Mol. Phys. **19** (1986) 4017

86Iti1 Itikawa, Y., Hayashi, M., Ichimura, A., Onda, K., Sakimoto, K., Takayanagi, K., Nakamura, M., Nishimura, H., Takayanagi, T.: J. Phys. Chem. Ref. Data **15** (1986) 985

92Bre1 Brennan, M.J., Alle, D.T., Euripides, P., Buckman, S.J., Brunger, M.J.: J. Phys. B: At. Mol. Opt. Phys. **25** (1992) 2669

93Shi1 Shi, X., Stephen, T.M., Burrow, P.D.: J. Phys. B: At. Mol. Opt. Phys. **26** (1993) 121

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

6.2.5.3 Oxygen (O_2)

The preferred cross section, listed in Table 6.2.5.3 and shown in Fig. 6.2.5.3, was obtained using the data of [71Tra1, 82Shy1, 93Kan1, 95Sul1]. All of these cross sections were derived from differential elastic scattering measurements.

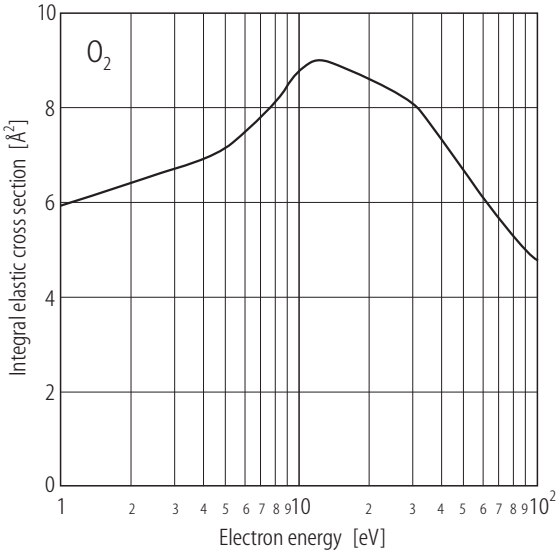

Fig. 6.2.5.3. Integral elastic scattering cross section for O_2 for energies below 100 eV.

Table 6.2.5.3. Preferred values of the integral elastic cross section (σ_i) for electrons scattered from molecular oxygen. The uncertainty in the cross section is estimated to be of the order of ± 20 %.

Energy [eV]	σ_i [Å^2]	Energy [eV]	σ_i [Å^2]	Energy [eV]	σ_i [Å^2]
1.0	5.97	8.0	8.21	40	7.30
2.0	6.45	9.0	8.49	50	6.59
3.0	6.74	10	8.80	60	6.08
4.0	6.93	12	9.00	70	5.63
5.0	7.20	15	8.89	80	5.29
6.0	7.52	20	8.60	90	5.01
7.0	7.86	30	8.09	100	4.78

References for 6.2.5.3

71Tra1 Trajmar, S., Cartwright, D.W., Williams, W.: J. Chem. Phys. **56** (1971) 1482
82Shy1 Shyn, T.W., Sharp, W.E.: Phys. Rev. A **26** (1982) 1369
93Kan1 Kanik, I., Trajmar, S., Nickel, J.C.: J. Geophys. Res. **98** (1993) 7447
95Sul1 Sullivan, J.P., Gibson, J.C., Gulley, R.J., Buckman, S.J.: J. Phys. B: At. Mol. Opt. Phys. **28** (1995) 4319

6.2.5.4 Carbon monoxide (CO)

The preferred cross section, listed in Table 6.2.5.4 and shown in Fig. 6.2.5.4, was obtained using the data of [78Tan1, 88Nic1, 93Kan1, 96Gib1]. The cross section of [93Kan1] is their preferred cross section based on an analysis of previous work. The present preferred cross section, which includes the more recent work of [96Gib1], is very similar to that of [93Kan1]. All of the other cross sections cited here were derived from differential elastic scattering measurements. There is a good level of agreement between the preferred cross section and the close-coupling SCF calculation of [80Ond1].

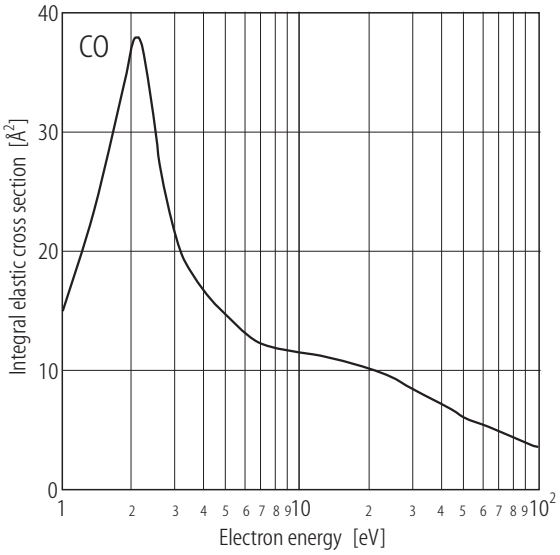

Fig. 6.2.5.4. Integral elastic scattering cross section for CO for energies below 100 eV.

Table 6.2.5.4. Preferred values of the integral elastic cross section (σ_i) for electrons scattered from carbon monoxide. The uncertainty in the cross section is estimated to be of the order of ± 15 %.

Energy [eV]	σ_i [Å^2]	Energy [eV]	σ_i [Å^2]	Energy [eV]	σ_i [Å^2]
1.0	14.72	3.0	21.22	20	10.19
1.2	19.39	3.5	18.11	30	8.49
1.4	24.33	4.0	16.56	40	7.08
1.6	29.29	4.5	15.42	50	5.94
1.8	33.5	5.0	14.43	60	5.38
2.0	37.78	6.0	13.02	70	4.81
2.1	37.92	7.0	12.17	80	4.25
2.2	36.65	8.0	11.89	90	3.96
2.4	31.55	9.0	11.60	100	3.68
2.6	26.46	10	11.46		
2.8	23.49	15	10.89		

References for 6.2.5.4

78Tan1 Tanaka, H., Srivastava, S.K., Chutjian, A.: J. Chem. Phys. **69** (1978) 5329

80Ond1 Onda, K., Truhlar, D.G.: J. Phys. C **72** (1980) 5249

88Nic1 Nickel, J.C., Mott, C., Kanik, I., McCollum, D.C.: J. Phys. B: At. Mol. Opt. Phys. **21** (1988) 1867

93Kan1 Kanik, I., Trajmar, S., Nickel, J.C.: J. Geophys. Res. **98** (1993) 7447

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

6.2.5.5 Nitric oxide (NO)

The preferred cross section, listed in Table 6.2.5.5 and shown in Fig. 6.2.5.5, was obtained using the only data available in the literature, the differential elastic scattering data of [95Moj1].

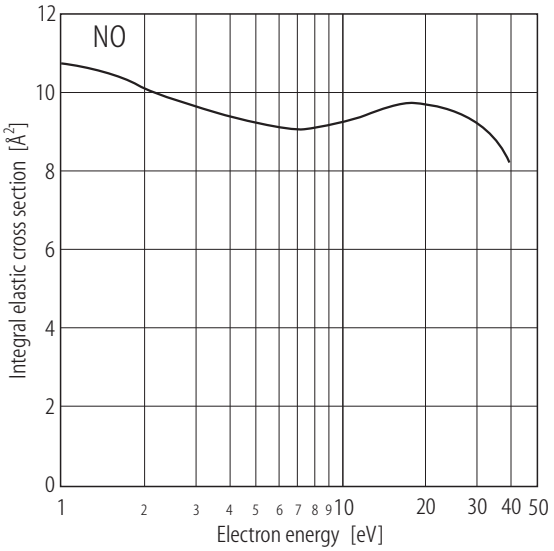

Fig. 6.2.5.5. Integral elastic scattering cross section for NO for energies below 50 eV.

Table 6.2.5.5. Preferred values of the integral elastic cross section (σ_i) for electrons scattered from nitric oxide. The uncertainty in the cross section is estimated to be of the order of ± 25 %.

Energy [eV]	σ_i [Å^2]
1.0	10.75
1.5	10.45
2.0	10.10
3.0	9.65
4.0	9.40
5.0	9.25
7.5	9.05
10	9.25
15	9.65
20	9.70
30	9.25
40	8.21

References for 6.2.5.5

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

6.2.6 Polyatomic molecules

6.2.6.1 Methane (CH_4)

The preferred cross section, listed in Table 6.2.6.1 and shown in Fig. 6.2.6.1, is obtained using the cross sections of [83Soh1, 85Fer1, 86Loh1, 86Soh1, 90Shy1, 91Boe1, 94Lun1, 97Bun1, 98Lun1]. This cross section is in reasonable agreement with the calculated cross section of [95Alt1], particularly at energies above 2 eV.

