CHONDRULE FORMATION BY COLLISIONS BETWEEN PLANETESIMALS, T. Yamamoto[1)], T. Kozasa[2)], R. Honda[3),1)], and H. Mizutani[1)], 1)Institute of Space and Astronautical Science, Yoshinodai 3-1-1, Sagamihara, Kanagawa 229, Japan, 2)Max-Planck-Institut für Kernphysik, Postfach 103980, D-6900 Heidelberg 1, Germany, 3) Department of Earth Science, Nagoya University, Furo-cho, Chikusa-ku, Nagoya 464, Japan

It is believed that chondrules are a primitive material that conserves memories of the events occurred in the early solar system. Many attempts have been made to decode the memories on the basis of chemical, mineralogical, and petrological analysis (see reviews in the book [1]). Important constraints on the formation conditions have been obtained from laboratory experiments (e.g. [2]). We take into account of the following constraints on the chondrule formation: (1) Chondrules passed through a liquid phase as suggested by their spherical appearance. (2) The cooling rate at crystallization of many of the chondrules are in the range of $-dT/dt \sim 1 - 10^{-3}$ K s^{-1}. (3) Many chondrules have sizes between $0.3 \sim 3$ mm. (4) The oxygen partial pressure in the environment where chondrules were formed is much higher than that expected for a solar nebula gas. It should be noted that the cooling rate derived from the experiments is much faster than the cooling rate of the solar nebula itself, but much slower than that expected in the cooling of a mm-sized body placed in a vacuum.

We propose a model of chondrule formation through condensation of grains in the cooling of a hot vapor produced at collisions of planetesimals. This mechanism has an advantage that there is no need to set special situations supposed in some of other models, since planetesimal collisions are a frequent event in the formation process of the planets. The chondrule formation by this mechanism is studied on the basis of the thermodynamics of the vapor cloud and a kinetic theory of condensation including nucleation and grain growth. It is examined whether this model satisfies the experimental constraints as stated above.

The results are summarized as follows: (1) It is confirmed that the grains pass through a liquid phase during condensation. The latent heat deposition during the growth of chondrules is found to cause them to pass through a liquid phase, and to control the cooling rate. (2) The observed cooling rate $-dT/dt < 1$ K s^{-1} is realized for the collisions producing the vapor mass larger than 10^{21} g. The grains condensed under this condition do not escape from a sphere of influence of planetesimal gravity, when the planetesimal mass is larger than 10^{24} g. (3) Grains of chondrule size are produced for the vapor mass of 10^{22} g or less. (4) High oxygen partial pressure is self-evident in this model, since the oxygen partial pressure of the vapor is much higher than that of the solar nebula gas so far as we assume that planetesimal composition is similar to chondrite composition. The origin of relict grains within the framework of this model is briefly discussed.

References: [1] *Meteorites and the Early Solar System* (1988) eds. J.F. Kerridge and M.S. Matthews, Univ. Arizona Press. [2] Nagahara, H. (1983) *Mem. Natl. Inst. Polar Res. Special Issue* **30**, 61.