The Role of Temperatures of Gas and Condensed Phase in Condensation Kinetics of Metallic Iron

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Metallic iron is one of the most abundant phases that condense from cooling gas of the solar abundance, and its size distribution and number density are crucial parameters to determine thermal structures of protoplanetary discs because of its large opacity. We carried out condensation experiments on metallic iron on a substrate of alumina under controlled gas and solid temperatures and supersaturation ratio S with the same experimental techniques as [1]. The condensation temperatures were 962 and 1064°C, which are close to that of metallic iron in a proto-solar disc. Figure 1 shows FE-SEM images of the surface of metallic iron condensed at 962°C with *S*~26 from gas at ~1360°C for different durations. Step structures on all the surface suggest the presence of kinetic hindrance. The steady growth of heating duration 9~54 hours enables us to calculate the growth rate by using the weight gain of condensed phase. The condensation coefficient, which represents the kinetic hindrance defined as the ratio between the measured growth rate and the ideal growth rate that is expressed by the Hertz-Knudsen equation, is ~0.8 at 962°C. Ikeda et al. [1] showed that the condensation coefficient is close to unity at 962°C for the gas temperature of ~1300°C, and thus the present result may suggest an importance of the difference in temperature between gas and condensed phase.

An experiment with a small saturation ratio *S*~5, which was not obtained in [1], at 1064°C from gas at ~1320°C showed that the condensation coefficient is ~0.5. The small condensation coefficient prolongs the formation time of metallic-iron dust.

Keywords: Metallic Iron; Condensation; Kinetics

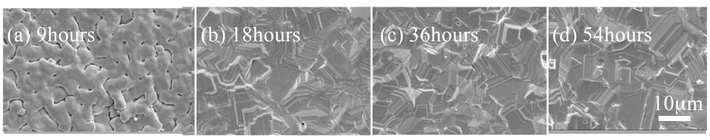

Figure 1. FE-SEM images of the surface of the condensates at 962°C with S~26 from gas at ~1360°C. Heating duration is (a) 9, (b) 18, (c) 36, and (d) 54 hours, respectively

References

[1] Y. Ikeda, H. Nagahara, K. Ozawa, and S. Tachibana, *LPS XVIII. Abstract#2403 (2007)*