# VIS-NIR REFLECTANCE MICRO-SPECTROSCOPY OF IDPs

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**Introduction:** Some classes of asteroids (B-, C-, Cb-, Cg-, P- and D-types, representing not less than 66% of the mass of the main belt) have no analogues clearly identified in the meteorite collections [1]. However, meteorites are not the only cosmomaterials found on Earth since no less than 30 000 tons of interplanetary dust particles (IDPs) enter the Earth's atmosphere each year [2]. IDPs originate from different parent bodies throughout the solar system [3, 4, 5]. Two IDP classes are identified, the Chondritic Smooth (CS-) IDPs that have platy and/or fibrous texture with mineralogy dominated by hydrous silicates and Chondritic Porous (CP-) IDPs that have a very porous texture with mineralogical component dominated by anhydrous silicates [6]. The reflectance measurements in the visible range (0.4 – 0.8 μm) performed on CP- and CS-IDPs in the 90s [7] and the simulated visible near infrared (Vis-NIR) spectra of IDPs with comparison of mid infrared (Mid-IR) spectra [1] have shown that IDPs may be good analogues to some asteroids and in particular to the classes not sampled by meteorites. These results are supported by the fact that some asteroids eject dust [8], as recently observed by OSIRIS-REx around Bennu asteroid (B-type) [9].

We report here the recent developments of a reflectance measurement device and the results obtained on the IDPs in the Vis-NIR range (0.45 – 1.0 μm). Mid-IR measurements (2.5 – 15 μm) are also performed at the French synchrotron SOLEIL (*https://www.synchrotron-soleil.fr/fr*) to better constrain the composition.

**Experiments:** Our setup, installed in a clean room, consists of a Vis-NIR spectrometer (Maya2000 Pro from Ocean Optics) coupled to a macroscope (Leica Z16 APO). A Vis-NIR optical fiber (100 or 50 μm in diameter) is used to collect the light diffused by the sample which is unilaterally illuminated by a halogen source through a 1000 μm diameter fiber (phase angle of ~ 45°). By changing the magnification and/or the diameter of the collection fiber it is possible to adapt the collection spot to the grain size down to 7 μm size. To obtain the reflectance spectrum of a micrometric grain with this setup, it is necessary to rotate the particle several times in the observation plane with respect to the incident light [10]. For the Mid-IR measurements the grains are transferred and crushed in a diamond compression cell [5, 11]. Transmission infrared spectroscopy (spectral resolution of 4 $cm^{-1}$) is performed on the SMIS beamline of SOLEIL thanks to a microscope coupled to a Fourier transform infrared spectrometer with its Mercury–Cadmium–Tellurium detector cooled with liquid nitrogen.

**Results and discussion:** We obtained spectra of 10 IDPs with reflectance levels covering a wide range (~ 1 to 11 % at 0.55 μm). The very low reflectance levels of some IDPs indicate that they could represent very dark asteroids like Ryugu, whose visible reflectance at 0.55 μm is 1.88 ± 0.17 % [12, 13]. The Vis-NIR spectra of IDPs show some absorption bands which are discussed using the Mid-IR measurements. IDPs exhibit also different spectral slopes. Some of IDPs have a red slope on the entire wavelength range, that will be compared with spectral slope of some asteroids. Other IDPs show a fall of the reflectance beyond 0.8 μm that can be produced by magnetite and/or by the absorption of minerals such as olivine and pyroxene.

We propose our analytical technique as a useful non-destructive tool to be applied on samples which will be collected by Hayabusa2 and OSIRIS-REx on asteroids Ryugu and Bennu. The laboratory spectra acquired on these precious grains will be compared to those obtained in-situ in space as well as by remote-sensing observations. Coupling other analytical techniques (FTIR and Raman) will be helpful to link the Vis-NIR spectra of grains (and thus their parent bodies surfaces) to their composition.

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