A MICRO-RAMAN SURVEY OF 10 IDPS AND 6 CARBONACEOUS CHONDRITES E. Quirico[1] , J. Borg[2], P-I Raynal[2] and L. d'Hendecourt[2], [1]Laboratoire de Planétologie de Grenoble BP 53 38041 Grenoble cedex France eric.quirico@obs.ujf-grenoble.fr, [2]Institut d'Astrophysique Spatiale Université Paris-Sud 91405 Orsay Cedex France.

Introduction: Though many studies point to a pristine origine of Organic Matter (OM) in some stratospheric IDPs [1], the chemical and physical properties of this material remain largely unknown. Following the pioneering work of [2], this study intended to provide new clues by using Raman microspectrometry.

Samples, experiments, data treatments : Ten stratospheric IDPs have been provided by the JSC Curation Center (NASA-USA). The set of chondrites has been provided by the Muséum National d'Histoire Naturelle (Paris-France). The spectral class of each IDP has been determined by IR microscopy (Tab. 1). Experiments were performed with a DILOR XY spectrometer and an Ar+ Spectraphysics laser, using a 514 nm excitation wavelength (located in LST ENS-Lyon France). The Raman spectra consisted of the first-order carbon G and D bands as detectable features, superimposed onto a Photo-Luminescence Background (PLB). The intensity of this PLB, I_{PLB}, has been quantified as the intensity of the linear background of the spectra at half spectral range. The spectra, subtracted from the PLB, were fitted with two Lorentzian profiles, providing 8 spectral parameters (for each band : spectral width, peak position, peak intensity and integrated intensity) [3,4].

Raman spectra: Unfortunately, no features but the first-order carbon bands G and D were detected. Each probed area of the samples of the 6 studied carbonaceous chondrites exhibits a Raman spectrum with the G- and D-bands, demonstrating that a polyaromatic composition is ubiquitous at the micrometric scale. But in most IDPs, some probed area exhibit Raman spectra without G- and D-bands (Tab. 1).

	Class	NM	Visual	I_{PLB}
A4	FeS	4/11	B.	104 ± 24
B4	FeS	7/8	B.	187 ± 29
I29	Ol	10/10	d. (+Barea)	249 ± 116
D6	Ol	6/9 (1)	d.	295 ± 131
D1	Ol (+Py)	10/15 (2)	d.	692 ± 293
G15	Ol (+Py)	8/14 (1)	d.	1556 ± 1346
D3	Px	11/11	d.	579 ± 441
D7	Px	10/11 (1)	d.	1100
C18	Px	6/6	d.	6608 ± 1474
C8	LS	10/10	d.	3389 ± 3507
Renazzo	CR2	17/17	d.	1486 ± 1047
Murchison	CM2	14/14	d.	946 ± 434
Cold Bokkeveld	CM2	12/12	d.	2115 ± 715
Allais	CI1	12/12	d.	18201 ± 5723
Ivuna	CI1	12/12	d.	10320 ± 3833
Orgueil	CI1	16/16	d.	12242 ± 7241

Table 1 : Class: IR-class for IDPs, chemical and petrographic type for meteorites (FeS=sulfide-rich ; Ol=olivine ; Py=pyroxene ; LS=layer-silicate). NM (number of measurements) : x/y indicates x spectra exhibiting the D and G bands for a total number of y probed area (the number between brackets indicates the number of spectra without the D and G bands which have been stored after measurement). Visual: visual aspect of grains in optical microscope – B=bright; d.=dark; Barea=a few bright area observed. I_{PLB} is the average PhotoLuminescence Background with 1-σ dispersion, corrected from experimental variations.

This reveals more heterogeneous abundance and/or composition of OM in IDPs. The spectral parameters of the G and D bands points to a highly disordered material, consistent with a weak or negligible thermal history. No IDP with a mature carbon, such as reported by [2], has been observed, questioning a statistical effect.

On the other hand, averaged values of the spectral parameters obtained from the numerical fit, for each IDP, has not allowed to draw a classification of IDPs, such as the one proposed by [2]. In addition, no correlation was found between these parameters and the intensity of the PLB, as well as with the IR class.

PLB intensity : The intensity of the PLB, I_{PLB}, correlates with the peak intensity of the G-band for all chondrites (Fig. 1). This result strongly suggests the chromophores are the aromatic compounds in OM. In IDPs, the correlation is less high, suggesting a higher compositional heterogeneity of the material.

