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On the nature of carbonaceous cosmic dust analogs

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Evolved stars are a factory of chemical complexity responsible for the formation of cosmic dust seeds, the building blocks of planets and life. With the advent of a new generation of radiotelescopes, spectroscopic signatures of abundant molecular species can be obtained with unprecedented radial resolution. However, many molecular structures, and the reaction mechanisms forming them, remain unidentified. We have designed and built an unprecedented ultra-high vacuum machine [1] combining gas aggregation sources with advanced in-situ surface-science characterization techniques. This system, named the *Stardust* machine, allows extreme control of all relevant physical parameters, enabling a perfect workbench for the formation of small C-clusters in conditions similar to those detected in space. Instead decomposition of molecular precursors, as in laboratory astrochemistry is usually employed, we formed dust analogs from low-pressure gas-phase atomic aggregation of C atoms in a hydrogen atmosphere. The result is the formation of amorphous C nanograins and small C-clusters, aliphatic in nature and exhibiting a low degree of hydrogenation. Our results indicate that aromatic species are not efficiently formed in the star photosphere, but after thermal processing of C-clusters on the surface of the cosmic grains.

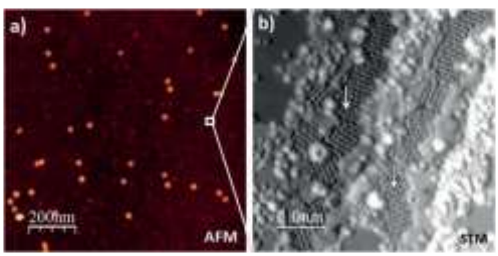

Figure 1 – Morphology of our cosmic-dust analog a) AFM image showing the presence of C-nanograins and small clusters forming a continuous layer b) STM image on the C-cluster film.

References

[1] L. Martínez, K. Lauwaet, G. Santoro, J.M. Sobrado, R.J. Peláez, V.J. Herrero, I. Tanarro, G. Ellis, J. Cernicharo, C. Joblin, Y. Huttel, J.A. Martín-Gago, Precisely controlled fabrication, manipulation and in-situ analysis of Cu based nanoparticles, Scientific Reports, 8 (2018) 7250.