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IONIZATION AND DISSOCIATIVE ATTACHMENT CROSS SECTIONS OF SO_2 MOLECULE BY ELECTRON COLLISION

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In this contribution results of ionization and dissociative attachment cross section measurements of low energy electrons with SO_2 molecule are presented. To the knowledge of authors no measurement of these data has been done so far. Some mass-spectrometric analysis and determination of abundance functions on electron energy of positive and negative ions from SO_2 by electron collision has been done (1)(2)(3).

Our measurements have been performed with a Tate-Smith type apparatus (4). The electron beam was formed by a trochoidal electron monochromator (5). In these measurements the electron beam energy half width was not reduced below 150 meV. The beam was aligned by a magnetic field parallel to the beam axis, 200-300 Oe in strength. Electrons were passed through the interaction chamber consisting of three pairs of electrodes, used for ion collection, forming a parallel plate condensor, and then collected in a Faraday cup. The chematic drawing of the electrode system is shown in Fig. 1.

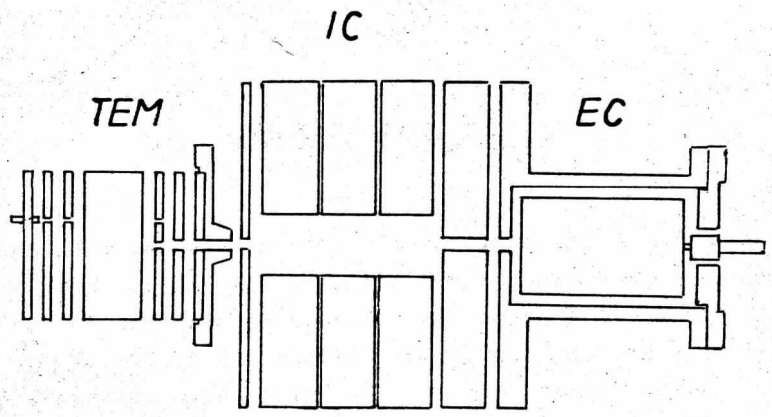

Fig. 1.

The vacuum container consisted of two differentialy pumped vessels. Oil diffusion pumps reduced the background pressure to

t.10^{-7} torr. The whole vacuum container was baked up to 330°C.

Results of total dissociative attachment cross section measurements are shown in Fig. 2. Negative ions have been detected in the electron energy region from 0.5 to 12.0 eV. The energy scale was defined using the positive ion appearance potential, corresponding to the ionization of SO_2, at a value of 12.34 eV (6). The ratio of cross sections in peaks of the attachment curve $|\sigma(4.7\ eV)/\sigma(7.3\ eV)|$ was determined to be 2.45, while the difference in their position in the energy scale is 2.6 eV. The difference in energy between the first peak and the positive ion appearance potential is found to be 7.6±0.2 eV.

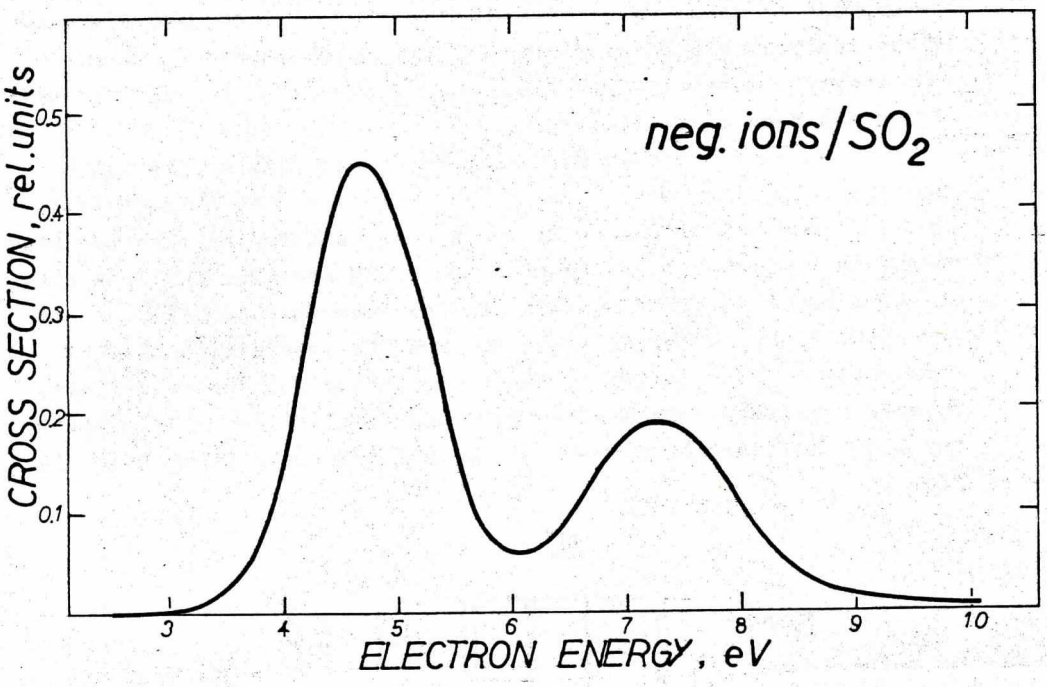

Fig. 2.

