

## Production of cluster ions and long lived neutral cluster molecules in laboratory plasma.

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An experiment was conducted at ISAS, wherein hydrated and cluster ions were produced inside a plasma chamber under controlled pressures of NO and water vapor. As reported in an earlier communication, it was found that at given pressure, different ions take different time to come to their peak abundance and these times are also pressure dependent. For NO and water vapor pressure of  $5 \times 10^{-2}$  Torr each, ions with mass numbers 66( $\text{NO}^+(\text{H}_2\text{O})_2$ ), 73( $\text{H}_3\text{O}^+(\text{H}_2\text{O})_3$ ) and 84( $\text{NO}^+(\text{H}_2\text{O})_3$ ) achieve their peak abundance in about a minute, mass numbers 48( $\text{NO}^+\text{H}_2\text{O}$ ), 55( $\text{H}_3\text{O}^+(\text{H}_2\text{O})_2$ ), 83( $\text{H}_3\text{O}^+(\text{H}_2\text{O})_2\text{N}_2$ ), 109( $\text{H}_3\text{O}^+(\text{H}_2\text{O})_5$ ) and 131( $\text{H}_3\text{O}^+\text{NO}(\text{H}_2\text{O})_3\text{N}_2$ ) in 5 to 10 minutes, mass numbers 91( $\text{H}_3\text{O}^+(\text{H}_2\text{O})_4$ ) and 102( $\text{NO}^+(\text{H}_2\text{O})_4$ ) in 10 to 20 minutes and mass numbers 43( $\text{N}_3\text{H}^+$ ), 88( $\text{NO}^+\text{NO.N}_2$ ) and 117( $\text{H}_3\text{O}^+\text{NO}(\text{H}_2\text{O})_2\text{O}_2$ ) take more than 20 minutes.

An experiment was done at NO and water vapor pressure of  $5 \times 10^{-2}$  Torr each, wherein the generation of ions was continued for nearly 60 minutes and after that the EUV source was turned off for some time to see how fast do these ions recombine and are reproduced by turning off and on the EUV source. As soon as the EUV source was turned off, all the ions recombined and the ion mass spectrometer did not measure any ions inside the chamber. After an interval of 1 min the source was turned on again and it was found that almost all the ions were present in their peak abundance instantaneously. This same experiment was continued where the EUV source was turned off for 2, 3, 5, 10, 20, 30, 45, 60 and 90 min and each time the EUV source was turned on, almost all the ions appeared in the very first scan with their peak abundance. As the ions take few minutes to a few tens of minutes to come to their peak abundance, when there are no ions to start with, this result shows that the hydrated, cluster and molecular ions, produced in the chamber for about 60 min, recombine as soon as the EUV source is turned off and these get converted to cluster neutral molecules. As soon as the source is turned on all or most of these cluster neutral molecules get ionized instantly, producing very rich spectrum of hydrated, cluster and molecular ions. These observations also indicate that neutral cluster molecules of varying masses can exist for times as large as 90 sec and may be even more.