LABORATORY INFRARED SPECTROSCOPIC MEASUREMENTS OF INTERPLANETARY DUST PARTICLES AND COMPARISON WITH ASTRONOMICAL OBSERVATIONS OF COMET DUST, Fraundorf P.,* Patel R.I.,**, Sandford, S.A. and Walker R.M., McDonnell Center for the Space Sciences, Washington University, St. Louis, MO 63130 USA. *Also Monsanto Research Center, St. Louis, MO 63166. **Present address: 3M Company, St. Paul, MN 55144.

Astronomical spectra of cosmic dust frequently exhibit broad features at \( \approx 10 \, \mu m \) and \( \approx 20 \, \mu m \) [1,2]. We previously reported 10 \( \mu m \) features in the IR transmittance of several chondritic stratospheric dust particles [3,4]. Given here are IR measurements of 21 such particles obtained using a Nicolet 7199 Fourier Transform Spectrometer. As shown in Fig. 1, three classes of particles, of comparative abundance are found: I) those whose silicate 10 \( \mu m \) feature resembles in width and location that of pyroxene (5 particles); II) those whose 10 \( \mu m \) features exhibit fine structure characteristic of Fe-rich, terrestrial olivine (6 particles) and; III) those in which the 10 \( \mu m \) band shows little structure, but is relatively narrow compared to the astronomical data (10 particles). The IR data, which measure the bulk properties of dust grains, support previous microscopic electron diffraction work which also showed that the crystalline silicates in different particles were dominated by either olivine, pyroxene, or layer lattice structures [4,5]. Type III particles are also characterized by the ubiquitous presence of OH bands (\( \approx 3400 \, \text{cm}^{-1} \) and 1610 \( \text{cm}^{-1} \)) and the frequent presence of a strong CO\(_3\) band at 1430 \( \text{cm}^{-1} \). Apart from the CO\(_3\) bands, type III spectra are similar to the spectrum of Murchison matrix material, which, in turn, is similar to the spectra obtained from terrestrial layer-lattice silicates.

Although the distinctions between the classes of particles are clear, there are differences between particles which fall within the same class (the variability is more marked for types I and III than type II). For example, one Ca-rich type III particle has a carbonate feature at 1430 \( \text{cm}^{-1} \) which is actually stronger than the accompanying 10 \( \mu m \) silicate feature. Neither the CO\(_3\) nor the OH features from the type III particles appear to be strongly correlated with the content of Ca or S (which themselves are uncorrelated) as measured by EDAX analysis. The signal to noise for equivalent masses in the IR also varies from particle to particle, suggesting variable fractions of crystalline silicate components.

Although we are still in the process of making density and electron diffraction measurements on particles, the following trends appear to be emerging. Type I particles are frequently fragile re-entrant structures with low densities (\( \leq 1 \, \text{g/cm}^3 \)). Pyroxene "laths," which have been attributed to a vapor growth process by Bradley and Brownlee [6], are frequently seen in such particles. These particles also appear to be the least well-crystallized, overall, of the three classes. In contrast, type III particles are generally compact, rather smooth-looking objects.

The presence of layer-lattice silicates in some particles has previously been reported by Brownlee [7] who also found that such particles were generally smooth and compact. However, in contrast to [7], we do not find that the presence of layer-lattice silicates is linked to a low Ca concentration.

In Fig. 2 we show a comparison of telescope IR emission data on dust from Comet Kohoutek [8] with a composite particle spectrum obtained by judicious adding of laboratory spectra. Although the agreement is good, it is not yet clear how the laboratory spectra should best be co-added to obtain...
the most representative composite spectrum. For example, it may be that "fluffy" particles should be given much larger weights due to their inherent fragilities which may lead to a relative depletion of their numbers in the collected populations. Previous heating experiments on dust particles and on chondritic meteorites have shown that olivine is a typical high temperature recrystallization product \[9,10\]. Thus, the type II particles may contain a disproportionate fraction of material altered by atmospheric entry and perhaps should be given less weight in comparing laboratory and astronomical data. Laboratory experiments are currently in progress to delineate spectral modifications produced by atmospheric entry or by thermal processing in the vicinity of the comet nucleus.

The laboratory results underscore the importance of obtaining high resolution spectral data for comet dust to look for small, residual fine structure in the 10 µm band, to allow detailed comparisons with the 20 µm feature, and to search for the carbonate bands observed in the stratospheric particles.


© Lunar and Planetary Institute • Provided by the NASA Astrophysics Data System