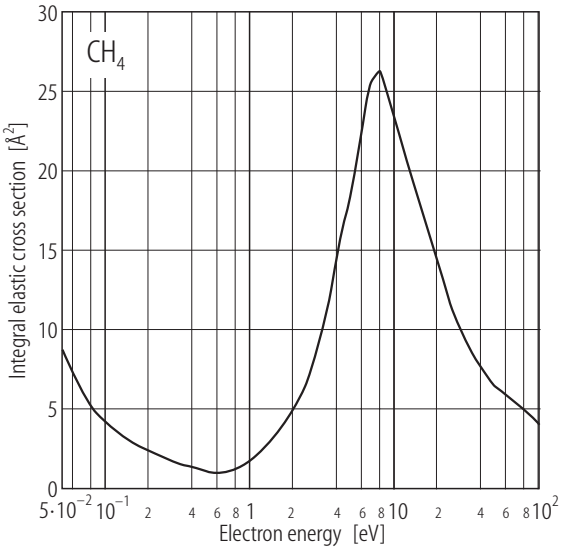

Fig. 6.2.6.1. Integral elastic scattering cross section for CH_4 for energies below 100 eV.

Table 6.2.6.1. Preferred values of the integral elastic cross section (σ_i) for electrons scattered from methane. The estimated uncertainty is ± 35 % below 1 eV and ± 25 % above 1 eV.

Energy [eV]	σ_i [Å^2]	Energy [eV]	σ_i [Å^2]	Energy [eV]	σ_i [Å^2]
0	21.1	0.80	1.16	9.0	25.0
0.05	8.80	0.9	1.42	10	23.3
0.1	4.16	1.0	1.72	15	18.1
0.15	2.88	1.5	3.12	20	14.22
0.20	2.33	2.0	4.88	30	9.65
0.25	1.93	3.0	8.69	40	7.63
0.30	1.59	4.0	14.2	50	6.47
0.40	1.31	5.0	18.4	75	5.25
0.50	1.09	6.0	22.8	100	4.0
0.60	0.96	7.0	25.6		
0.70	1.01	8.0	26.2		

References for 6.2.6.1

83Soh1 Sohn, W., Jung, K., Ehrhardt, H.: J. Phys. B: At. Mol. Phys. **16** (1983) 891
85Fer1 Ferch, J., Granitza, B., Raith, W.: J. Phys. B: At. Mol. Phys. **18** (1985) L445
86Loh1 Lohmann, B., Buckman, S.J.: J. Phys. B: At. Mol. Phys. **19** (1986) 2565
86Soh1 Sohn, W., Kochem, K.H., Scheuerlein, K.M, Jung, K., Ehrhardt, H.: J. Phys. B: At. Mol. Phys. **19** (1986) 3625
90Shy1 Shyn, T.W., Cravens, T.E.: J. Phys. B: At. Mol. Opt. Phys. **23** (1990) 293
91Boe1 Boesten, L., Tanaka, H.: J. Phys. B: At. Mol. Opt. Phys. **24** (1991) 821
94Lun1 Lunt, S.L., Randell, J., Ziesel, J.P., Mrotzek, G., Field, D.: J. Phys. B: At. Mol. Opt. Phys. **27** (1994) 1407
95Alt1 Althorpe, S.C., Gianturco, F.A., Sanna, N.: J. Phys. B: At. Mol. Opt. Phys. **28** (1995) 4165
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
98Lun1 Lunt, S.L., Randell, J., Ziesel, J.P., Mrotzek, G., Field, D.: J. Phys. B: At. Mol. Opt. Phys. **31** (1998) 4225

6.2.6.2 Ammonia (NH_3)

There has only been one experiment where absolute elastic scattering cross sections for ammonia have been determined. The preferred cross section is thus based on the sole differential scattering measurement of [92All1] at energies between 2 and 30 eV. This cross section is given in Table 6.2.6.2 and shown in Fig. 6.2.6.2. Due to the large dipole moment of this molecule and the subsequently strong forward scattering, the estimated uncertainty in the cross section is ± 40 %. At energies above 5 eV there is good agreement between this cross section and the Kohn variational calculation of [92Res1].

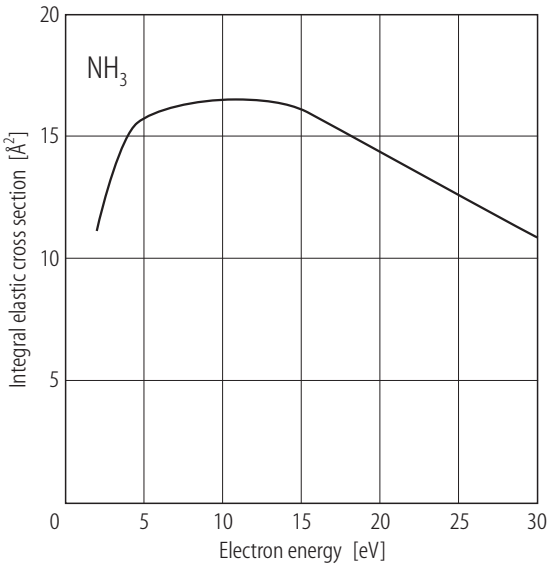

Fig. 6.2.6.2. Integral elastic scattering cross section for NH_3 for energies below 30 eV.

Table 6.2.6.2. Preferred values of the integral elastic cross section (σ_i) for electrons scattered from ammonia. The uncertainty in the cross section is estimated to be of the order of ± 40 %.

Energy [eV]	σ_i [Å^2]
2.0	11.2
3.0	13.5
4.0	15.1
5.0	15.8
7.5	16.3
10	16.5
15	16.1
20	14.4
30	10.9

References for 6.2.6.2

92All1 Alle, D.T., Gulley, R.J., Buckman, S.J., Brunger, M.J.: J. Phys. B: At. Mol. Opt. Phys. **25** (1992) 1533
92Res1 Rescigno, T.N., Lengsfield, B.H., McCurdy, C.W., Parker, S.D.: Phys. Rev. A **45** (1992) 7800

6.2.6.3 Water vapour (H_2O)

The preferred cross section, listed in Table 6.2.6.3 and shown in Fig. 6.2.6.3, was obtained from an analysis of the differential scattering data of [85Dan1, 86Kat1, 87Shy1, 91Joh1, 92Shy1]. As there are substantial differences between these cross sections the estimated uncertainty on the preferred cross section is ± 40 %. There is reasonable agreement between the preferred cross section and the theoretical calculations of (for example) [88Jai1] and [93Oka1].

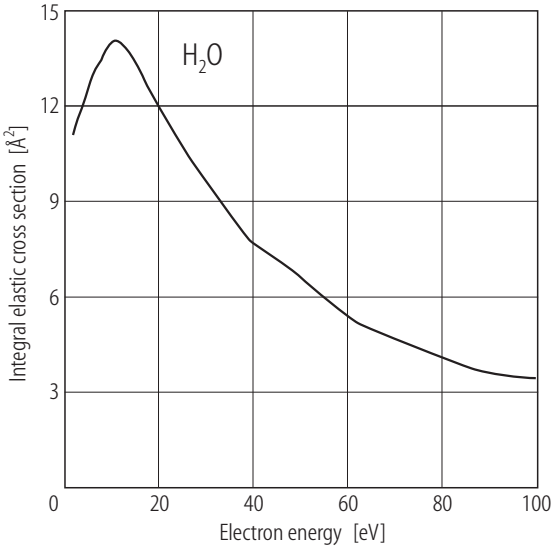

Fig. 6.2.6.3. Integral elastic scattering cross section for H_2O for energies below 100 eV.

Table 6.2.6.3. Preferred values of the integral elastic cross section (σ_i) for electrons scattered from water vapour. The uncertainty in the cross section is estimated to be of the order of ± 40 %.

