

§24. The Study of Microwave Irradiation on Functional Ceramic Particle Formation

Ozawa, M. (CRL, Nagoya Institute of Technology)

Introduction

The new synthesis method, aiming for shape-control of oxide powder, was investigated by the process under microwave-irradiation condition. The heating of the inside of the molecule level, the rapid heating is possible as the characteristic of the microwave irradiation. There is a phenomenon, which is heated (the super heating) higher than the boiling point, or extremely rapid heating because the selective heating of material is a possible with non-balance heating in the microwave irradiation. As for such microwave synthesis, the development of the new technique about the material fabrication is expected. In this study, I synthesized copper oxide fine particle and compared with the conventional typical heating method. The study to have paid attention to the function of the conductivity and the catalyst and so on is accomplished and it can do various functioning by copper oxide powder with the shape and also the effect of the process of the heating in case of particle synthesis can be examined.

Experimental

The microwave irradiation maintains a reaction fireplace to the constant temperature while it controls a temperature by the thermocouple signal in the water, which is in the input electric power control of 2.45 GHz in water. The temperature reached at 95°C within 5 minutes from the room temperature. Each of the copper nitrate hydrates ($\text{Cu}(\text{NO}_3)_2 \cdot 3\text{H}_2\text{O}$) and the hexamethylenetetramines was dissolved in distilled water separately, then mixed each other by stirring for 1 hour, and heated in the oven to the system of reaction. The mixed solution at 95°C using the heater and the microwave was kept for the period of 0.3 to 3 h. Also, as for the precursor body which was gotten by mixing solution, the CuO powder was made by heating at 360°C using the electric furnace. The observation of the synthesized sample, being under in the use structure of crystals, by the X ray diffraction, the electron diffraction, and SEM-EDS and TEM.

Results

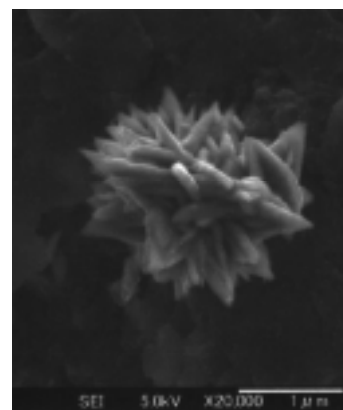
By heating 30 minutes at 95°C the raw material solutions in microwave irradiation heating, the CuO fine particle with the shape which is peculiar with more than one piece of prominence was synthesized. On the other hand, the leaf-like particle was synthesized via the mantle heating process. Also, by heating the precursor in the electric furnace, the ordinary globular CuO particle was gathered changed a way of heating only from the same leaving raw materials and that the various shape control became possible found.

All the powders by an electric furnace, a mantle heater and by the microwave irradiation were identified as the monoclinic CuO crystal from the result of the X ray diffraction. The grown mode to the direction of (110) and the direction of (111) after analyzing by using high resolution TEM became clear.

Generally, the curvature of the CuO particle, which was made by the electric furnace heating, was large. Also, the copper oxide particle, which was synthesized in the reaction by the outside heater heating, was characteristic shape like a leaf. The copper oxide, which was synthesized by the microwave irradiation, was the asteroid structure which consists of a lot of needle crystals. It had the form, which reflects the difference of each stone formation and growth.

The cause why asteroid copper oxide minute particle generated includes the rapid temperature rise which is due to the effect of the precursor particle and self generation of heat. As concerning the nucleus occurrence and the growth, it is controlled as following: that it changed into copper oxide at the low temperature of equal to or less than 100°C as it maintained the figure of the precursor. It is seen in the vapor-phase growth from the nucleus occurrence starting point but such growth is to be fitted in the shape maintenance as the precursor like this study. Regarding with the absorption of the microwave energy, it is necessary to examine the process of the energy change for the reaction.

Photo 1
CuO particle formed
by microwave-
process.



Summary

It was found that the shape of CuO, which is peculiar, generated quickly in case of microwave induced particle synthesis. There is large possibility of the functional ceramic particle synthesis by developing and analyzing the inner material heating under the microwave used.

Presentation

R.Kato et al, The Material Society of Japan, Tokai branch art and science lecture, March.5, 2010, Nagoya