§10. Compilation of Collision Data Relevant to Radiative Gas Cooling Divertor Designs

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Powerful fusion devices need effective gas cooling divertors in order to accommodate very high power densities on/near divertors. For example, in ITER designs, the particle power of the order of > 30 MW/m^2 has to be handled on its divertors. Thus, so-called mechanical divertors could be completely intolerable to such high power densities.To overcome such huge heat power dissipation, one of the most promising techniques is "radiative gas cooling" divertor scheme where the kinetic energy of particles is forced to be dissipated through radiations from particles themselves before they hit the divertor surfaces.

In such high particle density regions as in gas divertors, most of the particles present near divertors are likely in their excited states through a series of collisions with electrons, heavy particles such as protons, hydrogens or other heavier particles injected to dissipate particle heat power into radiation.

In the present work we are going to compile collision data involving hydrogen molecules, which are in the excited states, under collisions with electrons, hydrogens and protons. Data in plasma applications such as modeling should include those involving these high excited particles in electron impact[1)], heavy particle impact (hydrogen[2)], proton and helium) and collisions with solids. Otherwise, the final results could be significantly different from those in real situations. Up to now only a limited investigations have been reported. Particularly, systematic investigations are very few.

Generally speaking, the cross sections for particles in the excited states, even in energetically small, vibrationally excited states, are very much different from those in the ground state. Its consequences are tremendous in analysis and modeling of plasmas..

One of the examples of the observed significant effects in the excited states is shown in Table 1 where (relative) dissociative ionization cross sections are compared for two different neutral gaseous and neutralized CD_4 targets under 100 eV electron impact. Unfortunately at present are not known their absolute cross sections which are also expected to be significantly different from each other.

Table 1 Comparison of relative dissociative ionization cross sections at 100 eV electron impact for differently prepared CD_4 molecules

	CD_4^+	CD_3^+	CD_2^+
gaseous CD_4	100	85	15
neutralized CD_4	100	400	200

This significant difference in dissociative processes, understood to be due to CD_4 in the vibrationally (~ 2eV) excited states from the observed appearance potential, clearly indicates the importance of the internal energy of particles prior to collisions in determining the collision cross sections.

It should also be noted that such significant difference between target preparations (or the internal energy states) clearly depend on the molecular structures themselves.

One of the most important but still not widely recognized problems is the fact that the internal energy states of particles near divertors are quite different from those in laboratory experiments. Therefore, it is important to realize that the laboratory data have to be used carefully when they are applied to plasma modeling.

References

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