Energy [eV]	σ_i [Å^2]	Energy [eV]	σ_i [Å^2]	Energy [eV]	σ_i [Å^2]
2.0	11.1	9.0	13.8	50	6.62
3.0	11.6	10	14.0	60	5.37
4.0	11.9	12	14.0	70	4.72
5.0	12.4	15	13.4	80	4.13
6.0	12.9	20	12.0	90	3.60
7.0	13.2	30	9.65	100	3.43
8.0	13.5	40	7.70		

References for 6.2.6.3

85Dan1 Danjo, A., Nishimura, H.: J. Phys. Soc. Jpn. **54** (1985) 1224
86Kat1 Katase, A., Ishibashi, K., Matsuomoto, Y., Sakae, T., Maezono, S., Murakami, E., Watanabe, K., Makai, H.: J. Phys. B: At. Mol. Phys. **19** (1986) 2715
87Shy1 Shyn, T.W, Cho, S.Y.: Phys. Rev. A **36** (1987) 5138
88Jai1 Jain, A.: J. Phys. B: At. Mol. Opt. Phys. **21** (1988) 905
91Joh1 Johnstone, W.M., Newell, W.R.: J. Phys. B: At. Mol. Opt. Phys. **24** (1991) 3633
92Shy1 Shyn, T.W., Grafe, A.: Phys. Rev. A **46** (1992) 4406
93Oka1 Okamoto, Y., Onda, K., Itikawa, Y.: J. Phys. B: At. Mol. Opt. Phys. **26** (1993) 745

6.2.6.4 Acetylene (C_2H_2)

There have been two absolute measurements of differential elastic scattering in acetylene, those of [85Koc1] and [93Kha1]. The preferred elastic cross section for C_2H_2 is given in Table 6.2.6.4 and shown in Fig. 6.2.6.4.

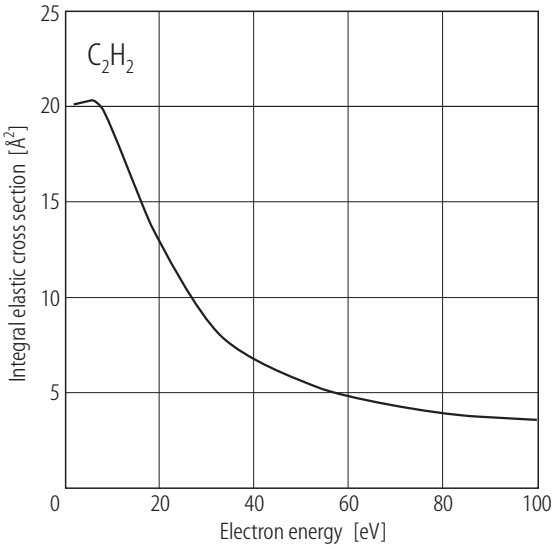

Fig. 6.2.6.4. Integral elastic scattering cross section for C_2H_2 for energies below 100 eV.

Table 6.2.6.4. Preferred values of the integral elastic cross section (σ_i) for electrons scattered from acetylene. The uncertainty in the cross section is estimated to be of the order of ± 25 %.

Energy [eV]	σ_i [Å^2]
2	20
5	20.3
10	20.3
15	15.1
20	12.8
30	8.5
50	5.6
100	3.7

References for 6.2.6.4

85Koc1 Kochem, K-H., Sohn, W., Jung, K., Ehrhardt, H., Chang, E.S.: J. Phys. B: At. Mol. Phys. **18** (1985) 1253
93Kha1 Khakoo, M.A, Jayaweera, T., Wang, S., Trajmar, S.: J. Phys. B: At. Mol. Opt. Phys. **26** (1993) 4845

6.2.6.5 Ethane (C_2H_6)

The preferred integral elastic scattering cross section for ethane is given in Table 6.2.6.5 and is shown in Fig. 6.2.6.5. It has been derived from the differential elastic scattering cross sections of [88Tan1] and [98Mer1].

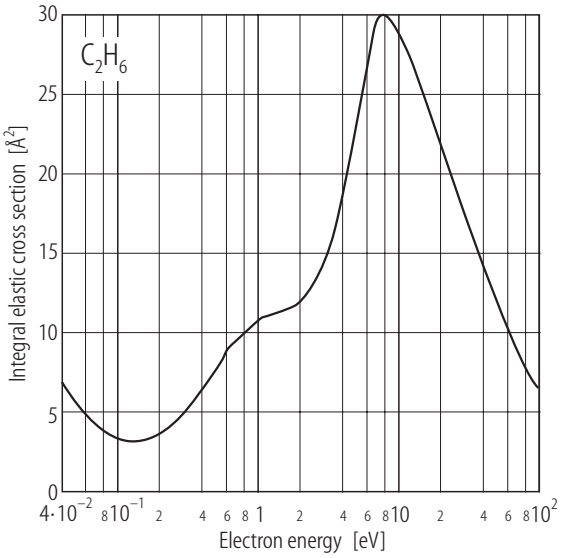

Fig. 6.2.6.5. Integral elastic scattering cross section for C_2H_6 for energies below 100 eV.

Table 6.2.6.5. Preferred values of the integral elastic cross section (σ_i) for electrons scattered from ethane. The uncertainty in the cross section is estimated to be of the order of ± 25 %.

Energy [eV]	σ_i [Å^2]	Energy [eV]	σ_i [Å^2]	Energy [eV]	σ_i [Å^2]
0	31.9	0.4	6.5	6.0	27.4
0.02	11.2	0.5	7.7	7.0	29.9
0.04	6.8	0.6	8.9	8.0	30.3
0.06	4.8	0.8	9.95	10	28.8
0.08	3.7	1.0	10.8	15	25.3
0.1	3.25	1.5	11.4	20	21.8
0.12	3.12	2.0	11.9	30	17.2
0.14	3.17	3.0	14.7	50	11.7
0.2	3.7	4.0	19.1	75	8.3
0.3	5.0	5.0	23.7	100	6.6

References for 6.2.6.5

88Tan1 Tanaka, H., Boesten, L., Matsunaga, D., Kudo, T.: J. Phys. B: At. Mol. Opt. Phys. **21** (1988) 1255

98Mer1 Merz, R., Linder, F.: J. Phys. B: At. Mol. Opt. Phys. **31** (1998) 4663

6.2.6.6 Silane (SiH_4)

The preferred integral elastic scattering cross section for silane is given in Table 6.2.6.6 and is shown in Fig. 6.2.6.6. It is derived from the differential scattering measurements of [90Tan1].

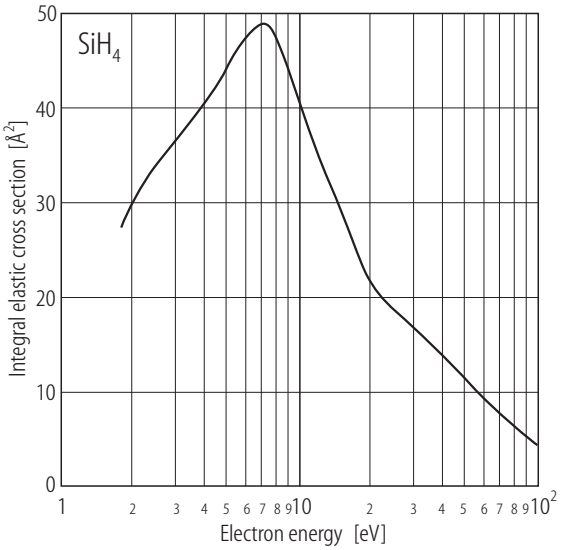

Fig. 6.2.6.6. Integral elastic scattering cross section for SiH_4 for energies below 100 eV.

Table 6.2.6.6. Preferred values of the integral elastic cross section (σ_i) for electrons scattered from silane. The uncertainty in the cross section is estimated to be of the order of ± 25 %.

Energy [eV]	σ_i [Å^2]
1.8	27.5
2.15	31.6
2.65	34.8
3	36.5
4	40.1
5	44.4
7.5	49.9
10	39.4
15	28.7
20	20.7
40	14
100	4.3

References for 6.2.6.6

90Tan1 Tanaka, H., Boesten, L., Sato, H., Kimura, M., Dillon, M.A., Spence, D.: J. Phys. B: At. Mol. Opt. Phys. **23** (1990) 577

6.2.6.7 Hydrogen sulphide (H_2S)

There has only been one measurement of elastic differential scattering for H_2S, that of [93Gul1]. The preferred integral elastic cross section derived from this work is given in Table 6.2.6.7. and is shown in Fig. 6.2.6.7. Due to the strong forward scattering, resulting from the large dipole moment, it is difficult to determine the small angle scattering cross section and as a result the uncertainty on the integral cross section is estimated to be ± 40 %. At energies above 5 eV there is reasonably good agreement between the preferred cross section, the close coupling calculation of [91Gia1] and the Kohn variational calculation of [92Len1].

