PHYSICAL PROPERTIES OF SUBMICRONIC CARBONACEOUS PARTICLES CANDIDATE AS COSMIC DUST

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ABSTRACT. We present here a compendium of our laboratory measurements of the physical properties of submicronic particles made by some carbonaceous materials candidate as cosmic dust: amorphous carbon, silicon carbide. Comparison with data obtained by other authors is presented and discussed in view of astrophysical applications.

1. INTRODUCTION

Solid particles produce the absorption and scattering of starlight representing one of the main agents which control transfer of radiation in the interstellar medium.

In spite of a large amount of direct observations, the composition, size distribution, structure and morphology of grains are still under debate.

Laboratory work on this subject has been developed since three years in our Department with the aim of performing an accurate analysis of the physical properties of different materials as possible candidates for cosmic dust.

At present we have investigated carbonaceous materials such as various types of amorphous carbon and silicon carbide, expected to be formed around carbon stars (Borghesi et al., 1983a,b) and in supernovae explosions (Greenberg, 1978).

2. EXPERIMENTAL

A detailed description of the experimental procedures has been reported elsewhere (Borghesi et al., 1983a,b); we summarize here the main items.

2.1. Amorphous carbon.

Two different production methods have been used for this material:
AC, by striking an arc between two amorphous carbon electrodes in a controlled Ar atmosphere at different ambient pressures;

R. H. Giese and P. Lamy (eds.), Properties and Interactions of Interplanetary Dust, 159–162.

BE-XY, by burning benzene and xylene in air at room pressure.

2.2. Silicon carbide.
Different samples of commercial mixture of α-SiC polytypes have been processed in this case. The raw material has dimensions much larger than 1 μm so that the particles were initially ground and sedimented in acetone to select appropriate size ranges for the grains.

The tendency of grains to clump together was prevented by appropriate ultrasonic treatment.

High magnification TEM analysis enables to determine particles shapes, their dimensions and size distributions. The morphological properties of grains are reported in Table I.

Table I. Morphological properties of the samples.

material	elongation	grain shape
AC	80 Å	spheroidal
BE-XY	300 Å	spheroidal
SiC	4000 Å	irregular

SEM analysis is in progress to study in detail the surface morphology of the particles in order to clarify the open question about the degree of "porosity" of the dust which was pointed out by Abadi and Wickramasinghe, 1976, Abadi et al., 1976, and Blanco et al., 1980.

Diffraction methods are used to determine the crystallographic structure of the grains. AC, BE and XY samples appear amorphous, while SiC samples appear essentially exaedric.

Transmission analysis is performed on double-beam Perkin-Elmer spectrometers - Mods. 330 and 683 - to cover the wavelength range 2000 Å - 40 μm.

3. RESULTS

Figure 1 reports the Q_{ext}/a values versus λ determined in our observations for amorphous carbon in the range 2000 Å - 40 μm for BE, XY and AC samples.

Absolute values for BE and XY samples agree within the experimental errors; while for AC samples they appear systematically lower; however the spectral slope is the same for the three kind of particles, i.e. $Q_{ext}/a \propto \lambda^{-1}$.

Our data are in good agreement with previous observations performed by Koike et al., 1980, on amorphous carbon obtained by means of the same production methods.

It is interesting to note that our spectra show a bump falling around 2500 Å while graphite measured by Huffman, 1975, presents a bump at around 2300 Å. Present data do not allow to individuate which, between the two materials, is the most likely to produce the observed interstellar feature. However, theoretical papers presented by Czyzak and Santiago, 1973, and Seki and Hasegawa, 1981, seem to indicate that some sort of amorphous carbon may be more likely.

Figure 2 reports the average of several measurements of the Qext/a for α-SiC in the range 25 - 40 μm.

The characteristic absorption band at 11.4 μm is clearly appearing, as well as the weak phonon resonances falling at 10.6 and 12.7 μm. The continuum, out of the band, presents a $\lambda^{-1.3}$ trend.

