

Preface

Ceramic materials, generally speaking, have a higher melting temperature than metal and polymer materials. Among ceramics, non-oxide ceramics have a higher melting or decomposition temperature than oxide ceramics. Therefore, non-oxide ceramics have been investigated extensively for structural use at high temperatures. Silicon nitride (Si_3N_4) ceramics have been widely investigated because they have relatively high toughness within ceramic materials and sustain high strength at high temperatures. Heat- and creep-resistant materials are needed for high-temperature structural use.

A ceramic is a typical brittle material, but fine-grained ceramic deforms plastically at high temperatures. A complicated-shaped ceramic part is fabricated by grinding with diamond tools. This way of shaping restricts the shape of the part, sometimes introduces surface cracks, which can be a fracture origin, and is a primary reason for the high cost of ceramic parts. If a plastic forming can be applied for a ceramic, like metal and polymer materials, the ceramic part will be used more widely, because complicated-shaped ceramic parts will be obtained with low cost without strength reliability degradation. Plasticity of fine-grained ceramic material has been investigated after F. Wakai reported superplasticity of Y_2O_3 -stabilized tetragonal ZrO_2 polycrystals. Fabrication of fine-grained silicon nitride ceramics and plastic deformation of them have been investigated following this trend.

The heat and creep resistance means that a material does not deform at high temperatures, whereas plastic deformation at high temperatures means that a material does deform easily at high temperatures. These properties are opposite in deformability at high temperatures. The material, silicon nitride, ceramic has been investigated for the two opposing characteristics. The heat- and creep-resistant silicon nitride ceramic was developed in a project on heat-resistant materials, and fine-grained silicon nitride ceramic with high deformability was developed in a project on nanoceramics in National Institute for Materials Science (NIMS).

These two results on silicon nitride ceramics are presented in this volume, *High-Temperature Mechanical Properties of Non-oxide Ceramics*. Deformation of

silicon nitride ceramics is explained briefly in Chap. 1. Fabrication and plastic deformation of silicon nitride ceramics are explained in Chap. 2. Fabrication and heat resistance of silicon nitride ceramics are explained in Chap. 3. Control of high-temperature deformation of silicon nitride ceramics is summarized in Chap. 4.

With this work, we hope to contribute to further development of non-oxide structural ceramics.

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Silicon Nitride

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