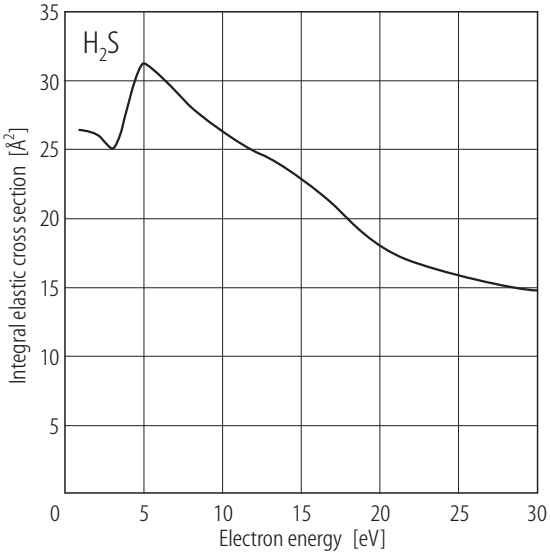

Fig. 6.2.6.7. Integral elastic scattering cross section for H_2S for energies below 30 eV.

Table 6.2.6.7. Preferred values of the integral elastic cross section (σ_i) for electrons scattered from hydrogen sulphide. The uncertainty in the cross section is estimated to be of the order of ± 40 %.

Energy [eV]	σ_i [Å^2]
1.0	26.3
2.0	26.0
3.0	25.1
5.0	31.1
10	26.2
15	22.9
20	18.0
30	14.8

References for 6.2.6.7

91Gia1 Gianturco, F.A.: J. Phys. B: At. Mol. Opt. Phys. **24** (1991) 4627
92Len1 Lengsfield, B.H. Rescigno, T.N., McCurdy, C.W., Parker, S.D.: Private communication, shown in [93Gul1]
93Gul1 Gulley, R.J., Brunger, M.J., Buckman, S.J.: J. Phys. B: At. Mol. Opt. Phys. **26** (1993) 1533

6.2.6.8 Carbon dioxide (CO_2)

The preferred integral elastic cross section for carbon dioxide at energies between 1 and 100 eV is given in Table 6.2.6.8 and shown in Fig. 6.2.6.8. It is based on the differential elastic scattering measurements of [80Reg1, 98Tan1, 99Gib1]. There is reasonable accord between this cross section and the calculations of [77Mor1, 96Tak1, 99Lee1].

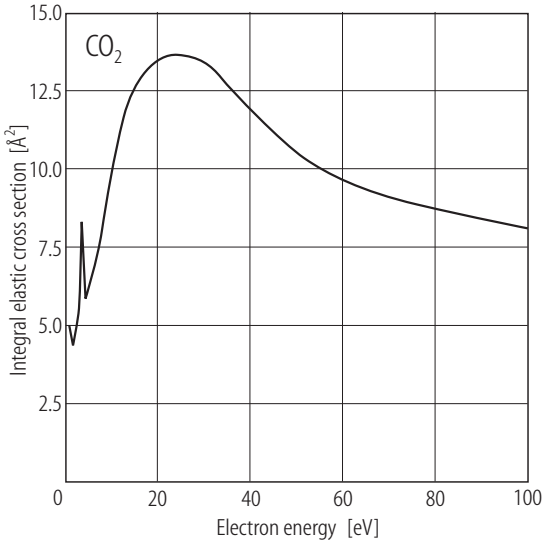

Fig. 6.2.6.8. Integral elastic scattering cross section for CO_2 for energies below 100 eV.

Table 6.2.6.8. Preferred values of the integral elastic cross section (σ_i) for electrons scattered from carbon dioxide. The uncertainty in the cross section is estimated to be of the order of ± 30 %.

Energy [eV]	σ_i [Å^2]	Energy [eV]	σ_i [Å^2]	Energy [eV]	σ_i [Å^2]
1.0	5.00	4.5	5.80	25	13.6
1.5	4.73	5.0	6.00	30	13.4
2.0	4.37	6.0	6.60	40	11.9
2.5	4.70	7.0	7.25	50	10.5
3.0	5.25	8.0	8.06	60	9.6
3.5	6.40	10.0	9.95	70	9.1
3.8	8.20	15	12.5	80	8.7
4.0	8.15	20	13.4	100	8.1

References for 6.2.6.8

77Mor1 Morrison, M.A., Lane, N.F., Collins, L.A.: Phys. Rev. A **15** (1977) 2186
80Reg1 Register, D.F., Nishimura, H., Trajmar, S.: J. Phys. B: At. Mol. Phys. **13** (1980) 1651
96Tak1 Takekawa, M., Itikawa, Y.: J. Phys. B: At. Mol. Opt. Phys. **29** (1996) 4227
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
99Lee1 Lee, C.H., Winstead, C., McKoy, V.: J. Chem. Phys. **111** (1999) 5056

6.2.6.9 Nitrous oxide (N_2O)

The preferred integral elastic cross section for Nitrous oxide at energies between 1 and 100 eV is given in Table 6.2.6.9. and shown in Fig. 6.2.6.9. It is based on the differential elastic scattering measurements of [93Joh1, 99Kit1, 00Kit1]. At energies above a few eV there is good agreement between this cross section and the recent variational calculation of [98Win1].

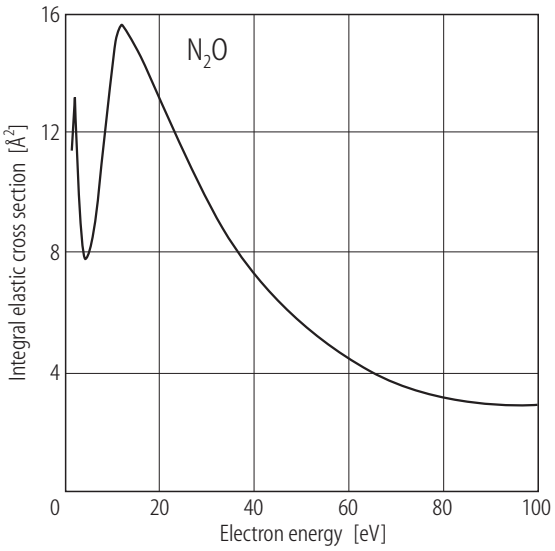

Fig. 6.2.6.9. Integral elastic scattering cross section for N_2O for energies below 100 eV.

Table 6.2.6.9. Preferred values of the integral elastic cross section (σ_i) for electrons scattered from nitrous oxide. The uncertainty in the cross section is estimated to be of the order of ± 25 %.

Energy [eV]	σ_i [Å^2]	Energy [eV]	σ_i [Å^2]
2.0	11.4	10	13.9
2.2	12.1	12	15.6
2.4	13.2	15	15.0
2.6	12.2	20	13.2
3.0	10.3	30	9.8
4.0	7.9	50	5.6
5.0	7.8	75	3.4
6.0	8.5	100	2.9
8.0	10.8		

References for 6.2.6.9

93Joh1 Johnstone, W.M., Newell, W.R.: J. Phys. B: At. Mol. Opt. Phys. **26** (1993) 129
98Win1 Winstead, C., McKoy, V: Phys. Rev. A **57** (1998) 3589
99Kit1 Kitajima, M., Sakamoto, Y., Watanabe, S., Suzuki, T., Ishikawa, T., Tanaka, H., Kimura, M.: Chem. Phys. Lett. **309** (1999) 414
00Kit1 Kitajima, M., Sakamoto, Y., Gulley R.J., Hoshino, M., Gibson, J.C., Tanaka, H., Buckman, S.J.: J. Phys. B: At. Mol. Opt. Phys. **33** (2000) 1687

6.2.6.10 Propane (C_3H_8)

The only measurements of the integral elastic scattering cross section for propane are those of [94Boe1, 99Tan1], both from the same laboratory and both derived from differential elastic scattering measurements at energies between 1.5 and 100 eV. The latter measurements, which are somewhat larger than the former, are taken as the preferred values. The preferred cross section for propane is given in Table 6.2.6.10 and shown in Fig. 6.2.6.10.

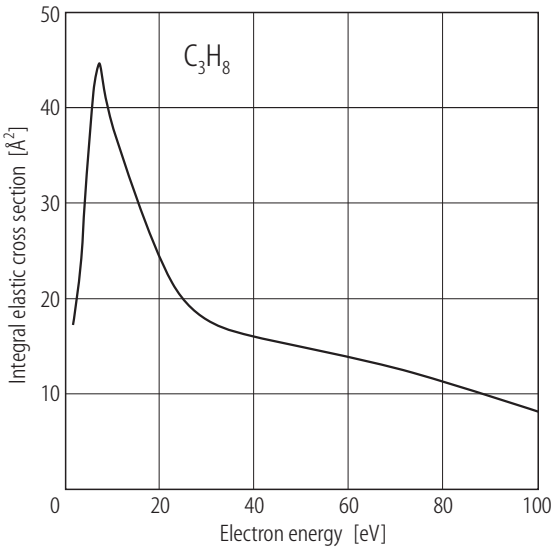

Fig. 6.2.6.10. Integral elastic scattering cross section for C_3H_8 at energies below 100 eV.