An averaged PLB intensity $\langle I_{PLB} \rangle$ has been calculated for each chondrite and each IDP. $\langle I_{PLB} \rangle$ is much higher for CI1 chondrites than for CM2/CR2, but with large variations within each meteorite (Fig. 2). For IDPs, the PLB intensity varies over a wide

range from one IDP to another, or within an IDP (Fig. 2). The highest values reach those obtained for the CI1 chondrites, and the lowest ones are much weaker than those measured in CM2/CR2 chondrites (Fig. 2, Tab. 1).

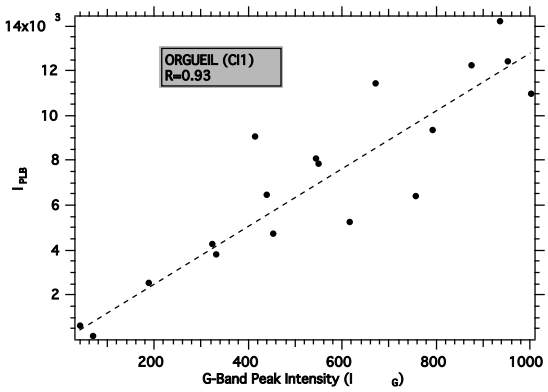

Figure 1 : The intensity of the PLB vs. the intensity of the G band, for the Orgueil chondrite. This diagram shows that both parameters correlate very well, thus that the aromatic units in the OM are the chromophores of the fluorescence signal.

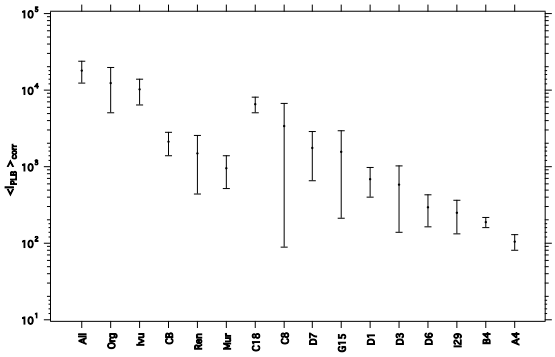

Figure 2 : The averaged PLB, corrected from variations of experimental conditions, for each studied object. The bar indicates the 1σ-dispersion. All : Alais ; Org : Orgueil ; Ivu : Ivuna ; CB : Cold Bokkeveld ; Ren : Rennazo ; Mur : Murchison. Other symbols point to IDPs (see Table 1).

The variation of the PLB intensity can be interpreted in terms of abundance and/or chemical properties variations of OM. However, OM abundance variations cannot account for all PLB intensity variations. First, the variations between CI1 and CM2/CR2 (by a factor of 2 to 15) is large, whereas the bulk carbon abundances in the objects are rather close. Second, $<I_{PLB}>$ in IDPs is at best equal to CI1 values, whereas the average bulk weight abundance is x4 higher than in carbonaceous chondrites [5]. We do not have accurate information about the bulk carbon abundance in each of these IDPs, and the statement that all IDPs have a bulk carbon abundance ~ x 4 weaker than the average cannot be excluded. However, it is very unlikely. These observations, in any case, suggest a chemical heterogeneity of OM.

Conclusion : Though the higher sensitivity of the present Raman spectrometers, this study failed in detecting spectral features but the first-order carbon bands D and G, in IDPs and in pristine carbonaceous chondrites. However, it has provided some new results : 1) OM in IDP appears more heterogenous than in carbonaceous chondrites, in terms of abundance and/or composition ; 2) the PLB signal recorded along the Raman spectra originates from aromatic chromophores located in OM ; 3) the PLB intensity is somewhat anomalous, as IDP values never exceed CI1 carbonaceous chondrites though their bulk carbon abundance is x4 higher.

References: [1] Aléon J. et al. (2001) *GCA*, 65, 4399-4412. [2] Wopenka B. (1988) *EPSL*, 88, 221-231. [3] Quirico E. et al. (2003) *Meteoritics & Planet. Sci*, 38, 795-812. [4] Quirico E. et al. *Meteoritics & Planet. Sci*, submitted. [5] Thomas et al. (1994) In *Analysis of Interplanetary Dust* (eds M. E. Zolensky, et al.), pp. 165-172, AIP Conf. Proc. 310. Amer. Inst. Phys., Woodbury.