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# Visible-Near Infrared micro-spectroscopy of interplanetary dust particles

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## Abstract

Meteorites have always been considered as representative of the surface of the asteroids of the main belt. However it has been recently reported that some chondritic porous interplanetary dust particles (CP-IDPs), typical size around 20 µm, sample bodies that formed in the outer region (> 5 AU) of the solar system [1], since their reflectance spectra are similar to those obtained from the remote sensing measurements of these asteroids (e.g. low-density icy asteroids C-, P-, and D-types). We present here preliminary results obtained from the visible-near infrared (Vis-NIR, 0.4-1.1 µm) micro-spectroscopy that we developed to analyze different extraterrestrial (E.T.) materials such as meteorites and the tiny IDPs as well as minerals found in the E.T. material.

## 1. Introduction

CP-IDPs are assumed to be the most pristine extraterrestrial particles available in the laboratory for studies with high spatial resolution analytical techniques. In the last decade, we have conducted several studies on these tiny particles 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 which are destructive. In this study, we enlarge our spectroscopic investigation to the Vis-NIR. The IDPs are allocated by NASA and sent between two glass-slide droplet containers, which 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 Vis-NIR 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.

## 2. Experimental procedure

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. This value is 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 45°. Before measuring the IDPs we collected spectra from minerals (olivine, pyroxene) as well as some carbonaceous meteorites such as Allende (CV), Frontier Mountain 95002 (CO) and Gilgoin (H5), 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 on a glass slide (olivine and meteorites) as well as individual grains of ~ 20 µm in size, and a pressed pellet (pyroxene). Two analyzed IDPs W7068 B37 (9 µm size) and L2079 C18 (35x27 µm size) are transferred onto a diamond window. We also analyzed L2071 E34 (22x20 µm) and W7068 C40 (25x23 µm) 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.

## 3. Results and Discussion

The obtained spectra from olivine and pyroxene exhibit the signatures of the two minerals about 600, 800 and 1050 nm for olivine and the specific band around 900 nm for pyroxene. These spectra are in a total agreement with what is found in macro-measurements. These results validated our analytical procedure. However, when we use this analytical procedure for individual grains of these minerals (~ 20 µm in size) 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. Figure 1 below shows the spectra obtained for the IDPs. The reflectance levels reported here are in a good agreement with those of Bradley et al. in the range 400-800 nm [4]. 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), other measurements are planed with a 50 µm fiber (spot of ~ 10 µm) for this IDP. The IDPs L2079 C18 and L2071 E34 have same levels around 4%. The IDP W7068 C40 has a reflectance level 3 fold higher. 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 our IDPs according to their level of reflectance in the 400-800 nm range. In future work, we will extend these measurements to about 20 IDPs and look for possible trends.

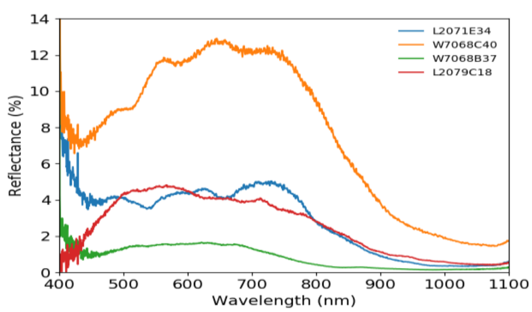


Figure 1: The Vis-NIR spectra of the four studied IDPs.

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