Table 6.2.6.10. Preferred values of the integral elastic cross section (σ_i) for electrons scattered from propane. The uncertainty in the cross section is estimated to be of the order of ± 35 %.

Energy [eV]	σ_i [Å^2]	Energy [eV]	σ_i [Å^2]
1.5	19.8	10	44.3
2.0	20.8	12	42.4
3.0	27.4	15	39.2
4.0	35.3	20	37.6
5.0	37.5	25	36.3
6.5	42.9	30	32.9
7.0	44.4	60	18.8
8.0	44.5	100	13.0
9.0	44.9		

References for 6.2.6.10

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

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

6.2.6.11 Carbonyl sulphide (OCS)

The preferred integral elastic cross section for carbonyl sulphide at energies between 0.4 and 5 eV is given in Table 6.2.6.11 and shown in Fig. 6.2.6.11. It is based on the only elastic differential scattering measurement available in the literature, those of [87Soh1].

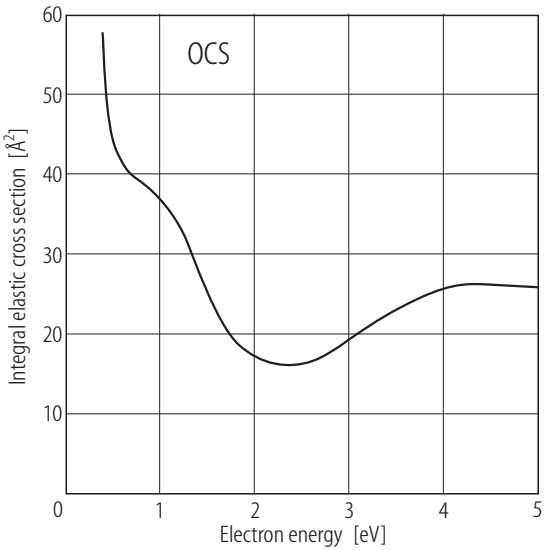

Fig. 6.2.6.11. Integral elastic scattering cross section for OCS at energies below 5 eV.

Table 6.2.6.11. Preferred values of the integral elastic cross section (σ_i) for electrons scattered from carbonyl sulphide. The uncertainty in the cross section is estimated to be of the order of ± 40 % below 1 eV and ± 30 % above 1 eV.

Energy [eV]	σ_i Å^2]
0.4	57.2
0.6	39.4
1.15	36.1
1.7	18.9
2	16.9
2.5	15.3
3	19.6
3.5	23.0
4	26.3
5	25.8

References for 6.2.6.11

87Soh1 Sohn, W., Kochem, H-H., Scheuerlein, K.M., Jung, K., Ehrhardt, H.: J. Phys. B: At. Mol. Phys. **20** (1987) 3217

6.2.6.12 Disilane (Si_2H_6)

The preferred integral elastic scattering cross section for Si_2H_6 is given in Table 6.2.6.12 and it is shown in Fig. 6.2.6.12. This cross section has been derived from the differential scattering measurements of [94Dil1].

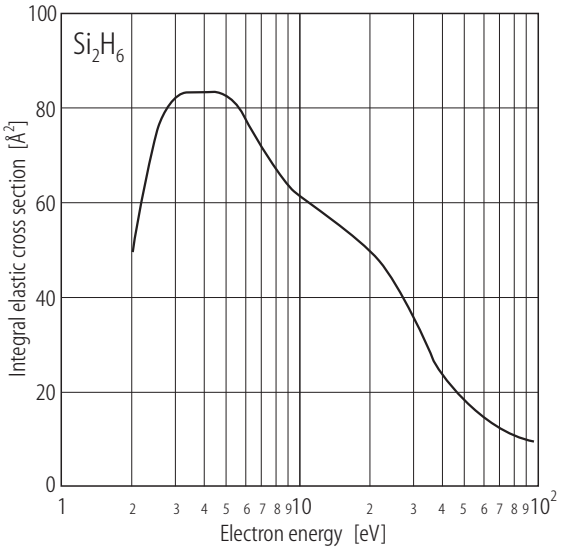

Fig. 6.2.6.12. Integral elastic scattering cross section for Si_2H_6 at energies below 100 eV.

Table 6.2.6.12. Preferred values of the integral elastic cross section (σ_i) for electrons scattered from disilane. The uncertainty in the cross section is estimated to be of the order of ± 30 %.

Energy [eV]	σ_i [Å^2]	Energy [eV]	σ_i [Å^2]
2	49.3	10	61.4
3	82.8	15	54.6
4	83.2	20	50.0
5	83.1	40	23.7
7.5	68.8	100	9.6

References for 6.2.6.12

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

6.2.6.13 Sulphur dioxide (SO_2)

The preferred integral elastic cross section for sulphur dioxide, for energies between 1 and 100 eV, is provided in Table 6.2.6.13 and shown in Fig. 6.2.6.13. This cross section is based on the differential elastic scattering measurements [89Tra1] and [94Gul1]. Due to the large dipole moment of this molecule, and the resultant strong forward scattering, the estimated uncertainty in this cross section is ± 45 %.

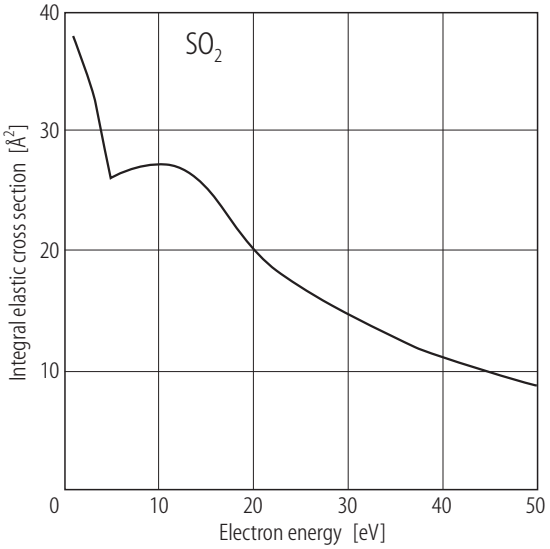

Fig. 6.2.6.13. Integral elastic scattering cross section for SO_2 at energies below 50 eV.

Table 6.2.6.13. Preferred values of the integral elastic cross section (σ_i) for electrons scattered from sulphur dioxide. The uncertainty in the cross section is estimated to be of the order of ± 45 %.

Energy [eV]	σ_i [Å^2]	Energy [eV]	σ_i [Å^2]
1.0	38.0	12	27.1
2.0	36.1	15	25.4
3.4	32.1	20	20.0
4.0	29.8	30	14.6
5.0	26.2	40	11.1
7.5	26.9	50	8.7
10	27.3		

References for 6.2.6.13

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

6.2.6.14 Nitogen trifluoride (NF_3)

The preferred integral elastic cross section for nitrogen trifluoride, for energies between 1.5 and 100 eV, is provided in Table 6.2.6.14 and shown in Fig. 6.2.6.14. This cross section is based on the only published elastic scattering measurements, those of [96Boe1].

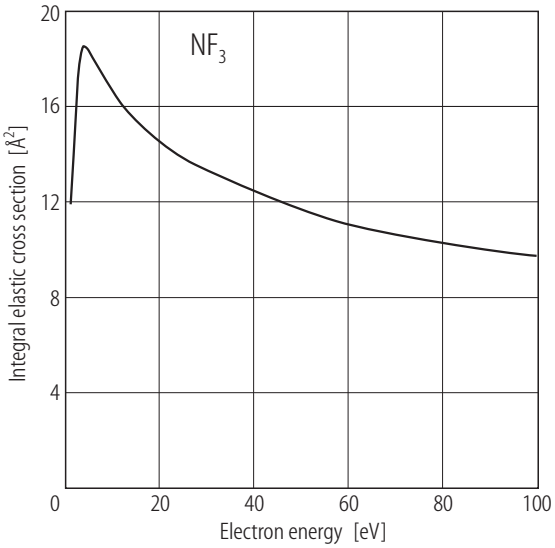

Fig. 6.2.6.14. Integral elastic scattering cross section for NF_3 at energies below 100 eV.

Table 6.2.6.14. Preferred values of the integral elastic cross section (σ_i) for electrons scattered from nitrogen trifluoride. The uncertainties in the cross section are estimated to be of the order of ± 25 %.

