dance with the predictions given by Smirnov, it was found that two- electron loss cross section values ($\sigma_{\bar{1}1}$) are very close to those for one-electron loss process of neutrals ($\sigma_{01}$). Three-electron loss cross sections decrease with increasing the second ionization potential of the primary particle and gas target mass number, $Z$, similarly as for two-electron loss process.

In the investigated energy range, two- and three-electron loss cross sections increase sharply and monotonically with energy, while those for one-electron loss process, are, in general, independent on energy, or in some cases increase very slowly with energy.

## 1.3 Electron detachment in $H^-$—H and $O^-$—O collisions

R. K. JANEV and A. R. TANČIĆ, *Institute of Nuclear Sciences "Boris Kidrič", Beograd, Yugoslavia*

*Abstract*

A semiclassical two-state approximation of the collisional electron detachment is given in impact parameter treatment. Averaging the auto-ionization width in the continuum, for the reaction probability the following expression is obtained

$$\omega(\varrho, v) = 1 - \exp\left[\frac{-2\Gamma}{v}(R_0^2 - \varrho^2)^{1/2}\right], \tag{1}$$

where $R_0$ is the stabilization internuclear distance, $\Gamma$ is the averaged width in the interval (0, $R_0$) $\varrho$ is the impact parameter and $v$ is the relative velocity of the colliding particles. The reaction cross section is obtained in the form:

$$Q(v) = \pi R_0^2 \left\{1 - \frac{2}{a^2}[1 - (1+a)e^{-a}]\right\}, \tag{2}$$

where $a = \dfrac{2\Gamma R_0}{v}$.

The formulae (1) and (2) refer both to symmetrical and antisymmetrical potential modes.

The total collisional detachment cross sections for $H^-$—H and $O^-$—O reactions are calculated and good agreement is obtained with the experimental data.

## 1.4 Electron-impact K-ionization cross-section for C and Al in the keV region

W. HINK, H. PASCHKE and A. ZIEGLER, *Physikalisches Institut der Universität Würzburg, Würzburg, W. Germany*

While in recent years the study of cross-sections of atoms in outer shells by electron impact has been subject of growing interest in experimental and theoretical work, experimental data on inner shell ionization cross-sections are still rare as well as accurate evaluation of these data. Lotz[1] developed an empirical formula which covers also inner shell ionization. But experimental results of inner shell ionization cross-sections of low $Z$ atoms - these are needed rather than data for high $Z$ atoms in the fields of astrophysics, plasma physics nad quantitative microanalasis with electron probes - are given only by Glupe and Mehlhorn[2], and Hink and Ziegler[3].

There are two methods for measuring the cross-section, e. g. for K-shell ionization. The first makes use of the emission of an Auger-electron following the process of ionization alternatively to the emission of a K-quantum. Glupe and Mehlhorn[2] used this method to determine the absolute K-ionization cross-sections of gaseous C, N, O, and Ne-targets. The authors used the second (conventional) method which is based on the indication of a hole in the K-shell by the alternatively emitted K-quantum to determine the absolute ionization cross-sections of solid thin film C and Al targets for electron impact energies in the region of a few keV to about 30 keV.

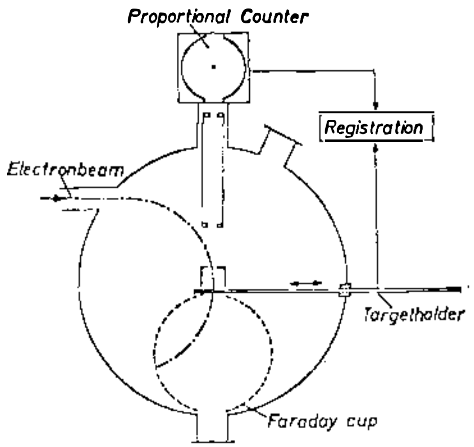


Fig. 1

The experimental arrangement is shown in Fig. 1[3]. A beam of monoenergetic electrons is focussed with diameter less than 1.5 mm on the unsupported or Pioloform-backed thin film target ($1.2\,\mu g/cm^2 < \varrho d < 30\,\mu g/cm^2$). The beam enters the target normally thereby minimizing the back scattering of electrons and the emission of bremsstrahlung in backward direction which is used for observation.

