Experimental study of N₂ desorption modified by the presence of CO on water ices surface


INTRODUCTION

CO and N₂ are two of the most abundant species in molecular clouds. + CO molecules are heavily depleted from the gas phase toward the centre of prestellar cores, whereas N₂ molecules still maintain a high gas phase abundance. + The reason of this difference is not understood because CO and N₂ have identical masses, similar sticking, and relatively closed the binding energies. + The aim is to measure, analyse and interpret desorption energy differences of CO and N₂ in the case of sub-layer regime when the two molecules are mixed on the ice, paying attention to the case where CO coverage dominates over those of N₂.

Experiments designed in the laboratory:
+ Different ice surfaces: Amorphous solid water (ASW) ice (i.e porous; compact) and crystalline ice.
+ UHV – Sub-monolayer regime.
+ Detections:
-->Thermally Programmed Desorption (TPD).
-->Quadrupole Mass Spectrometer (QMS).
-->Infrared Spectroscopy.
+ Molecular beams.
+ Flux controller.

The surface temperature is at 10 K in during deposition process. After that, It is heated from 10K to 60 K.
+ CO and N₂ molecules are deposited on ASW ice surface.
+ With the increase of the doses, temperature shifts towards lower values.
+ Surface density $= \frac{10^{15}}{\text{cm}^{-2}}$ on compact ASW ice.

CONCLUSIONS

+ CO and N₂ are mixed in the same conditions at 10 K.
+ The CO desorption behavior does not change on the substrate when the molecular doses are raised (red arrows), while the N₂ desorption is shifted towards lower temperatures (blue arrows).
+ CO desorption behavior is not affected the N₂ presence, whereas N₂ desorption temperature is lowered by CO co-adsorption.

THE MIXTURE OF CO AND N₂

The binding energies of CO and N₂ mixture

<table>
<thead>
<tr>
<th>Pure</th>
<th>Coverage (ML)</th>
<th>CO</th>
<th>N₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>Es (E)</td>
<td>0.5</td>
<td>1070 K - 1380 K</td>
<td>1250 K - 1580 K</td>
</tr>
<tr>
<td></td>
<td>0.75</td>
<td>960 K - 1400 K</td>
<td>1090 K - 1590 K</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>890 K - 1420 K</td>
<td>990 K - 1630 K</td>
</tr>
</tbody>
</table>

+ The values of binding energy decrease with the coverages.

REFERENCES


Purpose of the study: To measure, analyse and interpret desorption energy differences of CO and N₂ in the case of sub-layer regime when the two molecules are mixed on the ice, paying attention to the case where CO coverage dominates over those of N₂.