**REFLECTANCE SPECTROSCOPY OF INDIVIDUAL INTERPLANETARY DUST PARTICLES**

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In the absence of actual samples from most Solar System objects, reflectance spectroscopy provides a means of obtaining information about planetary surface compositions and mineralogy [1]. A large data base has been acquired from asteroids in the visible (VIS) and near infrared (IR) spectral range, and similar data have been acquired from all of the major classes of meteorites [1-3]. On the order of fifteen asteroid classes are recognised but most belong to the S, C, P, and D classes [1]. Comparison of meteorite spectra with those of asteroids suggests that meteorites are a highly biased sampling of the asteroids. In contrast to meteorites, interplanetary dust particles (IDPs) collected at 1 AU are derived from a broader range of Solar System objects [4]. Reflectance spectra from IDPs might result in recognition of samples of parent bodies not represented among meteorites. We have obtained the first reflectance spectra from individual IDPs as small as 5 μm over the visible wavelength range 380-800 nm. Many chondritic IDPs are ideal candidates for reflectance spectroscopy because they are extremely fine-grained and homogenous on a scale of micrometers. Spectra have also been collected from particle standards and meteorite fragments. We are now evaluating hardware modifications that will enable us to extend the range of measurement into the near-IR region (800-2100 nm).

Spectra are acquired using a reflected light microscope equipped with a halogen light source, 10X and 50X objectives, aperturing diaphrams, and a photometer unit with a photomultiplier tube (PMT) detector. The spectral response of the microscope photometer system itself is continuously monitored by collecting data from a pressed barium sulfate pellet over the 380 - 800 nm range with a 5 nm measurement interval. Particle data were collected from titanium oxide ($Ti_4O_7$), fragments of Allende (CV3) matrix, and chondritic IDPs (with diameters between 5 and 30 μm). The spectra were acquired using oblique illumination and measurement of the (scattered) light reflected perpendicular to the surface of the sample. Figure 1 compares a "bulk" spectrum (from a 2 mm diameter region of a pressed pellet) of $Ti_4O_7$ with that of an individual 20 μm diameter $Ti_4O_7$ particle. The $Ti_4O_7$ standard is homogenous, fine-grained (~0.5 μm average grain size), with a low (bulk) reflectivity that has been independently measured at JSC. Between 430 and 800 nm (Fig. 1), the reflectivity of the particle mimics that of the bulk sample. However, below 430 nm there is an abrupt drop-off into the UV. The reason for this drop-off is currently under investigation, but preliminary observations suggest that it is a scattering effect related to particle morphology. (This particle dependent UV drop-off may have implications with regard to interpretation of asteroid reflectance data). Under appropriately optimized conditions, it was possible to routinely determine the reflectivity of $Ti_4O_7$ particles (<25 μm diameter) within 1% of the (bulk) reflectivity of $Ti_4O_7$ between 430 and 850 nm (Fig. 1).

Figures 2 and 3 show reflectance spectra from 4 Allende fragments and 5 chondritic IDPs. The Allende spectra, collected from particles between 20 and 40 μm diameter, are compatible with bulk spectra of Allende and other CV3 meteorites (see Hiroi *et al.* [3]). The IDPs exhibit a broad range of reflectivities in the visible wavelength range (Fig. 3), although we see evidence of grouping among a much larger population of chondritic IDPs. Some IDPs (e.g. L2005AE11) exhibit generally flat spectra similar to those of carbonaceous chondrite meteorites and C-type asteroids, while others (L2011R7) exhibit a pronounced rise into the infrared similar to P and D asteroids (Fig. 3). Spectra from IDPs whose bulk carbon contents have been determined are also shown in Figure 3. Generally, the most carbon-rich IDPs exhibit the lowest albedos, although there are exceptions. Determination of the spatial distribution and chemical state of the carbon (e.g. amorphous carbon or carbonates) may explain these exceptions.

