Physical Conditions of Supernova Ejecta as Viewed from the Measured Sizes of Presolar Al_2O_3 Grains

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A few particles of presolar Al2O3 grains with sizes larger than 0.5 μm are considered to have been formed in the ejecta gas of core-collapse supernovae (SNe). With the aim at clarifying the formation condition of such submicron-sized presolar Al2O3 grains, we calculate the condensation process of Al2O3 grains for wide ranges of the density and cooling rate of the gas. We first show that the average radius and condensation efficiency of newly formed Al2O3 grains are nicely described by a non-dimensional quantity Lamda_on, defined as the ratio of the timescale on which the supersaturation ratio increases to the collision timescale of reactant gas species at dust formation. Then we find that the formation of submicron-sized Al2O3 grains requires at least 10 times higher gas densities than those obtained from one-dimensional SN models. This indicates that presolar Al2O3 grains identified as SN-origin might be formed in dense gas clumps, allowing us to propose that the measured sizes of presolar grains can be a powerful tool for constraining the physical conditions in which they formed. We also briefly discuss the survival of newly formed Al2O3 grains against destruction in the shocked gas within supernova remnants.