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## Ion Dissociation of Si Atom by Electron Impact

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### Abstract

*The ionization Dissociation of Si atom has been studied by electron impact with reference to semi empirical formula in the energy range from threshold to around 2200eV. Absolute cross -sections for electron impact ionization of Iron ions leading to the formation of  $Si^+$ ,  $Si^{+2}$  and  $Si^{+3}$  are measured, having the corresponding threshold energies are 8.15eV, 19.77eV, 34.79eV respectively.*

**Key Words:** Ionization cross section, cross section, ionization energy.

### Introduction:-

Fragmentation pattern of Chromium have been studied by electron impact with reference to Jain-khare in the energy range from threshold to around 2000eV. Absolute cross -sections for electron impact single ionization of Chromium ions leading to the formation of  $Si^+$ ,  $Si^{+2}$  and  $Si^{+3}$  are measured.

The role of collision phenomenon is important in theoretical and experimental investigations on the structure of matter on a microscopic scale. Hence, a knowledge of reliable atomic in the molecular Collision cross sections are in demand for Astrophysics, gas laser, plasma Chemistry, controlled thermonuclear fusion, transport phenomenon, chemical reaction, biophysics gases electronics , airglow etc.

In a scattering experiment a target is bombarded to a well defined collimated homogenous beam of monoenergetic particles from a large distance. After collision the particles of incident beam are scattered in all directions and their distribution is detected over large distances. The number of particles scattered into the detector per unit solid angle per unit incident flux is called the differential cross section for that particular direction. An integration of differential cross sections over all solid angles yields the total cross sections. Thus we note that the total cross section is the cross sectional area which the target presents to the direction of the beam and differential cross section is the effective area which the target presents to the beam for the deflection of the incident particle into a particular solid angle.

All these collision processes are analyzed theoretically by quantum collision theory. The probability that a given type of collision will occur under given conditions is usually expressed in terms of collision cross sections.

### Theoretical Methodology:-

Even on the theoretical side several more methods are available to compute the cross sections over a wide range of atoms and molecules. For example, there is no explanation for Irect dissociate, total, single and double ionization cross section. This formula is also applicable to calculate partial, photo, integral ionization

cross sections of atoms and molecules. The formula is useful for finding the rate coefficient of any atoms and molecules.

$$Q_i(E, W, \theta) = \frac{a_0^2 R^2}{E} \left[ \int_{k \rightarrow 0}^{E - I_i} \left\{ \frac{E - W}{E - I_i} \frac{1}{W} df_i(W, K, \theta) \times \ln [1 + C_i(E - I_i)] + \frac{E - I_i}{E(v_0^3 + v^3)} \times S_i \left( v - \frac{v^2}{E - v} + \frac{v^2}{(E - v)^2} \right) \right\} 2f \sin \theta d\theta \dots (I) \right]$$

Where  $a_0, R, K, S,$  And  $\theta$  represents the first Bohar radius, Rydbergs constant, momentum transfer, number of ionizable electrons and the scattering angle respectively, Summation of PDDCS over  $(I)$  gives the total PDDCS (DDCS)

$$Q_i'(E, W, \theta) = \sum_i Q_i(E, W, \theta).$$

Here it is interesting to note that  $Q_i(E, W, \theta)$  is isotropic and hence the material property of molecule, i.e., the oscillator strength must be isotropic in nature. Here  $df_i(W, K, \theta)$ , the differential generalized oscillator strength (DGOS) in the optical limit ( $K \rightarrow 0$ ) has been used. From Lassetre's Theorem [3], the DGOS in the Bethe regime is reduced to the cosine distribution form of the linear optical oscillator strengths  $df_i(W, 0)/dW$ , i.e.

$$df_i(W, K, \theta) \rightarrow (1/4f)[1 + S P_2(\cos \theta)] \times df_i(W, 0)/dW,$$

Where  $S$  is the asymmetric parameter and  $P_2(\cos \theta) = \frac{1}{2}(3\cos^2 \theta - 1)$  is the second order Legendry polynomial. In the present treatment,  $S$  is chosen as the probability of ionizing electrons in the ionization processes, however, it depends on the ejected electron energy. The oscillator strengths are directly proportional to the photo ionization cross sections [4]. Further integration of Eq. (I) with respect to the scattering angle  $\theta$  (from  $0$  to  $2\pi$ ) gives the PSDCS

$$Q_i(E, W) = \int Q_i(E, W, \theta) d\Omega,$$

Where differential solid angle  $d\Omega$  is  $2f \sin \theta d\theta$ .

Similarly, SDCS are given as

$$Q_i^T(E, W) = \sum_i Q_i(E, W).$$

Further integration of PSDCS with respect to  $W$  from  $I$  to  $W_{\max}(=E)$ , results in PICS, i.e.

$$Q_i(E) = \int Q_i(E, W) dW.$$

The present formulation requires the major input data of the photo ionization cross-sections in terms of the optical oscillator strengths. From vertical ionization thresholds to 70eV, these values for dissociative processes are taken from the compilation of Gallagher et al. (10-15% uncertainty) [4] and for direct ionization processes from Masuoka [5].

Even on the theoretical side several more methods are available to compute the cross sections over a wide range of atoms, molecules, radicals and even cluster but all of them are partially successful. Among the various as available formulism, only modified Jain Khare. In this research work, we calculate the ionization cross section of various atmospheric molecules and we are using modified Jain- Khare semi- empirical formula. This formula (Jain- Khare semi empirical) is applicable to calculate the direct dissociate, total, single and double ionization cross section. This formula is also applicable to calculate partial, photo, integral ionization cross sections of atoms and molecules. The formula is useful for finding the rate coefficient of any atoms and molecules. It is also applicable to calculate partial, photo, integral ionization cross sections of atoms and molecules.