The ground state of the SO_2 molecule is $^1A_1$ with an internuclear distance between S and O atoms of 1.43 Å, and bent at angle of $\alpha = 119.5^\circ$ (6). All atoms and atomic groups of the SO_2 molecule have positive electron affinities: EA(O) = 1.5 eV; EA(S) = 2.1 eV; EA(SO) = 1.1 eV; EA(O_2) = 0.4 eV (7). Using known values for dissotiation energies: D(SO-O) = 4.95 eV; S(S-O) = 5.35 eV and D(O-O) = 5.1 eV, and listed electron affinities, one can get the minimum possible energies at which negative ions can appeare: O^- at 3.45 eV, S^- at 3.1 eV, SO at 3.85 eV and O_2^- at 4.8 eV. By mass-spectrome-

tric investigation (1) (2) O^- and SO^- were found, as well as negative ions of mass 32, formed by electron attachment in SO_2. The O^- and SO^- currents vs. electron energy show the same type of dependance as the total attachment cross section curve given in Fig.2. Currents of negative ions of mass 32 showed three maxima of very low intensities. The first of them is due to S^- ions, since the energy condition for formation of O_2^- ions is not satisfied at energies the pear is situated at. Wether the second and the third peak can be ascribed to S^- or O_2^- ions, or both, is still not known. To determine the partial attachment cross sections for the formation of O^-, S^-, SO^- and O_2^- ions further careful mass-spectrometric investigations of negative ions from SO_2 are needed.

The total ionization cross section curve obtained in our experiments is shown in Fig. 3. Measurements have been done from the ionization potential up to 230 eV. In measuring ionization

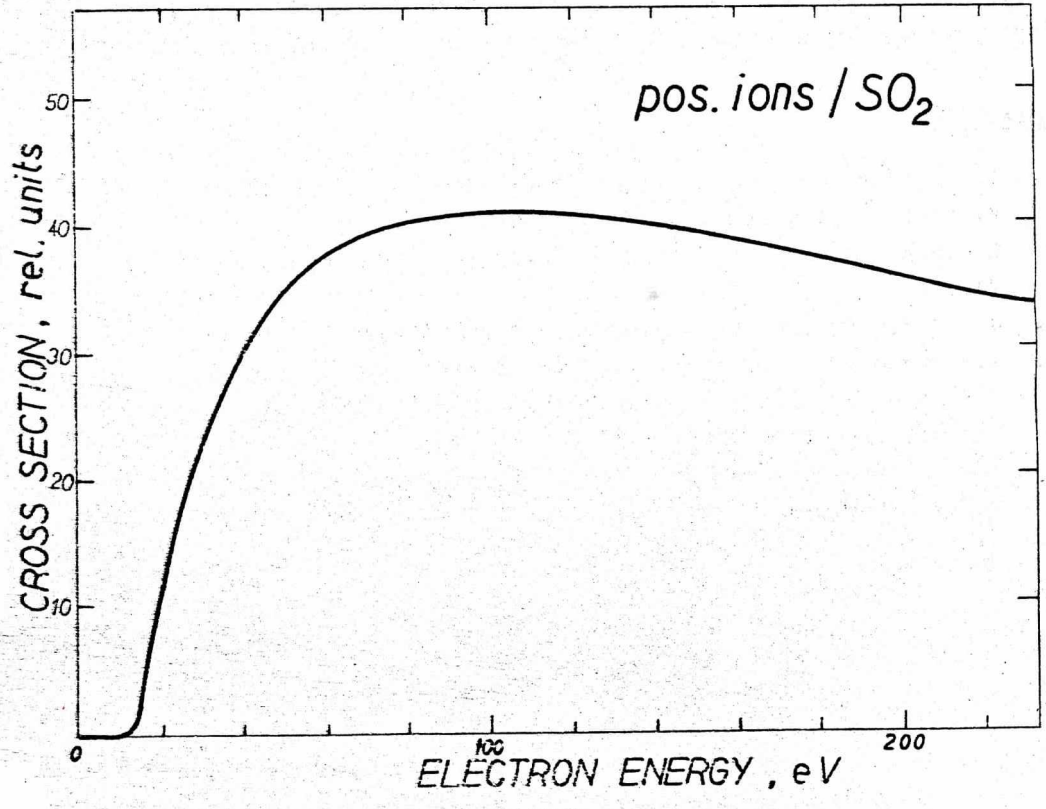

Fig. 3.

cross sections high electric field strengths had to be used between electrodes of the interaction chamber to acheave total ion collec-

tion. This is due presumably to high energy fragments from the ionization process. The cross section value at 100 eV energy is approximately 90 times higger than the attachment cross section value of the peak at lower energies.

For both attachment and ionization cross section measurements all necessary proofs for linearity between ion currents vs. electron curvent and gas pressure, ion and electron collector voltages ect. have been obtained. The room temperature was used in cross section calculations althougth some parts of the system were at higher temperatures. Previous checks with CO_2 showed that this procedure did not introduce a big error in results.

The second possible source of errors in cross section values are collisions of ions and excited molecules with metal surfaces, whose influence to the ion current measurements is unknown.

A separate experiment for ion gauge calibration is in progress, and results of it will be known in due coarse, so that final values for absolute cross sections could be determined.

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