Formation of Presolar Grains in Circumstellar Space

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We discuss elementary processes of condensation of presolar grains and physical conditions of the formation environment. Focus is placed on the structure of the TiC core/graphite mantle grains and SiC grains. Physical conditions for reproducing their structure, sizes, and the condensation sequence have been determined. Discussion is given also on the conditions of coexistence of graphite grains and SiC grains.

We discuss elementary processes of condensation of presolar grains and physical conditions of the formation environment. It is pointed out that the structure and morphology of the particles is an important source for revealing the physical conditions of the stellar sources of presolar grains. Focus is placed on TiC core/graphite mantle grains and SiC grains. The TiC core/graphite mantle grains has an appropriate complexity for extracting information on the formation conditions. SiC grains, on th other hand, are one of the ubiquitous kinds of presolar grains.

Physical conditions for reproducing their structure, sizes, and the condensation sequence have been determined. In doing so, we note 1) the core-mantle structure, which implies that TiC condensed at higher temperature than graphite, 2) TiC core radius, and 3) graphite mantle radius. The core and mantle radii reflect the density, cooling rate, and C/O abundance ratio of the gas in which the the grains condensed. We have determined mass loss rates, outflow velocities, and C/O abundance ratios of the C-rich AGB stars that reproduce the morphology of the presolar grains analyzed. It is shown that the observed morphology is reproduced in carbon stars not only at the post-AGB stage but also at earlier stages.

Discussion is given also on the conditions of coexistence of graphite grains and SiC grains. The calculations of the condensation temperatures shown that graphite always condenses at temperatures higher than SiC condenses, resulting in the depletion of carbon available for SiC condensation. On the other hand, both graphite and SiC presolar grains are present in the meteorites. It is shown that the paradox is resolved by taking into account of grain temperatures in the circumstellar space.

Discussion is given on the carrier of the 20.1 micron emission band observed in the post-AGB stars by the ISO. It is shown that TiC grains as a carrier of the band as proposed by Helden at al. (2000) is implausible.