A very porous lithology of the Acfer 094 meteorite.

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Acfer 094 is one of the most primitive carbonaceous chondrites since it contains abundant amorphous silicates in the matrix [1] and includes abundant presolar grains [e.g., 2,3]. We have focused on 3D structures of this meteorite to understand the origin and the earliest stage of accretion. The 3D structures of samples ~25 μm in size fibbed from a polished thin section were obtained using SR-based nanotomography (μCT) with the spatial resolution of ~100 nm [4,5]. New lithologies with various textures and Fe contents that have not been observed on the thin section were recognized. Among them, we found a very porous lithology (VPL) with textures in μCT, which are similar to that of CP-IDP. Three fragments of VPL 10 μm in size were recognized in the 2 fibbed matrix samples with distinct boundaries. In this study, we performed TEM observation of VPL.

The bulk desities of VPL and surrounding lithology are estimated to be ~1.4 amd ~2.4 g/cm^3, respectively, based on the phase contrasts in μCT. A TEM section was fibbed from the μCT sample by considering its 3D structure and observed with (S)TEM/EDS. The mineralogy and texture of the surrounding lithology are essentially the same as that of the matrix [1]; abundant amorphous silicates with small grains of forsterite, enstatite and Fe- or (Fe,Ni)-sufides. A small amount of organic materials is also present. In contrast, VPL mainly consists of loose aggregates of amorphous silicates (a few hundred nm), which contain sulfide nanoparticles. Aggregates of tiny enstatite crystals (~100 nm) are also present. Pores in VPL are filled with aggregates of carbonaceous materials, which are similar to organic nanoglobules (e.g., [6]). The coexistence of oragnic nanoglobules and amorphous silicates, which are easily hydrously-altered, is consistent with the cold origin of the nanoglobules related to ice [6]. The features of VPL indicate that VPL is the most primitive lithology, which might be a precursor of the main matrix.

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