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Growth of heterogeneously condensed grains

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Dust is the crucial component of the protoplanetary disc, which carrries the temperature when they are small and which coagulated toDust is the crucial component of the protoplanetary disc, which carries the temperature when they are small and which coagulated to form planetesimals. Dust is generally assumed to be small, 0.1-1 um, and their growth during sedimentation to the midplane or radial movement has been extensively studied. The validity of the size has, however, not been fully evaluated. Infrared observation simply suggests the presence of such small dust grains near the surface of discs, but does not say anything about larger grains. Furthermore, it shows the present of silicate, but does not for metallic iron, which is probably one of most abundant grains.

We have investigated the growth of silicate and metal by a heterogeneous condensation model taking the all the kinetic processes into consideration, which is thought to be plausible condensation process at low pressure conditions of protoplanetary discs. The results show the formation of metal onto previously condensed silicate (forsterite), which results in grains with core of forsteirte and mantle of metal. Assuming that metal covers forsterite homogeneously, the mantle blocks reaction with forsterite and residual gas to form enstatite, which results in condensation of SiO2 or Si-rich Mg silicate. The size of core-mantle type grains is dependent on pressure and cooling time scale of the gas, and it reaches cm or tens of cm in order at the largest with considerable size distribution.

We have further developed a model combining physics and chemistry, in which dust size and chemistry is defined by thermodynamics and kinetics of grain growth. By using the model we have estimated the change of dust size and structure during vertical and radial movement in the disc. The results predict more efficient formation of larger grains, which will result in more efficient planetesimal formation.