Pressureless Sintering of Ceria

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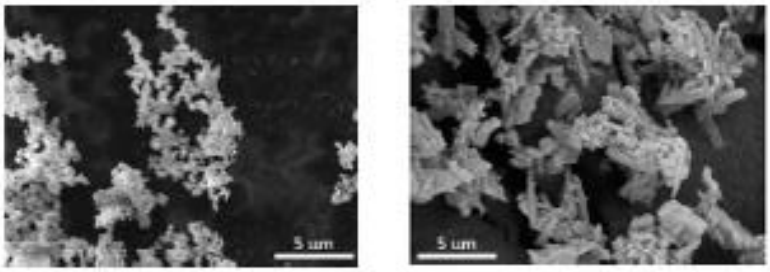
Cerium oxide (CeO_2), known as ceria, is widely used in several applications, such as automobile exhaust catalysts, electrolytes in solid oxide fuel cells, electrodes in gas sensors, and ultraviolet absorbents, owing to superior thermal and chemical stability, high ionic conductivity, good oxygen storage or release capacity and strong UV absorption.

Being a refractory oxide, ceria usually requires a high processing temperature, in the range up to 1500-1700 °C. Thence, reduction of the sintering temperature for ceria has practical meaning. One way to reduce the sintering temperature is by using different heating schedules, namely constant-rate of heating (CRH), rate-controlled sintering (RCS), and two-step sintering (TSS). In fact, the microstructure and grain size of this type of ceramics may vary depending on the material and method used.

In this work, the sintering behaviour of two micron-sized commercial powders with different purity, namely 99.0 and 99.9%, was investigated. Both the green density and the sinterability of the CeO_2 powder compacts increased with the decrease in particle size. Both the CRH and TSS heating schedules were investigated and their effect on the microstructural features of the sintered specimens were observed by scanning electron microscopy (SEM).

Pressureless sintering of die-pressed compacts was carried out in an electric heated furnace using molybdenum disilicide ($MoSi_2$) heating elements in static air at temperatures in the range of 1300-1600 °C for 1-3 h.

Relative densities as high as 98% were achieved for samples obtained from the 99.9% pure ceria powder (d_{50} = 1 µm), compacted at 50 MPa and sintered at 1600 °C for 3 h, independently of the heating schedule used. As for the ceria with 99.0% purity (d_{50} = 6 µm), it was not possible to go beyond 94% relative density, although the compacts were pressed at 200 MPa, in order to attain a similar green density.



SEM micrographs of CeO_2 powder with 99.9% purity (left) and 99.0% purity (right).

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