Energy [eV]	σ_i [Å^2]	Energy [eV]	σ_i [Å^2]
1.5	11.9	15	15.4
2.0	13.0	20	14.5
3.0	17.2	25	13.8
4.0	18.4	30	13.3
5.0	18.4	50	11.6
6.0	17.9	60	11
7.5	17.5	100	9.7
10	16.7		

References for 6.2.6.14

96Boe1 Boesten, L., Tachibana, Y., Nakano, Y., Shinohara, T., Tanaka, H., Dillon, M A.: J. Phys. B: At. Mol. Opt. Phys. **27** (1994) 1845

6.2.6.15 Carbon disulphide (CS_2)

The preferred integral elastic scattering cross section for carbon disulphide is given in Table 6.2.6.15 and is shown in Fig. 6.2.6.15. The only measurements for this molecule are the differential elastic scattering cross sections of [87Soh1] at energies between 0.3 and 5 eV.

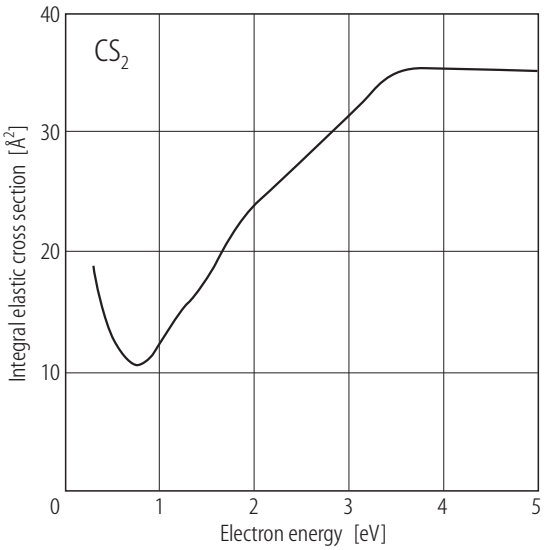

Fig. 6.2.6.15. Integral elastic scattering cross section for CS_2 at energies below 5 eV.

Table 6.2.6.15. Preferred values of the integral elastic cross section (σ_i) for electrons scattered from carbon disulphide. The uncertainty in the cross section is estimated to be of the order of ± 40 % below 1 eV and ± 30 % above 1 eV.

Energy [eV]	σ_i [Å^2]	Energy [eV]	σ_i [Å^2]
0.3	18.7	1.8	22.4
0.5	12.8	2.2	25.4
0.8	9.5	3	31.6
1	12.3	3.5	35.5
1.2	14.9	5	35.1
1.5	17.3		

References for 6.2.6.15

87Soh1 Sohn, W., Kochem, H-H., Scheuerlein, K.M., Jung, K., Ehrhardt, H.: J. Phys. B: At. Mol. Phys. **20** (1987) 3217

6.2.6.16 Germane (GeH_4)

The preferred integral elastic scattering cross section for germane is given in Table 6.2.6.16 and is shown in Fig. 6.2.6.16. The only measurements for this molecule are the differential elastic scattering cross sections of [93Dil1] at energies between 1 and 100 eV.

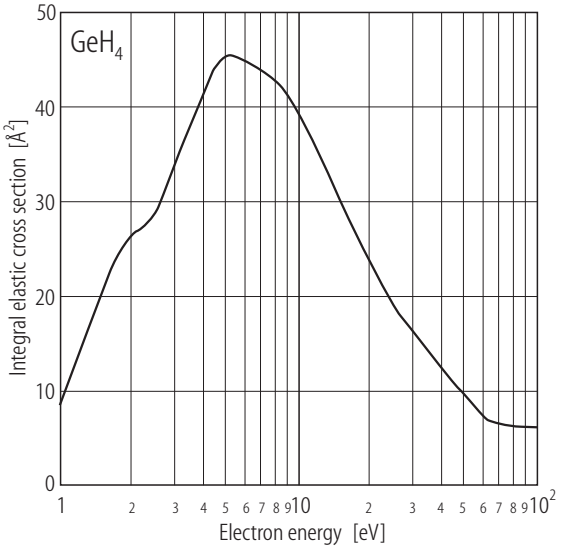

Fig. 6.2.6.16. Integral elastic scattering cross section for GeH_4 at energies below 100 eV.

Table 6.2.6.16. Preferred values of the integral elastic cross section (σ_i) for electrons scattered from germane. The uncertainty in the cross section is estimated to be of the order of ± 30 %.

Energy [eV]	σ_i [Å^2]	Energy [eV]	σ_i [Å^2]
1	8.4	10	39.42
2	26.45	15	30.14
2.5	28.76	20	23.63
3	34.07	60	7.47
5	45.48	100	6.36
7.5	43.4		

References for 6.2.6.16

93Dil1 Dillon, M.A., Boesten, L., Tanaka, H., Kimura, M., Sato, H.: J. Phys. B: At. Mol. Opt. Phys. **26** (1993) 3147

6.2.6.17 Benzene (C_6H_6)

The preferred values of the integral elastic scattering cross section for benzene are given in Table 6.2.6.17 and shown in Fig. 6.2.6.17. These have been derived from the differential elastic scattering measurements of [99 Gul1] and [01Cho1].

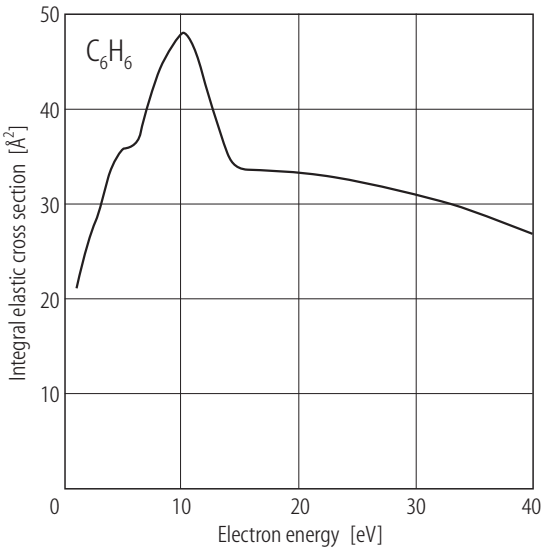

Fig. 6.2.6.17. Integral elastic scattering cross section for C_6H_6 at energies below 40 eV.

Table 6.2.6.17. Preferred values of the integral elastic cross section (σ_i) for electrons scattered from benzene. The estimated uncertainty is ± 25 %.

Energy [eV]	σ_i [Å^2]	Energy [eV]	σ_i [Å^2]
1.1	21.2	8.5	44.9
2.0	25.7	10	47.8
3.0	29.0	15	33.8
3.5	24.7	20	33.3
4.0	33.4	30	31.1
4.9	35.6	40	26.9
6.0	36.1		

References for 6.2.6.17

99Gul1 Gulley, R.J., Buckman, S.J.: J. Phys. B: At. Mol. Opt. Phys. **32** (1999) L405
01Cho1 Cho, H., Gulley, R.J., Sunohara, K., Kitajima, M., Uhlmann, L.J., Tanaka, H., Buckman, S.J.: J. Phys. B: At. Mol. Opt. Phys. **34** (2001) 1019

6.2.6.18 Carbon tetrafluoride (CF_4)

The preferred integral elastic scattering cross section for CF_4 is given in Table 6.2.6.18 and it is shown in Fig. 6.2.6.18. This cross section has been derived from the measurements of [89Sak1, 92Man1, 92Boe1], and a previous analysis of the CF_4 cross sections by [94Bon1].

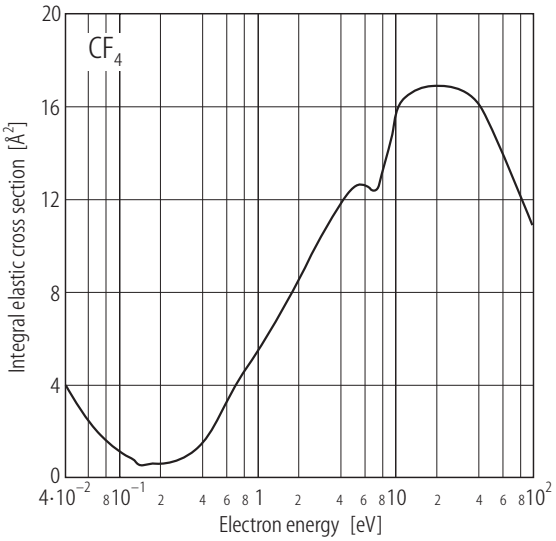

Fig. 6.2.6.18. Integral elastic scattering cross section for CF_4 at energies below 100 eV.

Table 6.2.6.18. Preferred values of the integral elastic cross section (σ_i) for electrons scattered from carbon tetrafluoride. The uncertainty in the cross section is estimated to be of the order of ± 25 %.

