Ionic and neutral kinetics in C_2H_2/Ar RF plasmas during the first stages of formation of interstellar carbonaceous dust analogues.

M. Jiménez-Redondo, L. Díaz-Pérez, R. J. Peláez, B. Maté, V. J. Herrero. I. Tanarro

Instituto de Estructura de la Materia (IEM-CSIC), Serrano 123, 28006 Madrid, Spain

i.tanarro@csic.es

Carbonaceous material represents a significant fraction of cosmic dust and a relevant reservoir of carbon in space. It originates characteristic IR absorption bands, revealing the presence of aliphatic and aromatic functional groups in variable proportions. Among the various materials investigated in the laboratory as possible carriers of these bands, hydrogenated amorphous carbon (a-C:H) leads to the best agreement with observations [1], although the composition and structure are still not clear.

In this work, we use capacitively-coupled RF plasmas of Ar with small C_2H_2 proportions to induce the gas-phase formation of a-C:H particles, as interstellar dust analogues. The gas phase is characterized by mass spectrometry of neutrals and positive and negative ions, optical emission spectroscopy and Langmuir probes. Special attention is paid to the first stages of dust formation; since it is observed that the generation of dust is accompanied by the disappearance of anions. The measured ion distributions are clearly dominated by species with an even number of carbon atoms, reflecting the characteristic polyyne structures, typical of the polymerization of acetylene. A kinetic model has been developed for the rationalization of the results [2].

The dust produced in the plasma is collected and analyzed ex-situ with FTIR spectroscopy [3] and Raman spectroscopy, and by Secondary Electron Microscopy; and then related to the final particle composition, that depends on the different discharge conditions.

[1] Kovacevic, E.; Stefanovic, I.; Berndt, J.; Pendleton, Y. J.; Winter, J. A Candidate Analog for Carbonaceous Interstellar Dust: Formation by Reactive Plasma Polymerization. *Astrophys. J.* 2005, *623* (1), 242–251

[2] Jiménez-Redondo, M.; Tanarro, I.; Peláez, R. J.; Díaz-Pérez, L.; Herrero, V. J. "Ionic Polymerization in Cold Plasmas of Acetylene with Ar and He". *J. Phys. Chem. A* 2019, *123*, 8135−8147.

[3] Maté, B.; Jimenez-Redondo, M.; Peláez, R. J.; Tanarro, I.; Herrero, V. J. "Desorption of N2, CO, CH4 and CO2 from interstellar carbonaceous dust analogues", *MNRAS* (2019) *490*, 2936–2947.