Exploring the acting role of CO₂ atmosphere in the formation pathways of organic and C-containing inorganic compounds using LIBS

L.M. Cabalín, T. Delgado, L. García, J. J. Laserna
Departamento de Química Analítica, Universidad de Málaga, Facultad de Ciencias, UMALASERLAB, 29071 Málaga, España
Contact: J.J. Laserna, laserna@uma.es

INTRODUCTION

In the context of the SuperCam preparation work for the MARS 2020 mission, the aim of this paper was to explore the influence of background gas in Martian surface conditions on the formation of emitting species in laser-induced plasmas (LIBS) of C-containing compounds in order to identify the organic sources. For this purpose, the evaluation of different possible formation pathways of species coexisting in the plasma plume such as C, H, N, O, CN, C₂, CH, etc generated in air and in simulated Martian atmosphere has been investigated.

RESULTS AND DISCUSSION

EFFECT OF SURROUNDING ATMOSPHERE

Possible pathways to produce emitting species

- CN
- C₂
- CO₂
- CO
- O₂
- H₂O
- N₂
- Ar
- He

Formation molecular species (CN and C₂) in CO₂ atmosphere

"Changes in the behavior of the signal, in relation to the organic dopant in CO₂ for CN and C₂ band systems using 7.24 J cm⁻² as fluence value.

Effect of matrix in different surrounding atmospheres

- Air
- CO₂

Variation of the intensity of the atomic carbon signal in pyrene as the function of the doped inorganic matrix (CaCO₃ and CaSO₄) in both air and CO₂ atmospheres.

LIBS identification of organic compounds

<table>
<thead>
<tr>
<th>Compound</th>
<th>Air</th>
<th>CO₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urea</td>
<td>0.50</td>
<td>1.00</td>
</tr>
<tr>
<td>Glycine</td>
<td>0.50</td>
<td>1.00</td>
</tr>
<tr>
<td>Adenine</td>
<td>0.50</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Flow chart for Organic compound detection in synthetic matrices

This flow chart represents the decision tree followed from a new LIBS acquisition in CO₂ atmosphere with the view to identification purposes, according to the detailed evaluation of emission spectra acquired using experimental conditions previously defined. This decision tree would be valid as long as the absence of N-base mineralogical phases in the tested material is ensured.

Limit of detection of emitting species

The table shows limit of detection of emitting species calculated in pure CaCO₃ with a variable content of organic material and expressed as percent for LIBS measurements were determined in air and CO₂ atmospheres, both at 7 mbar and using two fluence regimes: 14.5 J cm⁻² and 7.24 J cm⁻².