Dissociative electron attachment to CO molecule probed by velocity slice imaging technique

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Synopsis We have studied dissociative electron attachment to CO molecule using the well-established velocity slice imaging spectrometer. We have conclusively determined the symmetries of the TNI states involved in both the channels producing O^- ions. Also in contrast to a recent report we observed that there is no need to invoke coherent interference between different states. Recent calculations and experimental study by other groups also strongly support our claims.

Low-energy electron-molecule collision leading to dissociative electron attachment (DEA) is an important process from the fundamental as well as the application point of view. DEA is a two-step resonant process resulting into a final anionic and neutral fragments from a parent neutral molecule via intermediate temporary negative ion (TNI) state. DEA study of molecules are important starting from electrical discharges, atmospheric chemistry, installer medium chemistry to radiation induced damage of living cell and biologically important molecules.

Carbon monoxide (CO) is a simple but important heteronuclear diatomic molecule. But only few studies on DEA to CO exist in literature using modern techniques like velocity map imaging or momentum imaging. DEA to CO have two possible channels for O^- production with energy threshold 9.62 and 10.88 eV and are shown by equation 1 and 2 respectively.

$$e^- + \mathrm{CO}(^1\Sigma^+) \rightarrow \mathrm{CO}^{-*} \rightarrow \mathrm{O}^-(^2P) + \mathrm{C}(^3P) \quad (1)$$

$$e^- + \mathrm{CO}(^1\Sigma^+) \rightarrow \mathrm{CO}^{-*} \rightarrow \mathrm{O}^-(^2P) + \mathrm{C}^*(^1D) \quad (2)$$

From the angular distribution measurements over a limited angular range Hall *et al.* [1] concluded a TNI state with Π symmetry is responsible for both the processes. In contrast, Tian *et al.* [2] reported that for 10 eV incident electron energy Σ and Π two states are involved but, for 10.6 eV three TNI states, Π, Δ and Φ, with coherent interference between them are present. To address these issues we have studied DEA to CO [3] using a recently developed velocity slice imaging (VSI) spectrometer similar to that was reported by Nandi *et al.* [4] with few modifications. VSI technique is a well-established method for simultaneous measurement of the kinetic energy and angular distribution of the fragment anions produced due to DEA over the entire 2π angle.

From the systematic kinetic energy distribution measurements we have identified both the processes. To determine the symmetry of the TNI states we have measured angular distributions of the O^- ions produced due to both the processes separately. We observed a Σ state is primarily responsible for both the processes. In addition a minor contrbution from a Π state also exists for process 1 and the contribution increases with increasing incident electron energy. In a recent R-matrix calculation Dora *et al.* [5] also observed only a Σ resonant state. From the angular distribution measurements we also have observed that there is no need to invoke the coherent interference between different states as suggested by Tian *et al.* In a recent experimental study Gope *et al.* [6] also observed similar results and strongly supported our conclusions.

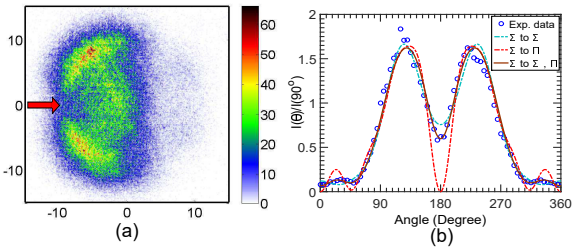

Figure 1. (a) The VSI of O^- ions for 11 eV beam energy and (b) angular distribution of the ions created due to process I for 11 eV beam energy along with fitted curves.

References

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