ASTROPHYSICAL INTERESTING COMPOUND GRAINS PRODUCED BY A GAS EVAPORATION METHOD

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ABSTRACT. Production methods of Fe_3O_4 grain and MgS grain have been introduced. Fe_3O_4 grain was produced in an Ar gas pressure range of 25 to 100 Torr by evaporating FeO powder. The growth of Fe_3O_4 have been discussed as the result of oxidation of Fe grains. MgS grain produced by the reaction of Mg and S vapors grew in the coagulation of tiny cubic sulfide.

1. INTRODUCTION

The most advanced method for producing grains of metal or oxide is the so-called "gas evaporation method", in which a material is heated in inert gas atmosphere(Kimoto et al.(1963)). The heated vapor is subsequently cooled and condensed in the gas atmosphere, resulting in a smoke which looks like that of a candle. The direct evaporation of the oxide or sulfide in the gas was not always given the same components of the evaporant, i.e. decomposition took place (Kaito(1983)). We proposed various methods for producing compounds(Kaito (1981), Kaito et al.(1989)), by using the convection flow of inert gas. New attempts for production of Fe_3O_4 grain and the production of MgS grain are described in this paper.

2. EXPERIMENTAL PROCEDURE

The sample preparation chamber is a glass cylinder of 17 cm in inner diameter and 33 cm in height. A tantalum v-boat (length 50 mm, width 2mm and depth 1 mm) charged with powder of FeO (99.9%) was placed in the chamber. Ar gas at 10-100 Torr was introduced into the chamber and the boat heated up at about 1800°C. Grains in the produced smoke were collected on thin carbon film supported by electron microscopic grids at various position in smoke and observed with a Hitachi H-800 electron microscope. The three-heater method which has been shown in a previous paper (Kaito et al (1990)) was applied for the production of MgS grains.

A.C. Levasseur-Regourd and H. Hasegawa (eds.), Origin and Evolution of Interplanetary Dust, 117–120.

3. RESULTS AND DISCUSSION

Typical smoke which formed by evaporating FeO in Ar gas at 100 Torr is shown in Fig.1(a). The evaporation source was almost perpendicular to the photographic plane. Figs. 1(b) and 1(c) show electron microscopic image and electron diffraction(ED) pattern from the grain collected in smoke shown in Fig.1(a). ED pattern shows the formation of magnetite. External shape of the well-grown grains was cubic octahedron.

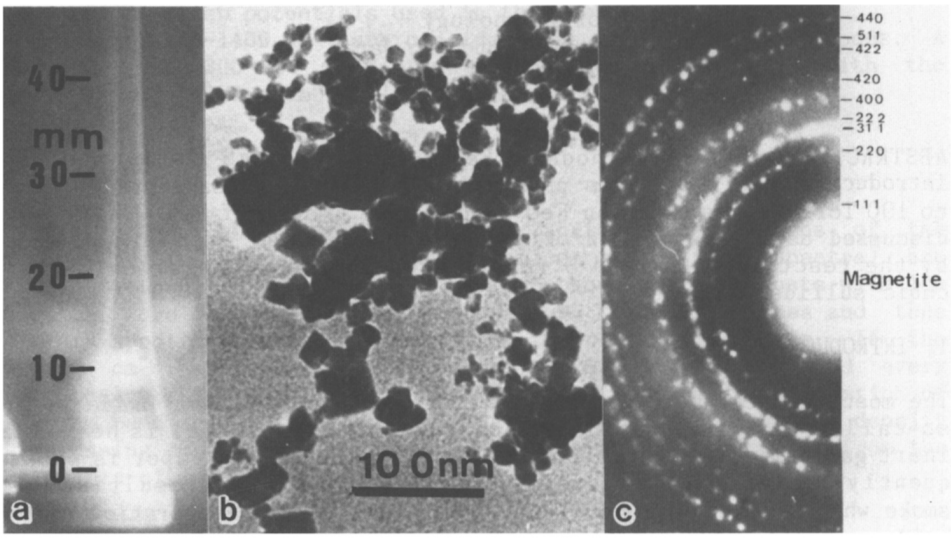

Fig.1. (a) Smoke of Fe_3O_4 grains formed by evaporating FeO powder in Ar gas at 100 Torr, (b) and (c) show electron microscopic image and electron diffraction pattern.

