VIS-NIR REFLECTANCE MICRO-SPECTROSCOPY OF INTERPLANETARY DUST PARTICLES

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Introduction: The Chondritic Porous Interplanetary Dust Particles (CP-IDPs) are assumed to be the most pristine extraterrestrial particles available in the laboratory for studies with high spatial resolution analytical techniques. It has been recently proposed that they sample bodies that formed in the outer region (> 5 AU) of the solar system [1], i.e. low-density icy asteroids (C-, P-, and D-types). we have conducted several studies on these tiny particles (typical size of ~ 20 µm), using mid- and Far-infrared (2-50 µm) micro-spectroscopy (IR) performed on the French synchrotron SOLEIL [2, 3]. This technique is non-destructive, gives information on the mineralogy and organics of the samples [2] and allows comparison with astronomical data [3]. A full study of the IDPs requires the combination of different analytical techniques including those wich are destructive. The IDPs are allocated by NASA and sent between two glass-slide droplet containers, wich are not suitable for IR micro-spectroscopy. We aim in this study to acquire spectra from different IDPs *in-situ* in their containers in the visible near infrared (Vis-NIR) range 0.4 -1.1 µm in order to i/ have a first characterization of the IDPs before transferring them to other substrates for complementary analyses ii/ provide data in the Vis-NIR range of the IDPs to be compared with the remote sensing data from the asteroids' surfaces. iii/ to complete with IR and Raman measurements for a better understanding and interpretation of the Vis-NIR spectra and thus the observational data. Currently little has been reported on this topic, Bradley et al. have compared in the visible range the signatures of some CP-IDPs and CS-IDPs (Chondritic Smooth) [4], but more data are necessary to better elucidate the comparison with asteroidal spectra.

Experiments: We installed in a clean room a Vis-NIR spectrometer (Maya2000 Pro from Ocean Optics) coupled through a Vis-NIR optical fiber (100 µm in diameter used for the collection of the reflected light by the samples) to an objective X6,3 of an optical microscope (Zeiss) [5]. With this objective the collecting spot is reduced to 20 µm. These values are in the same order than the IDPs sizes. The samples are illuminated by a 1000 µm diameter optical fiber coupled to a halogen light source. The angle between the two fibers is about 60°. Before measuring the IDPs we collected spectra from minerals (olivine, pyroxene) as well as some meteorites such as Allende (CV), Gilgoin (H5), Frontier mountain 95002 (CO) and DAG684 (Eucrite) in order to compare our micro-measurements to the macro-measurements reported elsewhere [6-7]. These samples have been used as powder dispersed in a glass slide as well as individual grains of ~ 20 µm in size (for olivine and meteorites), or a pressed pellet (pyroxene). The analyzed IDPs are W7068 B37, L2079 C18 (transferred onto a diamond window) and L2071 E34 and W7068 C40 (which are still on their substrate as sent by NASA). We performed measurements on the IDPs in different locations (when the collecting spot is smaller than the IDP) and also by rotating the glass slide exposing thus different sides of the sample to the illuminating light. We then averaged the different spectra.

Results: We obtained spectra from olivine and pyroxene with reflectance levels around 60 % and 70% respectively which are in a good agreement with the obtained values using macro-measurements |7]. The specific signatures of the two minerals about 0.6, 0.8 and 1.05 µm for olivine and 0.9 µm for pyroxene have been found. These results validated our analytical procedure. However when we used the same analytical procedure for individual grains of these minerals as well as some meteorites, the obtained spectra drastically decrease above 800 nm. We first explain this phenomenon by possible effects of diffusion and scattering of the light in the grains leading to the loose of the signal and/or by chromatic aberration. The analyzed IDPs gave levels of reflectance in good agreement with those reported by Bradley et al. [4] in the range 400-800 nm. The IDP W7068 B37 has a lower reflectance level, this can be explained by its size (9 µm) smaller than the spot size of detection (~ 20 µm). The IDPs L2079 C18 and L2071 E34 have same reflectance levels around 4%, and the IDP W7068 C40 has a reflectance level 3 fold higher. To better explain these different reflectance levels, the composition of these samples will be investigated thanks to the next synchrotron IR micro-spectroscopy measurements. These encouraging preliminary results indicate that it is possible to classify the IDPs according to their level of reflectance in the 400-800 nm range. In future work, we will investigate the decrease of reflectance observed above 800 nm and then extend these measurements to about 20 IDPs and look for possible trends.

References: [1] P. Vernazza et al. (2015) *The Astrophysical Journal* 806:204. [2] Merouane et al. (2014) *The Astrophysical Journal* 780:174. [3] Brunetto et al. (2011) *Icarus*, 212, 896-910. [4] J.P. Bradley et al. (1996) *Meteoritics & Planetary Science* 31, 394-402. [5] Bonal et al., (2015) *Meteoritics & Planetary Science* 50, 1562-1576. [6] Beck et al. (2012), *Icarus* 218, 364-377. [7] Lantz, et al., (2017) *Icarus*, 285, 43-57.