Our results are in good agreement with those presented by Dorschner et al., 1977, and Friedemann et al., 1981. A comparison with the observations of β-SiC performed by Stephens, 1980, shows that, in this case, the main band is splitted in two peaks while the central one is absent. This behaviour may be interpreted as due to the different crystallographic composition (polytypes for α-SiC, cubic for β-SiC).

By comparing astronomical observations with α-SiC and β-SiC bands the former appears to be the most indicated to simulate the cosmic spectra.

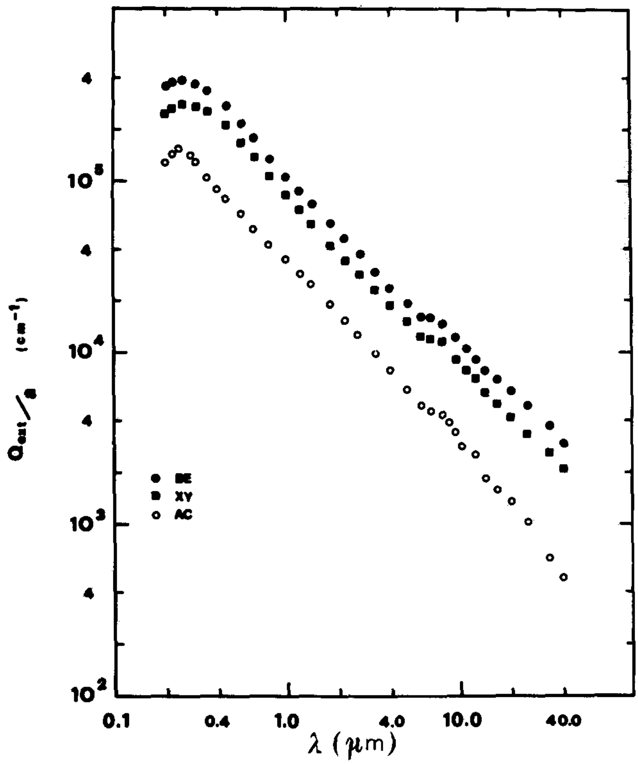

Figure 1. The extinction efficiency of BE, XY, AC samples (mean values).

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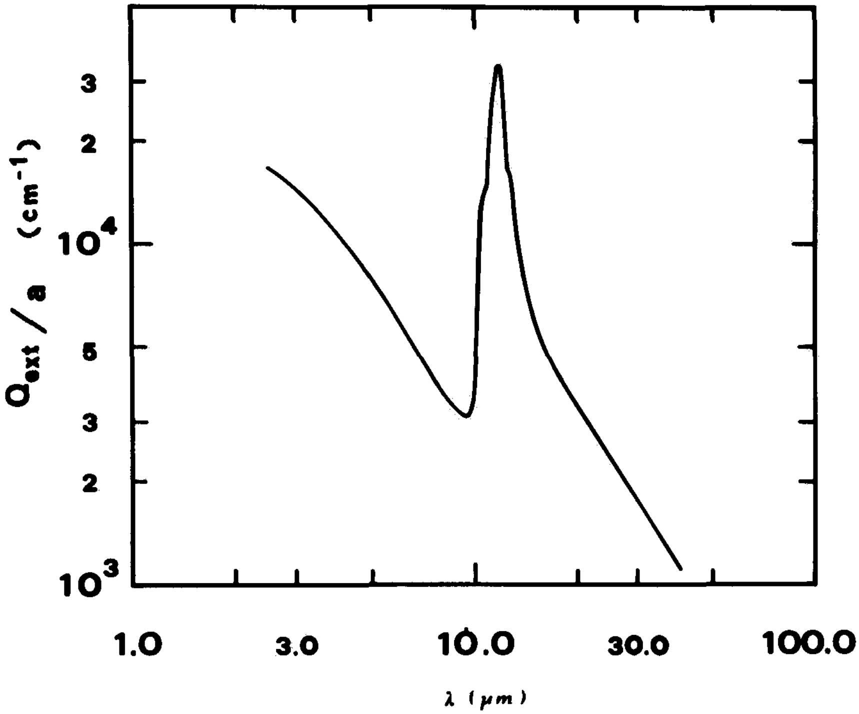

Figure 2. The extinction efficiency of α-SiC samples (mean values).

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