ACCRETION OF FINE PARTICLES : PRELIMINARY EXPERIMENTS. N.Sugiura, T.Okada and K.Kiyota Geophysical Institute, University of Tokyo

In the beginning of the solar system, condensable materials were in the form of fine particles. The fine particles settled onto the equatorial plane to form a dust layer which broke up to form planetesimals. In a static nebula, if a fine particle settles alone it takes millions of years to settle down, while if fine particles stick together on mutual encounter, it takes only thousands of years to settle down (1). Thus sticking probability of fine particles is an important parameter which affects formation of planetesimals and planets.

If the solar nebula was turbulent, it is estimated that aggregates of particles must be larger than 1 meter in diameter to be able to settle down onto the equatorial plane (2). Thus, sticking probability of fine particles is quite important in this case, too.

Aggregation of fine particles could also be a quite important factor in early atmospheres of planets. Early atmospheres are expected to be rich in fine particles due to (a) comminution of existing solid materials and (b) evaporation and recondensation, by impact events. Thermal structure of atmospheres depends strongly on the size of fine particles, because opacity is nearly proportional to the total cross-section of the particles which depends strongly on sticking probability of fine particles.

Many factors, composition, shape and size of particles, adsorbed materials on the surface of particles, electric charge, ambient gas pressure... etc., could affect sticking probability of particles. Sticking probability of fine particles is, however, very poorly known. At smaller sizes, (much less than 1 micrometer), it is generally considered that the probability is high (nearly 1) but at sizes larger than 1 micrometer, there exist almost no data on the sticking probability.

A pilot experiment on accretion of particles was made using particles produced by condensation in air. A YAG laser was used as a heat source for evaporation of materials. The laser beam is 4 mm in diameter and the power is less than 50 W. Aggregates of fine particles settled on sampling plates were observed with an electron microscope. Sizes of floating aggregates were also monitored by measuring intensity of scattered light.

Oxide particles were produced by combusting metals. Grain sizes are not well controlled, but are generally around 1 micrometer. So far, MgO and SiO_2 powder have been examined.

Observation with the scattered light suggests that MgO generally makes small aggregates (less than 10 micrometer), while SiO_2 aggregates are larger than 10 micrometer (Fig.1).

Observation with electron microscope is generally in accord with the scattered light observation and shows that MgO aggregates are small and equidimensional while SiO_2 aggregates are large and made of long chains of the grains (Fig.2).

The preliminary results indicate that sticking probability and accretional growth rates could be quite different for various materials. It seems that chemical fractionation could have occurred in the early solar nebula due to the difference in

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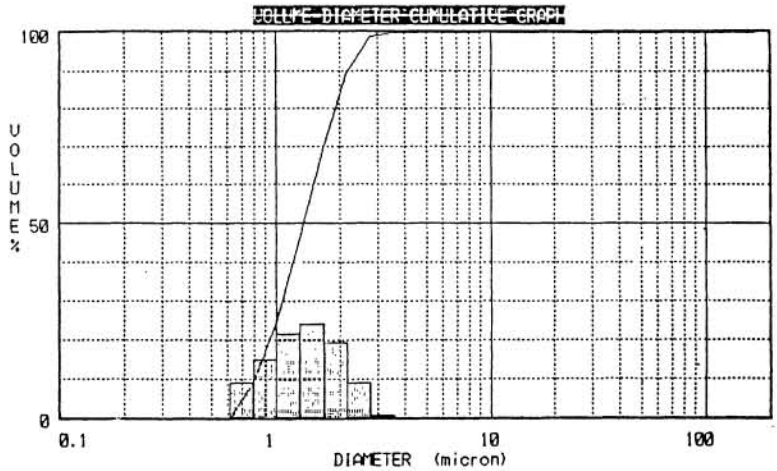
sticking probability of minerals.

(1) Y.Nakagawa, K.Nakazawa and C.Hayashi, 1981, Icarus, 45, 517.
(2) S.J.Weidenschilling, B.Donn and P.Meakin, 1989, in The formation and evolution of planetary systems, eds H.a.Weaver and L.Danly,Cambridge Univ. Press.



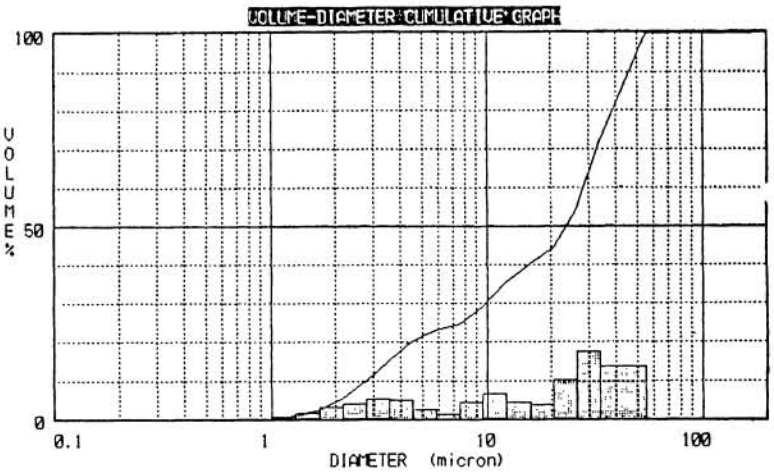


Fig.1 Size distribution of fine particle aggregates obtained by scattered light observation. MgO (top) and SiO_2 (bottom).

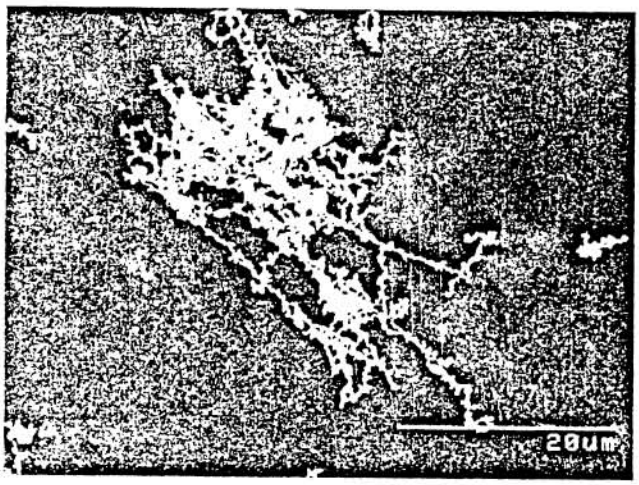


Fig.2 An aggregate of SiO_2 particles. Long chains of particles are observed.

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