Low temperature crystallization of amorphous silicates in astrphysical environment

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Recent observations show the ubiquity of crystalline silicate in various objects, among which comets provide the best opportunity to study possible processing of pristine matter during their formation and evolution. While thermal processing of bare amorphous silicates in the hot inner solar nebula has been invoked, its drawback is a difficulty in explaining the interstellar composition of cometary ices. Here we apply Greenberg's model of core-mantle interstellar grains to propose low temperature crystallization of the amorphous silicate core due to the energy released by chemical reactions in the organic refractory mantle when moderately heated by solar radiation.

Recently, Kaito et al.[1] prepared particles of amorphous Mg silicate coated with amorphous carbon in methane atmosphere. They found that their crystallization temperatures are lowered substantially due to the energy released by graphitization of amorphous carbon. Inclusion of CH_4 in the amorphous carbon mantle further reduces the crystallization temperature to room temperature.

We model the experiment of Kaito et al. and clarify the conditions of low temperature crystallization. We show that the present mechanism of crystallization is capable of reproducing the strengths of crystalline silicate features observed in comets. Our model can reconcile crystalline silicate in the comae of comets with the interstellar composition of ices in their nuclei. Discussion is given on the astrophysical implications of the low temperature crystallization.

References

[1] C. Kaito, Y. Miyazaki, A. Kumamoto, and Y. Kimura, *Astrophys. J.* **666**, L57 (2007)