

# Ion induced fragmentation of small atomic and molecular clusters

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**Synopsis** Properties of Ar<sub>2</sub> and Ne<sub>2</sub> van der Waals rare gas dimers have been investigated under collision with slow highly charged ions. Within such dimers, the large internuclear distance (about 4Å) between the two closed shell atoms results in a very specific behavior compared to what is known from diatomic covalent molecules. Furthermore, molecular dimers such as (N<sub>2</sub>)<sub>2</sub> or (CO)<sub>2</sub> have also been used to probe the influence of a chemical environment on molecular fragmentation.

We use a COLTRIMS (COLd Target Recoil Ion Momentum Spectroscopy) setup to provide a comprehensive picture of both the collision and relaxation processes at play when low bounded van der Waals rare gas or molecular dimers are irradiated by highly charged ions in the keV energy range.

In such collisions, the highly charged projectile ion can capture several electrons from the dimer target. The resulting multi-ionized target then relaxes either by direct fragmentation or via some intermediate energy or charge transfer mechanisms. For instance, Radiative Charge Transfer (RCT) has been identified to have a significant contribution to the relaxation of doubly charged Ar<sub>2</sub><sup>2+</sup> and Ne<sub>2</sub><sup>2+</sup>. Its relative intensity with respect to direct Coulomb Explosion (CE) depends on the projectile charge state as RCT requires the two electrons to be captured on only one of the two atoms of the dimer [1]. The production rate is quantitatively well reproduced by an extended version of the Classical Over the Barrier Model [2]. Moreover, Internuclear Coulombic Decay (ICD) is triggered by a single inner shell electron capture and has been evidenced for the low charge state projectile O<sup>3+</sup> [3].

In the case of molecular dimers (N<sub>2</sub>)<sub>2</sub> or (CO)<sub>2</sub>, intermolecular as well as intramolecular

fragmentation may take place as the multiply charged monomer cations of such molecules have mainly dissociative states. Some specific fragmentation channels of the dimers have been carefully compared to the corresponding one of the monomers to shed light on how the presence of a neighbor ion may influence the fragmentation of the second molecule. For (N<sub>2</sub>)<sub>2</sub>, only concerted dissociation consisting in the quasi-simultaneous cleavage of both the van der Waals and covalent bonds is observed. The corresponding Kinetic Energy Release (KER) spectra of the dimer is thus very similar to the one of the monomer but shifted towards higher energies due to the coulomb repulsion from the second molecular ion [4]. Contrarily, for (CO)<sub>2</sub> both concerted and sequential dissociation are observed. The later process is a signature of the existence of metastable states of the CO<sup>2+</sup> dication with life times much longer than 1ps and seem to be associated to low KER values.

## References

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