Topics

Hollow Alumina Particles with the Nano-shell Structure

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Hollow oxide particles have been widely used for lightweight and thermally insulating fillers. However, commercial hollow particles, such as the Shirasu Balloon, have large particle diameters ranging from 30 to 3000 μm, which allows fracture of the hollow shell during the mixing process. Also, large filler particles degrade the strength of a base material. Even recently reported hollow particles with diameters of 5-20 μm[1)2)] are still larger than the size of intrinsic defects in a base material, causing degradation in strength. Furthermore, the specific surface areas of the commercial particles are too small (< 10 m^2/g) to be used for adsorbents and catalyst carriers, which require a large specific surface area (> 100 m^2/g).

We have synthesized new hollow alumina particles with a nano-shell structure (MP-A: Micro Pop-Alumina), through our original process, the emulsion combustion method. MP-A is synthesized by atomizing and firing the water/oil (w/o) type emulsion consisting of an aluminum nitrate aqueous solution, kerosene and a surfactant.

Figs. 1 (a) and (b) are the transmission electron microscopic images of MP-A. The low magnification image (a) shows that MP-A is a hollow particle with a submicron diameter and a very thin shell. The high magnification image (b) shows that the thickness of the shell is 10-20 nm. MP-A is characterized by a large specific surface area, low bulk density and high thermal stability, as summarized in **Table 1**.

The low density and the smaller diameter (than the intrinsic defects) of MP-A make it superior to commercial hollow particles as lightweight and thermally insulating fillers. The high thermal stability and the large specific surface area could extend its application to catalyst carriers and adsorbents. In addition, the low bulk density suggests the potential use of MP-A as a highly porous material by sintering.

The unique features of the new hollow alumina particles (MP-A) would lead to applications in various kinds of devices in the future. We are trying to apply the synthesis technique to other compositions, such as titania and zirconia, and to create novel oxide particles with unique shapes and morphologies.

References

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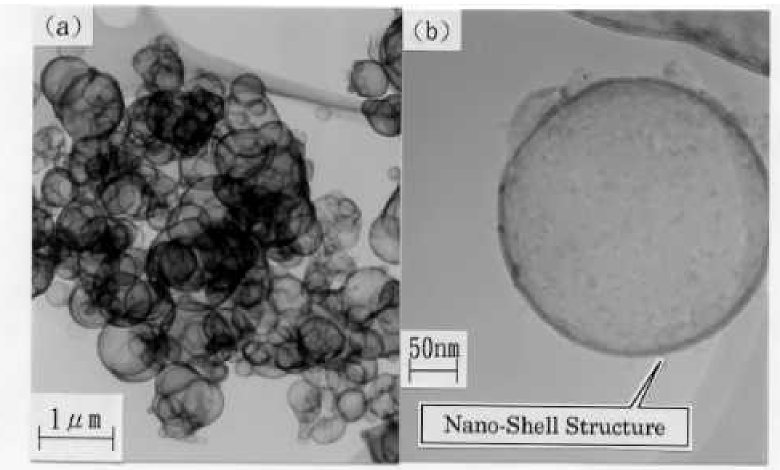

Fig. 1 Transmission electron microscopic images of the synthesized MP-A particles.

Table 1 Powder characteristics of MP-A.

Particle diameter	200–800 nm
Shell thickness	10–20 nm
Crystalline phase	γ–alumina
Specific surface area	~ 50m^2/g
Bulk density	~ 0.1g/cm^3
Thermal stability	1000°C (in air)