TABLE 1. Results of analyses of iron oxide grains

Ar Gas Pressure (Torr)	10	15	17-20	25-100
Produced Grain	α -Fe	α -Fe (FeO)	FeO	Fe_3O_4

() means the oxide produced on the surface of α-Fe

A summary of the produced grains due to gas pressure is shown in table 1. The magnetite grains were predominantly produced above 25 Torr. At 10 Torr gas pressure, iron grains were produced. At 15 Torr gas pressure, FeO oxide (Wustite) was produced on the surface of iron. The grain of wustite predominantly appeared in gas pressures of 17-20 Torr. Produced grains were changed by the gas pressure of inert gas.

https://doi.org/10.1017/S0252921100066616 Published online by Cambridge University Press

These results show that the evaporated FeO powder was decomposed and oxidation took place in the atmosphere. The temperature of the grains became a few hundred degrees at a point about 10 mm above the evaporation source . The oxidation of iron grain took place near the heat source. Therefore the formation of various oxides by the gas pressure is due to variation of the oxygen gas density per unit volume in smoke. The shape of the smoke changes drastically below the gas pressure of 25 Torr. The width of the smoke at 100 Torr at 10 mm from the evaporation source is about 7 mm as seen in Fig1(a), but the values become about 1.7 and 3 times greater at gas pressure of 20 Torr and 10 Torr, therefore the density of the decomposed oxygen vapors per unit volume becomes smaller. Sine the melting point of iron is 1536^{o}C, the decomposed iron gas was condensed as the iron grain near the evaporation source. The decomposed oxygen can be in the state of gas in the flow of Ar gas. Therefore the oxidation of iron took place and oxide grains can be produced in a high gas pressure.

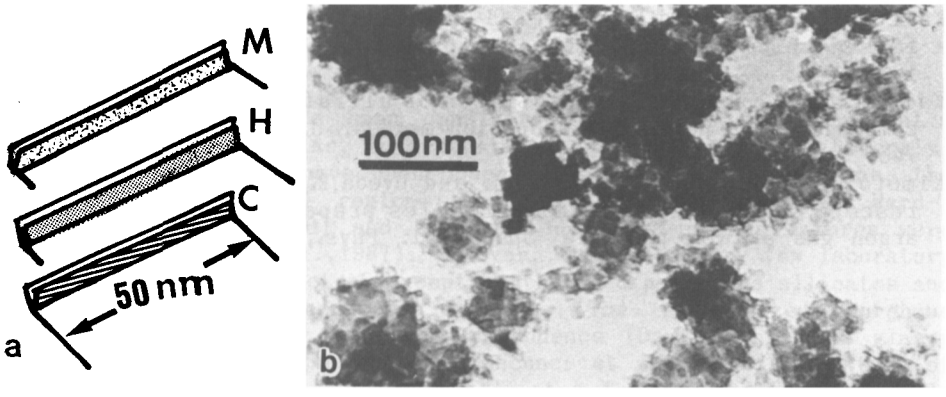

Fig.2. (a) Schematic representation of the production method for MgS.(b) Electron microscopic image.

Fig.2(b) shows MgS grains produced by using the three-heater method which indicated schematically in Fig.2(a). The temperature at locations 5mm above and 5 mm below the heater H which was heated at 1200^{o}C in Ar gas pressure at 100 Torr became 500^{o}C and 300^{o}C (Kaito and Saito (1990)). Heaters M and C which were used as the evaporation source of Mg and S were set at the above locations. In order to control the vapor pressure of both the Mg and the S to bring them closer to the same level, the boat M was heated. When the temperature of the boat M was maintained at about 650^{o}C, the vapor pressure of Mg was 2.04 Torr which was nearly same of the vapor pressure of the S at the boat C (350^{o}C). The evaporated sulfur vapor rose due to the convective flow from the heater H and reacted with the Mg vapor around heater M.

https://doi.org/10.1017/S0252921100066616 Published online by Cambridge University Press

The shape of the smoke was similar to that shown in Fig.1(a). Since MgS has the crystal structure of NaCl type, the external shape of the sulfide became a cubic form (Kaito et al.(1988)). The melting point of MgS was higher, therefore the surface melting coalescence predominantly took place(Kaito, (1985)). Then the small crystallites were coalesced as seen in Fig.2.

4. References

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