

Photolysis of Formic Acid at 355nm

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Synopsis: Several dissociation channels induced by multiphoton absorption of formic acid from a laser of radiation of 355nm was investigated using a supersonic molecular beam and a time of flight mass spectrometer. From the detected products it is possible, on the light of available results, to conclude that they arise from *trans* – formic acid, and the dissociation of clusters among other features. The effect of the carrier gases: He and Ar was also investigated.

Photodissociation is an important method to investigate fundamental characteristics of different chemical aspects. In particular, small molecules as the formic acid offers an opportunity to show some properties of such systems.

The present work deals with the interaction of formic acid with 355nm laser radiation. The beam was produced with formic acid 96% pure, mixed with Argon and Helium in order to investigate the influence of carrier gases introduced into the ionization chamber through a supersonic expansion process, by a pulsed valve. More than 30 different cations were detected on the range of 10^9 - 10^{10} W/cm² intensity, using He and Ar as carrier gases. The sample gas and the laser light interact at 90°. The pressure inside the chamber was $\sim 1 \times 10^{-7}$ Torr. The formed ions were accelerated at 1.5 keV to the free field region of the R-TOF spectrometer.

Most of the detected ions have been observed in experiments of formic acid destruction by soft X rays [1] or ultraviolet region [2]. However, in the present case the parent ion was not observed as it happens with O^+ for some laser intensities. The presence of CH_3^+ not been reported before, is attributed to a processes of proton transfer, whereas H_2^+ presumable product of a roaming processes was not observed. A special topic discusses, with regard to formic acid, the conformation-specific dynamics which leads to values of the ratio CO/CO_2 of the order of 9 and less than 0.5 depending if the photolysis is from a *trans*- or *cis*- Our results show a value for this ratio scale, depending on the carrier gas, between 9 to 0.5, indicating that we are dealing with *trans*-formic acid molecule. In general, some of the products can be interpreted on basis of excited potential energy surfaces [1,2]. In Table [1] the relative intensities as a function of some intensities and He as carrier gas.

Figure 1 shows the effects of the carrier gas on the total ion current.

Table 1. Ion yield for different intensities (W/cm²) with He as carrier gas.

Ion	Intensity		
	1.06×10^9	4.68×10^9	6.81×10^9
^{a, b, c} H^+	0.047	2.284	4.736
^{a, c} C^+	0.641	7.709	10.308
^c CH_3^+	0.040	1.181	2.477
^{a, b, c} O^+		0.017	0.094
^{a, b, c} H_2O^+	0.094	3.251	5.467
^{a, b, c} CO^+	0.032	0.309	0.546
^{a, c} CO_2^+	0.005	0.037	0.045

^aIons reported in [1], ^bIons reported in [2] ^cIons reported in the present work.

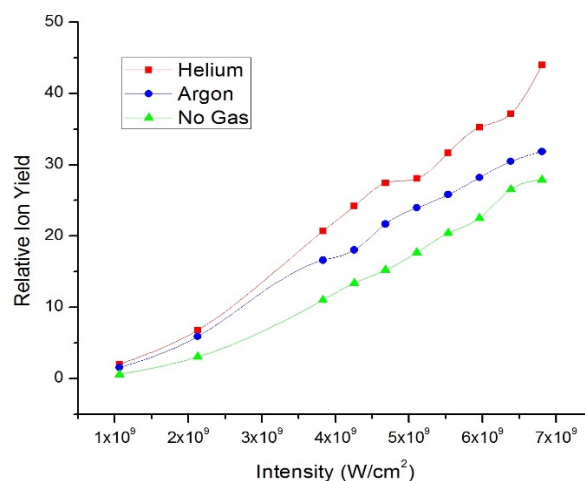


Figure 1. Relative intensity as a function of carrier gas.

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References

- [1] H.M. Boechat-Roberty et al 2005 A&A. **438** 915
- [2] M.S. Arruda et al 2012 J. Phys. Chem. A **116** 6693

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