The ionization cross-section $Q_K$ of the K-shell was evaluated from the number $N_{reg}$ of registrated K-quanta according to formula:

$$Q_K = \frac{1}{\omega_K} \cdot \frac{4\pi}{\Omega} \cdot \frac{A}{N_A \cdot \varrho \cdot d} \cdot \frac{1}{q/e} \cdot \frac{N_{reg}}{\varepsilon}$$

| | |
|---|---|
| $\varrho \cdot N_A/A$ | number of target atoms per unit volume, |
| $\omega_K$ | fluorescence yield of the K-shell, |
| $\Omega$ | solid angle of observation, |
| $q/e$ | number of electrons impinging on the target, |
| $\varepsilon$ | counting efficiency of the proportional counter, |
| $\varrho d$ | mass-thickness of the target. |

The measurements had to be corrected in some cases for 1. scattering of electrons within the target, and 2. backscattering of electrons from the Pioloform--backening.

Inspection of recent literature together with the evaluation of the experimental results of the authors in the low $Z$ region shows that the semi-empirical formula for $\omega_K$ given by Byrne and Howarth[4] for medium $Z$ elements, may be extended to low $Z$ elements. Using these values for $\omega_K$ all available experimental results in the low $Z$ region are in reasonable agreement with the semi-empirical Gryzinski-formula[5] for $Q_K$ inclusive the Glupe-Mehlhorn data. The latter are evaluated with the wellknown Auger yield and not the fluorescence yield. In addition the comparison of theoretical and experimental data on $Q_K$ for Carbon by proton impact gives a strong support for the value of $\omega_K$ given by the above mentioned formula.

The experimental ionization cross-section for the K-shell of C ($\omega_K = 0.0035$) and Al ($\omega_K = 0.046$) is given in Fig. 2 and 3 together with theoretical curves[5, 6, 7]. The relativistic computations of Arthurs and Moiseiwitsch[8] and of Perlman[9] fall in this low $Z$-region practically together with the non-relativistic quantum mechanical calculation of Burhop[7]. The use of Coulomb wave functions for the impact electron (Rudge and Schwartz[6] give better agreement with experiment than the Burhop calculation.

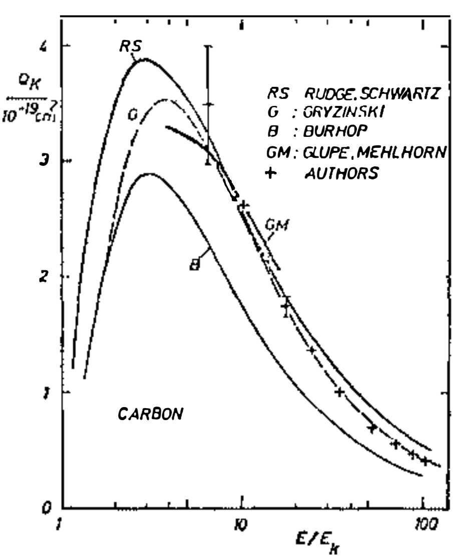


Fig. 2

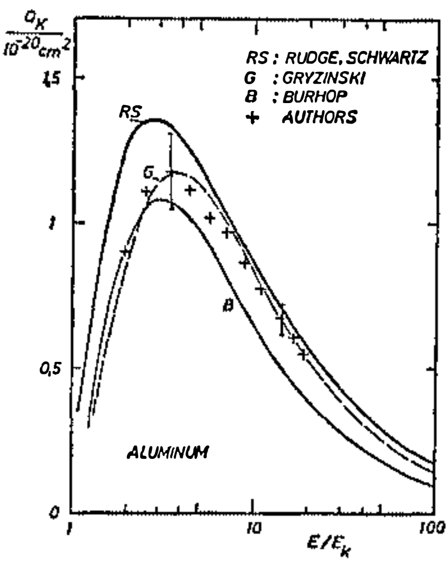


Fig. 3

## References

1) W. Lotz, J. Opt. Soc. Amer. **60** (1970) 206;
2) G. Glupe and W. Mehlhorn, Phys. Letters **25** A (1967) 274;
3) W. Hink und A. Ziegler, Z. Phys. **226** (1969) 222;
4) J. Byrne and N. Howarth, J. Phys. B **3** (1970) 280;
5) M. Gryzinski, Phys. Rev. **138** A (1965) 336;
6) M. .R H. Rudge and S. B. Schwartz, Proc. Phys. Soc. **88** (1966) 563;
7) E. H. S. Burhop, Proc. Cambridge Phil. Soc. **36** (1940) 43;
8) A. M. Arthurs, and B. L. Moiseiwitsch, Proc. Roy. Soc. (London) A **247** (1958) 550;
9) H. S. Perlman, Proc. Phys. Soc. **76** (1960) 623.