Dust seed formation using an adjustable multi-magnetron gas aggregation source

L. Martínez[1,*], K. Lauwaet[1], G. Santoro[1], J. Sobrado[2], R. Peláez[3], I. Tanarro[3], C. Joblin[4], J. Cernicharo[1], Y. Huttel[1], J.A. Martín-Gago[1]

[1] Instituto de Ciencia de Materiales de Madrid (ICMM-CSIC), c/Sor Juana Inés de la Cruz, 3. Madrid-28049 (Spain)
[2] Centro de Astrobiología (CSIC-INTA), Ctra. de Torrejon a Ajalvir, Km 4. Torrejon de Ardoz-28850 (Spain).
[3] IEM. CSIC. Instituto de Estructura de la Materia. Molecular Physics Department. C/Serrano 123, 28006 Madrid (Spain)
[4]Institut de Recherche en Astrophysique et Planétologie (IRAP), Université de Toulouse UPS-OMP, CNRS, 9 Avenue du Colonel Roche, 31028 Toulouse Cedex 4 (France)
*lidia.martinez@icmm.csic.es

Gas aggregation sources are undoubtedly of attracting interest as an alternative route for nanoparticle fabrication. This is mainly due to the fact that it is a technique able to fabricate nanoparticles with controlled size and composition in clean environment (high or ultra-high vacuum). Among different types of gas aggregation sources, the ones based on sputtering are the most popular mainly due to the important proportion of ionized nanoparticles produced, which allows mass/charge selection by using a quadrupole. In the framework of the European project ERC Synergy Grant "Gas and dust from stars to the laboratory: Exploring the NANOCOSMOS", we are building the Stardust machine, designed to simulate in the laboratory the formation of nanoparticles, small clusters and molecules in the photosphere of a red-giant star. The first part of Stardust, where the seed formation of dust analogs is produced, is an implementation of a sputtering gas aggregation source called Multiple Ion Custer Source (MICS). In it, we try to reproduce the condensation sequence in which atoms of the refractory materials start aggregating to create clusters and its growth to nanoparticles. The MICS consists in three completely independent magnetrons inside an aggregation zone. With it, it is possible to fabricate nanoparticles of controlled size, composition and structure in ultra-high vacuum. Previous works demonstrated that with this equipment it is possible to fabricate nanoparticles of a single element, alloyed nanoparticles with controlled stoichiometry, as well as core@shell nanoparticles. For the Stardust machine, the size of the magnetrons and the aggregation zone were scaled up in order to be able to fabricate nanoparticles of bigger sizes in larger quantities (high flux). The aggregation zone includes new entrances that will enable to perform new fundamental research. We will present the experiments carried out during the commissioning of Stardust in order to test some of the capabilities of the equipment, focusing on the generation of nanoparticles / dust analogs.

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