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Superplasticity in Fine-grained Oxide Ceramics

Hidehiro Yoshida[1*]

[1]National Institute for Materials Science

Within the field of material science, superplasticity is defined as the ability of a polycrystalline material to exhibit a high tensile ductility, and provides an attractive route for net-shape forming and the joining of materials. Ceramic materials are generally very brittle in comparison with metals and alloys, but when their grain size is controlled to less than about 1 micrometer, they become highly deformable at high temperatures. Superplasticity in ceramics was first demonstrated by Wakai et al. in 1986, and this discovery was followed by developments of various superplastic ceramics. In ceramic materials in which the grains are rigid, the combination of grain boundary sliding and grain switching can be regarded as the main mechanism of superplastic deformation. In actual ceramic materials, however, experimental studies have shown that superplastic deformation is inherently accompanied by accelerated grain growth (dynamic grain growth) and intergranular cavitation. The former increases the level of flow stress for a given strain rate and enhances the latter. The purpose of this paper is to provide an overview of superplasticity in fine-grained oxide ceramics, placing emphasis on the microstructural conditions essential for the occurrence of superplasticity.

Keywords: superplasticity, oxide, grain boundary, ductility, grain growth, diffusion