MINERALOGY OF PLATELET GRAINS IN CARBON-RICH CP INTERPLANETARY DUST PARTICLES, Roy Christoffersen and Peter R. Buseck, Depts. of Geology and Chemistry, Arizona State Univ., Tempe, AZ, 85287

Introduction. The carbonaceous material in chondritic-porous (CP) interplanetary dust particles (IDPs) typically occurs as part of an extremely fine-grained matrix (<50 Å grain size) that also has a substantial non-carbon crystalline component. In some rare CP particles, however, the matrix is mostly amorphous and very rich in carbon (or carbon-bearing) compounds (1). We have encountered two such carbon-rich particles (NASA Nos. U2001E3 and U2001E5) in the course of our transmission electron microscope (TEM) investigation of C-type IDPs. When prepared for TEM examination, these particles disaggregated only partially, and tended to flatten into large pancake-like clumps in a manner typical of other carbon-rich IDPs (2). This has facilitated detailed examination of their structures.

In addition to being rich in amorphous carbon, the particles are distinctive in containing many plate-like single crystal grains of Mg-olivine, enstatite, and magnetite. The magnetite grains in U2001E3 contain structural features not previously reported in IDP magnetites.

Carbon. The precise nature of the carbonaceous material in both particles is imperfectly known. The material is described here as amorphous since it shows only diffuse scattering in electron diffraction patterns and shows no diffraction contrast features in bright-field images. Electron energy loss and energy-dispersive X-ray spectroscopy show only C; however, the presence of H, or other light elements in minor amounts cannot be ruled out. We find the material to be unstable in the electron beam, indicating it may contain hydrocarbons or other volatile components as suggested by Bradley et al. (1). Unlike silicon-oil contaminants the material tends to be massive and clump-like. It can occur as separate masses, grain coatings, or interstitial to grains in the undisaggregated portions of the particles.

Platelets. The flattened particles take the form of aggregates of enstatite, Mg-olivine and magnetite crystals held together by amorphous carbon. Notably the crystals are seldom smaller than 1000 Å and most are between 1000 and 3000 Å in size. However, enstatite and Mg-olivine grains with dimensions between 5000 and 8000 Å also occur. Pyrrhotite grains are present but are rare.

Although specification of particle shape in TEM images is difficult, the extreme electron transparency and uniform contrast of some of these grains indicate they are very thin (100 to 300 Å), and are plate-like in shape. Several grains have partially euhedral outlines, while others are irregular and angular.

TEM study of the more distinct enstatite and Mg-olivine platelets shows the presence of isolated dislocations with no other defects in some grains, while other crystals show intense strain-field contrast and complex patterns of Moiré fringes. Some nominally single crystals have diffuse or streaked diffraction spots and show Moiré fringes. Such grains appear to consist of overlapping thin-crystal plates that are crystallographically related.

The structure of certain magnetite grains in U2001E3 is of particular interest. These are characteristically thin on (111) and show partially euhedral outlines. In [111] bright field images these grains are
criss-crossed by a network of planar defects that appear to be parallel to \( \{110\} \). Selected-area [111] diffraction patterns of these grains in most cases show faint reflections at the normally extinct (110) positions. Preliminary contrast experiments suggest the planar defects are stacking faults, although they could also be thin, structurally coherent regions of a second phase.

In a [111] lattice-fringe image of one grain, the \( \{110\} \) fault-traces outline polygonal regions that show different degrees of focus. Some of these regions show a single set of Moiré fringes. Assuming that focus conditions were appropriate, a possible interpretation is that this image shows the presence of surface-steps on the (111) face of the grain. Work is in progress to more precisely define the nature of these features.

Discussion. We have suggested (3) along with Bradley et al. (1) that certain of the carbon components in CP particles may have formed via gas reactions in the early solar system that used dust grains as catalysts. For this mechanism to explain the abundant carbon in carbon-rich IDPs it is important that at least some of their constituent mineral grains, especially the magnetite, have a demonstrable origin as primitive condensates. The dominant platelet morphology of the larger grains in the particles we have examined is suggestive of such an origin (4) and we are studying several aspects of their structures that may shed more light on this possibility.

References.

(2) J. Bradley, personal communication, 1983.