We have established that it is possible to measure the reflectivities of individual (<25 μm diameter) IDPs within the visible wavelength range 430 - 800 nm. Noble gas measurements and electron microscopic studies of many of these IDPs have been initiated in order to evaluate spectral reflectivities in terms of mineralogy, petrography, thermal histories,and sources of IDPs.

## References


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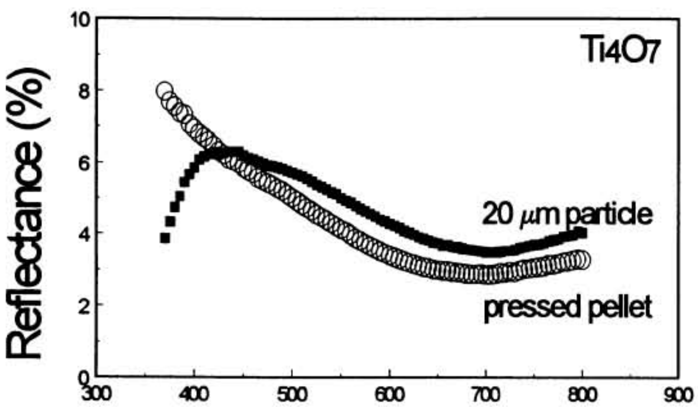


Figure 1. Reflectance spectra of $Ti_4O_7$ from a pressed pellet and from a typical 20 μm fragment. ($Ti_4O_7$ sample was provided by Carl Allen, Lockheed, NASA/JSC)

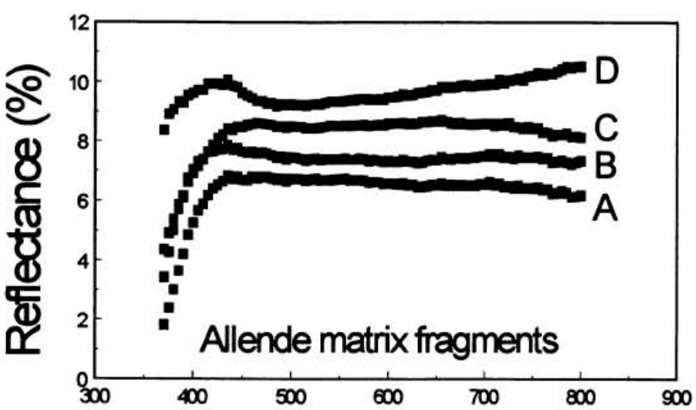


Figure 2. Reflectance spectra from four 20- to 40-μm sized fragments of matrix from the Allende CV3 chondrite. Spectra B, C, and D are shifted from A by 1, 2, and 3 reflectance units, respectively.

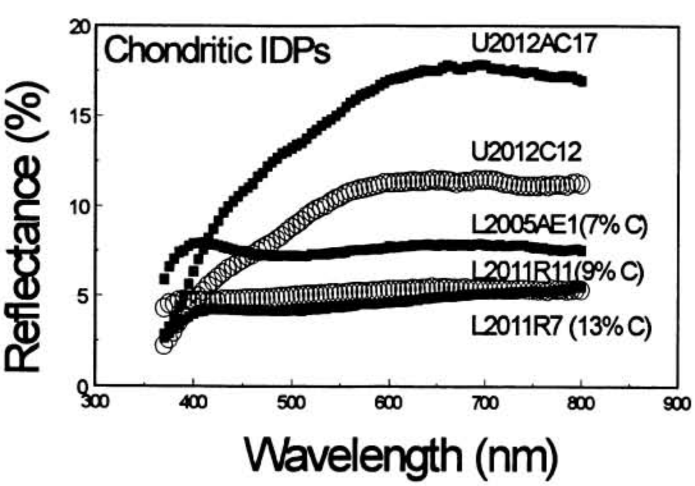


Figure 3. Reflectance spectra from individual chondritic IDPs showing the range of reflectivities and spectral slopes observed in IDPs.