

Molecular content in Si + C (star)dust growth processes

S. D. Wiersma¹, D. Nuñez-Reyes¹, P. Jusko¹, M.-C. Ji¹, H. Sabbah¹, S. Zamith², A. Bonnamy¹, K. Makasheva³ and C. Joblin¹

G. Santoro⁴, P. Merino⁴, M. Pousa⁴, L. Martínez⁴, G. Tajuelo-Castilla⁴ and J. A. Martín-Gago⁴

M. Agúndez⁵ and J. Cernicharo⁵

¹ IRAP, Université de Toulouse III - Paul Sabatier, CNRS, CNES (France)

² LCAR, FeRMI, Université de Toulouse III - Paul Sabatier, CNRS (France)

³ LAPLACE, Université de Toulouse III - Paul Sabatier, INPT, CNRS (France)

⁴ ICMM, CSIC, Madrid (Spain)

⁵ IFF, CSIC, Madrid (Spain)

The outflows of C-rich AGB stars produce a rich, dusty chemistry in which silicon is of major importance. Our view of the molecular species involved in hydrocarbon growth and dust formation is still very limited, in particular for organosilicon dust. Within the ERC NANOCOSMOS synergy, we study the chemistry of Si with different forms of C using two dust analogue sources and a variety of analytical techniques. In PIRENEA 2 [1], one or two solid rods (Si, SiC and Si+C) are laser vaporized in the presence of a He pulse (with C₂H₂ or not). The formed molecules are analysed in-situ via quadrupole mass spectrometry. In the Stardust setup [2], Si and C are sputtered with Ar, and the formed species can react with H₂. Various in-situ diagnostic methods are available, including temperature programmed desorption (TPD) mass spectrometry. For both setups, deposits including dust and molecules are prepared for ex-situ analysis using the high-resolution laser desorption/ionization molecular analyser AROMA [3].

TPD of the Si+C+H₂ Stardust sample showed the desorption of various hydrocarbons, up to the size of C₁₀H₈. In PIRENEA 2, the in-situ mass spectrometry of experiments using Si, SiC or Si+C with C₂H₂ revealed the formation of SiC_{4+2n}H_{4+2n}⁺ species, where *n* increases with the C₂H₂ fraction, which can be indicative of the formation of polyacetylenic chains. We found that the chemistry does not depend much on the available carbon sources. The AROMA analysis of both the Stardust and the PIRENEA 2 dust analogues reveals a large variety of hydrocarbons, in particular of polycyclic aromatic hydrocarbons (PAHs). The most abundant PAH is found to be C₁₆H₁₀⁺. In general, the presence of Si is found to increase the fraction of formed PAHs relative to other detected molecular families. Possible hydrocarbon growth scenarios involving Si will be discussed.

References

[1] A. Bonnamy et al., (2018), <https://tinyurl.com/pirenea2>.

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[3] H. Sabbah et al., Astrophys. J., 843(34), pp. 1–8 (2017)