

Low Temperature and High Speed Forming of High Strength Structural Ceramics



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Hidehiro Yoshida

Functional Powder and Advanced Ceramics Field / Field-Assisted Sintering Group
YOSHIDA.Hidehiro@nims.go.jp | https://samurai.nims.go.jp/profiles/yoshida_hidehiro



Background

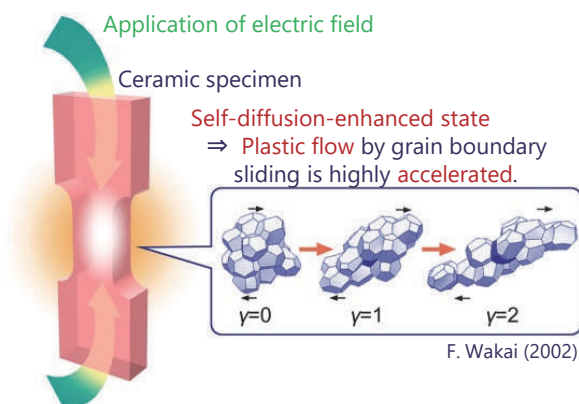
- High strength structural ceramics is brittle, difficult to plastically deform
- Superplastic forming of ceramics requires high temperature and low strain rate
- Attainment of superplastic flow without changing materials microstructure

Aim

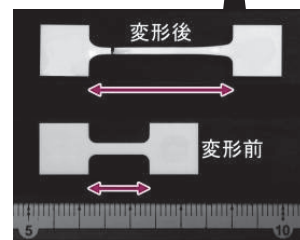
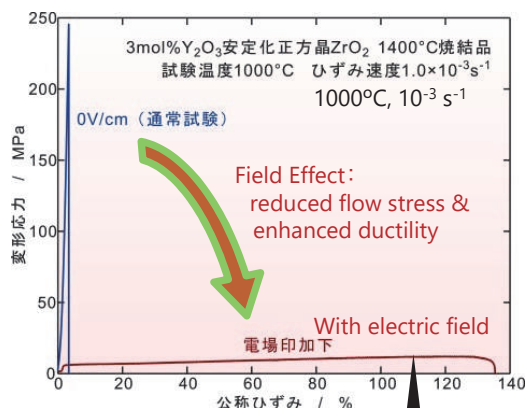
- To attain superplastic flow in structural ceramics at lower than 1000°C
- To develop electric-field-assisted superplastic forming technique for brittle ceramics

Advanced Research Topics

Ceramic materials can transit to self-diffusion-enhanced state beyond threshold temperature and field strength conditions. This means that superplastic flow at low stress level can be achieved at 1000°C and $>10^{-3}\text{ s}^{-1}$. (Patent:2016-226977)



- For instance, tetragonal ZrO_2 polycrystal (TZP), a typical structural ceramics, can show plastic deformation >150% of nominal strain at <math><1000^{\circ}\text{C}</math> and $>10^{-3}\text{ s}^{-1}$. These conditions are comparable to those for superplastic flow in Ni or Ti-based alloys.



Publications

- F. Wakai et al., *Acta Mater.*, **50** (2002) 1177.
- H. Yoshida, Y. Sasaki, *Scripta Mater.*, **146** (2018) 173.

Applied area and future prospects

- Application: plastic forming of fine ceramics
- Applicable to structural ceramics and ceramic composites
- Compression and bending are available

Issues for technology transfer

- Application to large-scale components
- Application to complex shape
- Improvement of working accuracy