Energy [eV]	σ_i [Å^2]	Energy [eV]	σ_i [Å^2]	Energy [eV]	σ_i [Å^2]
0	20	0.30	0.90	8	13.1
0.02	6.5	0.40	1.6	9	14.3
0.04	4.0	0.50	2.6	10	15.8
0.06	2.3	0.75	4.3	15	16.8
0.08	1.6	1.0	5.5	20	16.9
0.10	1.1	1.5	7.2	30	16.7
0.12	0.85	2	8.6	40	16.0
0.14	0.53	3	10.6	50	15.1
0.16	0.62	4	11.9	75	12.6
0.18	0.58	5	12.5	100	10.9
0.20	0.60	6	12.6		
0.25	0.7	7	12.3		

References for 6.2.6.18

89Sak1 Sakae, T., Sumiyoshi, E., Murakami, E., Matsumoto, Y., Ishibashi, K., Katase, A.: J. Phys. B: At. Mol. Opt. Phys. **27** (1989) 1385

92Man1 Mann, A., Linder, F.: J. Phys. B: At. Mol. Opt. Phys. **25** (1992) 533

92Boe1 Boesten, L., Tanaka, H., Kobayashi, A., Dillon, M.A., Kimura, M.: J. Phys. B: At. Mol. Opt. Phys. **25** (1992) 1607

94Bon1 Bonham, R.A.: Jpn. J. Appl. Phys. **33** (1994) 4157
96Chr1 Christophorou, L.G., Olthoff, J.K., Rao, M.V.V.S.: J. Phys. Chem. Ref. Data **25** (1996) 1341

6.2.6.19 Trifluorochloromethane (CF_3Cl)

The preferred integral elastic scattering cross section for CF_3Cl is given in Table 6.2.6.19 and is shown in Fig. 6.2.6.19. It is derived from the elastic differential cross section measurements of [92Man1] which span the energy range from 1 to 10 eV.

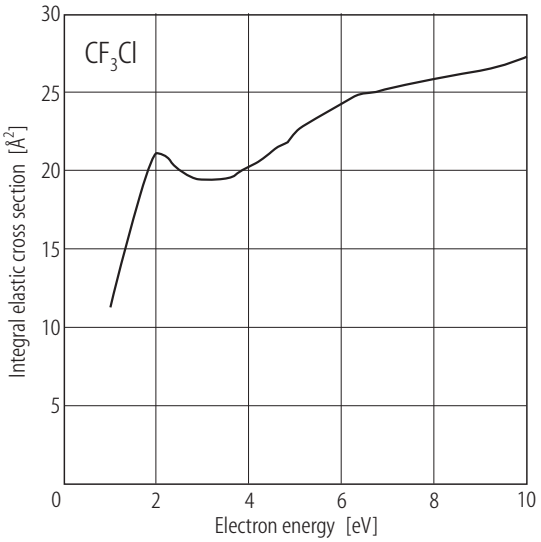

Fig. 6.2.6.19. Integral elastic scattering cross section for CF_3Cl at energies below 10 eV.

Table 6.2.6.19. Preferred values of the integral elastic cross section (σ_i) for electrons scattered from CF_3Cl. The estimated uncertainty is ± 40 %.

Energy [eV]	σ_i [Å^2]	Energy [eV]	σ_i [Å^2]	Energy [eV]	σ_i [Å^2]
1	11.3	3.2	19.4	6.0	24.3
1.2	13.5	3.4	19.4	6.5	25.0
1.4	15.9	3.6	19.6	7.0	25.2
1.6	18.1	3.8	19.7	7.5	25.5
1.8	19.7	4.0	20.3	8.0	25.8
2.0	21.2	4.2	20.6	8.5	26.1
2.2	21.0	4.4	21.0	9	26.4
2.4	20.4	4.6	21.5	9.5	26.8
2.6	19.8	4.8	21.8	10	27.3
2.8	19.5	5	22.4		
3	19.4	5.5	23.5		

References for 6.2.6.19

92Man1 Mann, A. and Linder, F.: J. Phys. B: At. Mol. Opt. Phys. **25** (1992) 1621

6.2.6.20 Difluorodichloromethane (CF_2Cl_2)

The preferred integral elastic scattering cross section for CF_2Cl_2 is given in Table 6.2.6.20 and is shown in Fig. 6.2.6.20. It is derived from the elastic differential cross section measurements of [92Man2] which span the energy range from 0.5 - 9.5 eV. These data have also been considered by [97Chr1] who have derived a cross section set for this molecule.

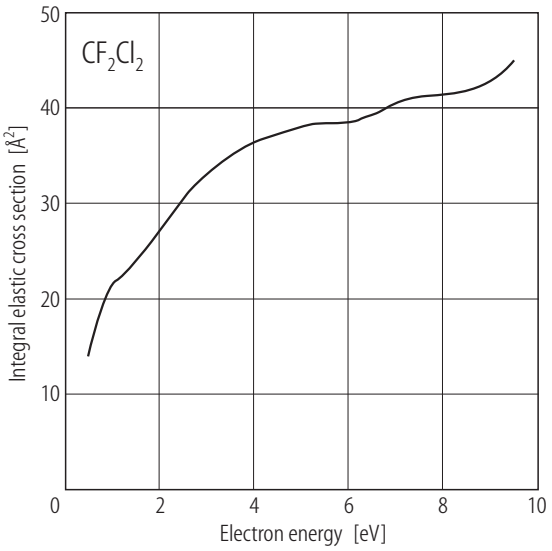

Fig. 6.2.6.20. Integral elastic scattering cross section for CF_2Cl_2 at energies below 10 eV.

Table 6.2.6.20. Preferred values of the integral elastic cross section (σ_i) for electrons scattered from CF_2Cl_2. The estimated uncertainty is ± 40 %.

Energy [eV]	σ_i [Å^2]	Energy [eV]	σ_i [Å^2]	Energy [eV]	σ_i [Å^2]
0.5	14.2	4.0	36.4	7.5	41.2
1.0	21.4	4.5	37.2	8.0	41.3
1.5	23.9	5.0	38.0	8.5	41.8
2.0	27.2	5.5	38.5	9.0	42.9
2.5	30.6	6.0	38.5	9.5	44.9
3.0	33.1	6.5	39.4		
3.5	34.9	7.0	40.6		

References for 6.2.6.20

92Man2 Mann, A., Linder, F.: J. Phys. B: At. Mol. Opt. Phys. **25** (1992) 1633
97Chr1 Christophorou, L.G., Olthoff, J.K., Wang, Y.: J. Phys. Chem. Ref. Data **26** (1997) 1205

6.2.6.21 Hexafluoroethane (C_2F_6)

The preferred integral elastic scattering cross section for hexafluoroethane is given in Table 6.2.6.21 and is shown in Fig. 6.2.6.21. This cross section is based on the differential scattering measurements of [94Tak1] and the extensive review of [98Chr1], who propose a suggested cross section based on additional, unpublished, differential scattering results of [97Mer1]. The tabulated values below are thus taken from the work of [98Chr1].

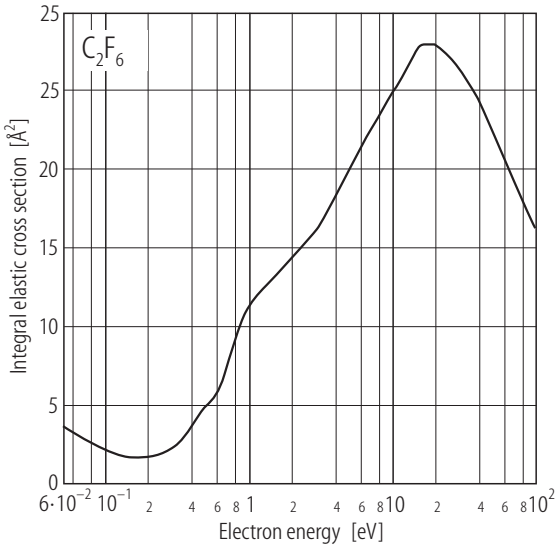

Fig. 6.2.6.21. Integral elastic scattering cross section for C_2F_6 at energies below 100 eV.

Table 6.2.6.21. Preferred values of the integral elastic cross section (σ_i) for electrons scattered from hexafluoroethane. The estimated uncertainty is ± 40 %.

