CHARACTERIZATION AND POSSIBLE ORIGIN OF A CARBONACEOUS COATING ON AN UNUSUAL NANOCRYSTALLINE SILICATE AGGREGATE IN THE MATRIX OF THE MET00426 CR3 CHONDRITE.

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Introduction: Pristine chondrites are the best samples to study the nebular dust from which asteroidal parent bodies accreted. MET00426 (CR3.00) is known to have preserved one of the highest concentrations of presolar silicates [1], as well as potential nebular condensates, as a result of minimal parent body aqueous alteration and metamorphism. Its matrix contains amorphous hydrated silicate, phyllosilicates, sulphides and organic matter particles [2, 3]. During FIB-TEM studies of MET00426 matrix, we encountered an unusual particle coated with organic material, embedded within the normal fine-grained matrix. Here we report the results of TEM and STXM studies of this particle and discuss the possible formation mechanism of the carbonaceous material.

Results: The aggregate (500 nm in size) is composed of nanocrystalline Mg-Fe-Ca silicates (20-40 nm, probably diopside or augite) associated with sulphides and organic matter. The silicates are more Mg-rich (Mg# > 80 at. %) than the surrounding matrix and some individual domains are richer in Ca. Energy filtered TEM shows a continuous coating (~20 nm in thickness) of carbonaceous material on the aggregate. High resolution TEM indicates that the carbonaceous material is slightly ordered, with small (1 to 5 nm) graphene layers stacked together and oriented parallel to the surface of the silicates. This degree of structural ordering is different from the more disordered organics found elsewhere in the matrix [3]. STXM mapping confirms the dominant aromaticity of this carbon coating and the absence of oxidized functional groups usually present in CR organics [3].

Discussion: This intriguing aggregate shares several microstructural similarities with presolar grains, such as grain size, high-Mg and Ca content, chemical variation at the nanometer scale and nanocrystalline features [4]. However, an attempt to measure the O-isotopic composition by NanoSIMS was unsuccessful. Nevertheless, we interpret this particle as having a nebular or presolar origin. Therefore the occurrence of the carbon-coating provides information about organic formation prior to parent body accretion. This kind of coating has also been described around silicates in CP-IDPs [5], but the silicate mineralogy is different. Two possible synthesis mechanisms for the formation of this coating were suggested by [5]; Fischer-Tropsch processes [6] and polymerization of simple organic molecules by UV irradiation within an icy mantle on silicate grains that can occur in the interstellar medium [7]. In both cases, these observations demonstrate that organic synthesis reactions on the surface of silicate grains did contribute to the structural and chemical diversity of carbonaceous material in chondrites.

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