The STARDUST machine: Analysis modules

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The STARDUST machine is devoted to investigating interstellar dust formation and growth within AGB stars by producing dust analogues in a highly controlled environment mimicking that of dying stars. Here the modules dedicated to analysing the dust analogues after formation and processing, , the so-called INFRA-ICE and ANA chambers, will be presented.

Within the ERC-Synergy grant "Gas and dust from stars to the laboratory: Exploring the Nanocosmos" we are designing and building a machine devoted to the simulation of dust formation in the atmosphere of Asymptotic Giant Branch stars (AGBs): the STARDUST machine. STARDUST offers unique capabilities in terms of dust analogue fabrication. An extreme control of the composition, size and stochiometry of the analogues is being achieved along with accurate in-flight processing under conditions mimicking those encountered by cosmic dust particles travelling towards the interestellar medium (see abstract by K. Lauwaet et al.).

Besides the outstanding possibilities of STARDUST for fabricating and processing dust analogues, two additional modules are being assembled with the objectives to analyse both the analogues and the processes that simulate dust formation, growth, accretion and subsequent chemistry therein: the INFRA-ICE module and the ANA module.

The INFRA-ICE chamber is comprised of two main parts; lower and upper Ultra High Vacuum (UHV) chambers. Within the lower UHV chamber, near- and mid-infrared (NIR and MIR) spectroscopy, both in transmission and grazing incidence geometries (i.e. IR reflection-absortion spectroscopy, IRRAS) will be available for characterizing the chemical composition of the dust analogues and/or the composition and conformational structure of the molecules produced during analogue processing. This will be performed on-substrate (by collecting the analogues) and, later, in-flight via a novel multipath design. Additionally, standard radioastronomy receivers could be coupled to acquire rotational emmision spectra (see abstracts by B. Alemán et al. and I. Tanarro et al.).

The upper UHV chamber, out of the flight path of the dust anaolgues, will be devoted to the preparation of ice analogues of astronomical interest. Here, processing of the ices by ultraviolet (UV) radiation, electron and ion bombardement as well as atomic hydrogen and gas exposure will be performed. In addition, transmision IR spectroscopy and mass spectroscopy will be available as well as temperature programmed desorption (TPD).

The ANA module consists of a UHV chamber in which the dust analogues will be collected on a substrate and further analysed by means of UV and X-ray photoelectron spectroscopy (UPS/XPS), Auger electron spectroscopy (AES) and TPD. Heating capabilities of the collected analogues up to 1400 K are available along with electron and ion bombardement, UV irradiation and atomic hydrogen and gas exposure. All the processes occuring with the dust analogues during heating, irradiation and exposure can be monitored in-situ by the available characterization techniques.

In summary, the STARDUST machine constitutes a unique platform for investigating interstellar dust formation and growth within the atmosphere of AGBs as well as for the study of the processes to which the dust is subjected during its fifty year journey to the interstellar medium.