P155-003 **Room: 301A** **Time: May 14 9:26-9:39**

Synthesis of TiC-core, carbon-mantle spherule analogy based on fullerenes and their 21-microns feature

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We demonstrate a new formation route for TiC-core, graphitic-mantle spherules that are extracted from primitive meteorites but that does not require c-atom addition and the very long timescales associated with such growth in stellar atmospheres [1].

Most of the carbon in the outflows of carbon-rich asymptotic giant blanch (AGB) stars is in the form of CO and C2H2 [2]. Carbonaceous materials such as polycyclic aromatic hydrocarbons and fullerenes are believed to form from C2H2 and its derivatives because CO is a very stable molecule [3,4]. Therefore, all of the theoretical calculations for the formation of graphitic mantles were carried out based on C2H2 gas abundances, i.e., no one ever considered CO gas as a carbon source. Here, we will demonstrate that large cage structure carbon particles can be produced from CO gas by the Boudouard reaction. Production of fullerenes from CO gas by the Boudouard reaction in the circumstellar envelopes of carbon-rich AGB stars will provide a unified explanation for the formation of TiC-core, graphitic-mantle spherules and an origin of the 21-microns feature observed in post-AGB stars.

The formation environment of TiC-core, graphitic-mantle spherules was calculated after their discovery in acid residues derived from the Murchison carbonaceous meteorite [5]. The graphitic spherules include metal carbide crystals such as TiC and were identified as presolar grains from their isotopic content. They were assumed to form within the circumstellar envelopes of carbon-rich AGB stars [1,5]. The metal carbide crystals consist of Ti and/or Zr-Mo carbide, are generally located at the center of individual graphite spherules and are surrounded by well-graphitized carbon. It has therefore, been assumed that TiC condensed prior to the surrounding carbon. However if fullerenes are formed in the circumstellar envelopes of carbon-rich AGB stars, then a new formation route can be considered: Large fullerene cages are deposited onto previously-nucleated TiC to produce TiC-core, carbon-mantle spherules. Because the sublimation temperature for such fullerenes is low they actually condense after the formation of the TiC cores. New constraints for the environment and timescale for the formation of TiC-core, graphitic-mantle spherules are suggested by the results of this study. In particular, TiC-core, graphitic-mantle grains found in primitive meteorites that have never experienced hydration could be mantled by fullerenes or carbon nanotubes rather than by graphite. In situ observations of these grains in primitive anhydrous meteoritic matrix could confirm or refute this prediction and could demonstrate that the graphitic mantle on such grains is a metamorphic feature due to interaction of the pre-solar fullerenes with water within the meteorite matrix.

We also observed a 21-microns feature in the solids condensed during the experiment described above. The feature has nearly the same shape and position as is observed for one of the most enigmatic features in post-AGB stars. The infrared spectra of large fullerenes interacting with Ti atoms show a characteristic feature at 20.3 microns that closely corresponds to the 21-microns feature observed in post-AGB stars. Both the laboratory and stellar spectra also show a small but significant peak at 19.0 microns, which is attributed to fullerenes. We propose that the interaction between fullerenes and Ti atoms may be a plausible explanation for the 21-microns feature seen in some post-AGB stars.

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