Energy [eV]	σ_i [Å^2]	Energy [eV]	σ_i [Å^2]	Energy [eV]	σ_i [Å^2]
0.01	12.2	0.50	4.9	8.0	23.5
0.02	7.9	0.60	5.71	9.0	24.3
0.04	4.4	0.80	9.39	10	24.9
0.06	3.1	1.0	11.3	15	27.9
0.08	2.4	1.5	13.2	20	28.0
0.10	2.07	2.0	14.5	30	26.3
0.15	1.69	3.0	16.3	40	24.4
0.20	1.66	4.0	18.3	60	20.9
0.25	1.99	5.0	20.1	80	18.4
0.30	2.4	6.0	21.4	100	16.4
0.40	3.7	7.0	22.5		

References for 6.2.6.21

94Tak1 Takagi, T., Boesten, L., Tanaka, H., Dillon, M.A.: J. Phys. B: At. Mol. Opt. Phys. **27** (1994) 5389
97Mer1 Merz, R., Linder, F.: Private communication to L.G. Christophorou and J.K. Olthoff 1997
98Chr1 Christophorou, L.G., Olthoff, J.K.: J. Phys. Chem. Ref. Data **27** (1998) 1

6.2.6.22 Sulphur hexafluoride (SF_6)

The preferred integral elastic cross section for SF_6 is given in Table 6.2.6.22 and is shown in Fig. 6.2.6.22. It is based on the differential elastic scattering measurements of [76Sri1, 79Roh1, 89Sak1, 91Joh1, 00Cho1]. We also note the recent, extensive review of [00Chr1] in which a similar preferred cross section is provided.

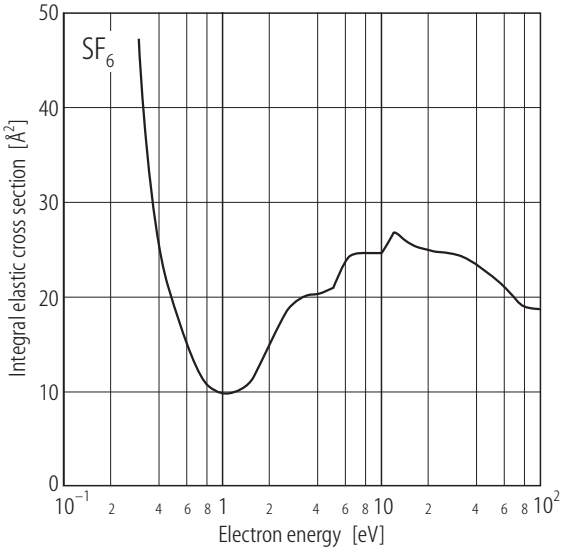

Fig. 6.2.6.22. Integral elastic scattering cross section for SF_6 at energies below 100 eV.

Table 6.2.6.22. Preferred values of the integral elastic cross section (σ_i) for electrons scattered from SF_6. The estimated uncertainty is ± 25 %.

Energy [eV]	σ_i [Å^2]	Energy [eV]	σ_i [Å^2]	Energy [eV]	σ_i [Å^2]
0.30	47.0	1.5	10.8	8.0	24.5
0.35	32.0	2.0	14.8	9.0	24.5
0.40	25.7	2.5	17.9	10	24.5
0.45	21.8	3.0	19.5	12	26.7
0.50	18.8	3.5	20.0	15	25.5
0.60	14.8	4.0	20.1	20	24.8
0.70	12.6	4.5	20.5	30	24.3
0.80	10.9	5.0	20.8	50	22.1
0.90	10.0	5.5	22.5	75	19.1
1.0	9.7	6.0	23.8	100	18.5
1.25	9.8	7.0	24.4		

References for 6.2.6.22

76Sri1 Srivastava, S.K., Trajmar, S., Chutjian, A., Williams, W.: J. Chem. Phys. **64** (1976) 2767
79Roh1 Rohr, K.: J. Phys. B: At. Mol. Phys. **12** (1979) L185
89Sak1 Sakae, T., Sumiyoshi, S., Murakami, E., Matsumoto, Y., Ishibashi, K., Katase, J.: 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., Trantham, K.W., Uhlmann, L.J., Dedman, C.J., Buckman, S.J.: J. Phys. B: At. Mol. Opt. Phys. **33** (2000) 3531
00Chr1 Christophorou, L.G., Olthoff, J.K.: J. Phys. Chem. Ref. Data **29** (2000) 267

6.2.6.23 Hexafluorobenzene (C_6F_6)

The preferred integral elastic scattering cross section for hexafluorobenzene is given in Table 6.2.6.23 and is shown in Fig. 6.2.6.23. This cross section is based on the differential scattering measurements of [01Cho1].

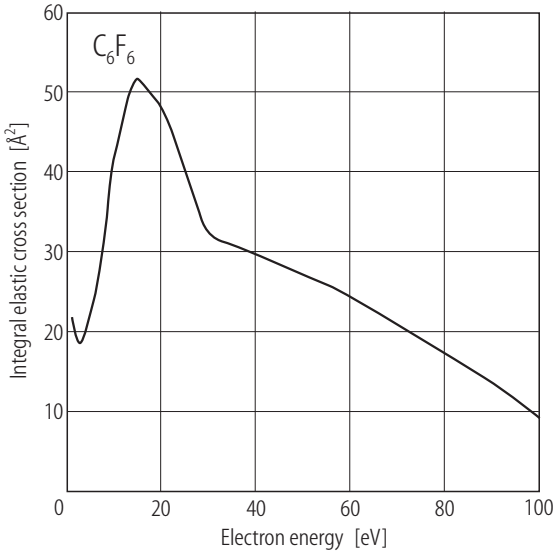

Fig. 6.2.6.23. Integral elastic scattering cross section for C_6F_6 at energies below 100 eV.

Table 6.2.6.23. Preferred values of the integral elastic cross section (σ_i) for electrons scattered from hexafluoro-benzene. The estimated uncertainty is ± 30 %.

Energy [eV]	σ_i [Å^2]	Energy [eV]	σ_i [Å^2]
1.5	21.8	15	51.6
3	18.6	20	48.0
5	21.5	30	32.7
8	31.0	60	24.3
10	41.1	100	9.0

References for 6.2.6.23

[01Cho1] Cho, H., Gulley, R.J., Sunohara, K., Kitajima, M., Uhlmann, L.J., Tanaka, H., Buckman, S.J.: J. Phys. B: At. Mol. Opt. Phys. **34** (2001) 1019

6.2.6.24 Perfluoropropane (C_3F_8)

The preferred integral elastic scattering cross section for perfluoropropane is given in Table 6.2.6.24 and is shown in Fig. 6.2.6.24. [98Chr1] constructed a set of preferred cross sections for this molecule based on the differential elastic scattering cross sections of [97Shi1]. These measurements have since been updated by [99Tan1] but tabulated results were not published. The tabulated values of [98Chr1], are reproduced below.

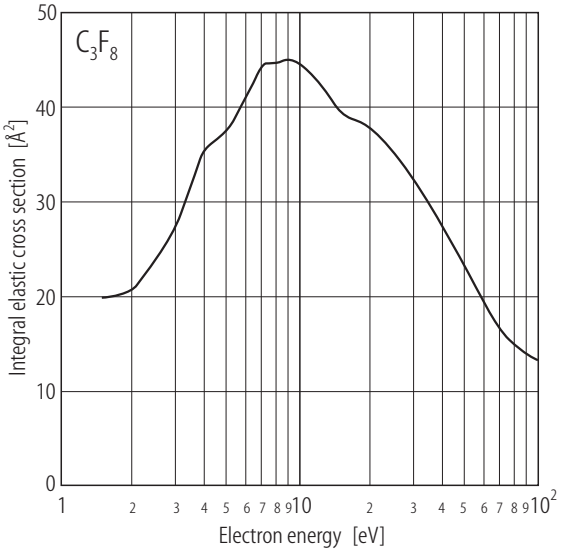

Fig. 6.2.6.24. Integral elastic scattering cross section for C_3F_8 at energies below 100 eV.

Table 6.2.6.24. Preferred values of the integral elastic cross section (σ_i) for electrons scattered from perfluoropropane. The estimated uncertainty is ± 30 %.

Energy [eV]	σ_i [Å^2]	Energy [eV]	σ_i [Å^2]
1.5	19.6	9.0	45.0
2.0	20.7	10	44.4
3.0	27.4	12	42.4
4.0	35.4	15	39.1
5.0	37.5	20	37.6
6.5	42.9	30	32.3
7.0	44.4	60	18.7
8.0	44.6	100	12.9

References for 6.2.6.24

97Shi1 Shinohara, T., Tachibana, Y., Yuri, M., Tanaka, H., Boesten, L.: Abstracts of XIX ICPEAC, Whistler (Mitchell, J.B.A., McConkey, J.W., Brion, C.E., eds.), 1995, p. 13

98Chr1 Christophorou, L.G., Olthoff, J.K.: J. Phys. Chem. Ref. Data **27** (1998) 889

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