In the calculation of single differential cross-section for the production of  $i^{\text{th}}$ -type of ion we have replaced it by  $(v + I_i)$ . The energy loss suffered by primary electron is from the calculation of partial double

differential cross section as a function, second any electron energy cross it and the scattered angle on the differentials of eqn. with respect to solid angle  $d\Omega = \sin\theta d\theta d\phi$

Double differential cross sections are angular dependent in all the scattering geometric and hence the angular oscillator strength  $df_i$  (in this context, we have employed the triple different generalized oscillator strengths in the Bethe region rather than the linear optical oscillator strengths. Lassette theorem. In the optical limit, where  $K \rightarrow 0$ , TDGOS reduces to the angular linear oscillator strengths.

$$df(\vec{S}, k, \theta) \rightarrow \frac{1}{4f} \cdot \frac{df_i(\vec{S}, 0)}{dW} [1 + BP_2 \cos \theta]$$

$$\lim K \rightarrow 0$$

The triple differential cross section is derived by the differential of double cross sections with respect to the energy of the second ejected electron. In (e, 3e) process, however, the outgoing electrons are indistinguishable; the two ejected electrons are designated by their energies  $v$  &  $\kappa$  respectively. The total energy loss is defined by  $W = I_i + v + \kappa$  at fixed incident electron energy and second electron energy treating constant values of  $(I_i + v)$  one gets

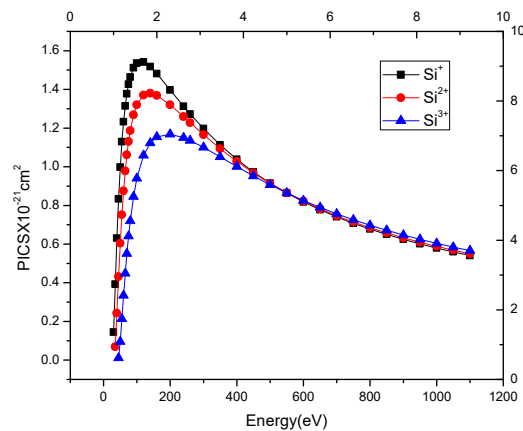
$$dW = d\kappa$$

### Results and discussion:-

In this paper the results of the absolute partial ionization cross section measurements for the Si are calculated from threshold to 2200 eV by the use of modified Jain-Khare approach. Table 1 shows the measured partial cross sections for the formation of the  $Si^+$  parent ion and all singly charged fragment ions  $Si^{2+}$  and  $Si^{3+}$ . These partial ionization cross sections are also summarized in Table 1.

Energy(eV)	$Si^+$	$Si^{2+}$	$Si^{3+}$	Energy(eV)	$Si^+$	$Si^{2+}$	$Si^{3+}$
13				200	1.397617	1.320447	1.167876
15				240	1.313121	1.259606	1.150181
20				260	1.272849	1.22825	1.135535
25				300	1.19739	1.166533	1.100227
30	0.144917			350	1.112819	1.09381	1.050905
35	0.392464	0.068777		400	1.038407	1.027413	1.000717
40	0.630839	0.243321		450	0.972959	0.967508	0.952266
45	0.833664	0.431701	0.010804	500	0.915217	0.913673	0.906683
50	0.998415	0.603671	0.095842	550	0.86404	0.865322	0.864344
55	1.129971	0.751737	0.213452	600	0.818458	0.821783	0.825248
60	1.233449	0.875581	0.334701	650	0.777619	0.782459	0.789245
65	1.314877	0.978221	0.448531	700	0.74086	0.746809	0.756098
70	1.377788	1.062114	0.550834	750	0.707589	0.714374	0.725561
75	1.426856	1.131034	0.641158	800	0.677367	0.684755	0.697371
80	1.463727	1.186619	0.719582	850	0.649768	0.657606	0.671299
90	1.51214	1.268321	0.846179	900	0.624479	0.632643	0.647158
100	1.5362	1.320681	0.939904	950	0.601205	0.609595	0.624724
120	1.541835	1.370881	1.05951	1000	0.579737	0.588282	0.60385
140	1.518264	1.380276	1.122858	1050	0.559836	0.568489	0.584368
160	1.481985	1.369168	1.154265	1100	0.541366	0.550065	0.566168

The results from fragmentations of Si are shown in TABLE 1.



The present result are in satisfactory agreement with data .Further, there is no way to compare the present results above  $W > (E+I)/2$ , the maximum energy employed in the experiments. However, the present results are symmetric with respect to  $W/2$ . It is remarkable that differential cross- sections can be divided qualitatively in two parts, one the dipole allowed part, known as the glancing collision and second the non dipole part known as the knock-on collision, corresponding to the Bethe and the Moller parts of the present semi-empirical formula.

Large values of the differential cross-section for slow secondary electron appear from the growing contribution of the dipole allowed interaction while above  $W \geq (E+I)/2$  the cross-section is highly affected by the exchange effects, which are taken into account through the Moller part of the formula.

The accuracy of the present formula is linked with the accuracy of oscillator strength. Theoretically, the accuracy of the present calculation can be increased if we have the more accurate experimental data for the photo-ionization cross-section for the production of various ions.

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