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SiO dust formation from CO gas as a reactant

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Circumstellar dust of silicates and other oxides finding in carbon rich star (C/O>1) suggests the possibility that the stellar atmosphere underwent an oxygen rich (C/O<1) environment of previous mass loss rate phase. This is based on the thermal stability of CO molecule. When this ratio is larger than unity, all oxygen will be trapped in the very stable CO molecule.

Since CO is one of the most abundant molecule in the dust-forming region, we considered that the reaction pathway of using CO molecule as a reactant for oxidation of silicon. Silicon oxides are the main components of silicate dust and precursor substances.

Our laboratory experiments of grain formation in a CO gas atmosphere show that amorphous SiO grains can be directly produced from silicon oxidation. SiO smoke produced by the evaporation of a fragment of Si (10 mg) from the tungsten boat at a gas pressure of 10 kPa of CO.

The color of the collected grains was yellow brown and their electron diffraction pattern showed a halo. No existence of tungsten in the produced SiO grain was detected by energy dispersive x-ray spectroscopy. The mid-IR feature of the SiO grain embedded in KBr pellet is similar to that of beta-cristobalite, i.e., the grain may be composed of microcrystallites of Si and beta-cristobalite. Moreover, the residue of evaporation was examined by transmission electron microscopy and turned out the beta-SiC which has cubic structure of high temperature phase. Graphite layer was formed to be parallel to the surface of {111} SiC planes.

Demonstration of formation of circumstellar oxide dust on oxidative or reductive condition requires the introduction of gas species other than oxygen controlled partial pressure.

Keywords: carbon monoxide, silicon monoxide, circumstellar dust, grain formation, transmission electron microscopy, infrared-spectroscopic analysis