

# DOE Heavy Vehicle Propulsion Materials Program

Deformation Processes for the Next Generation Ceramics

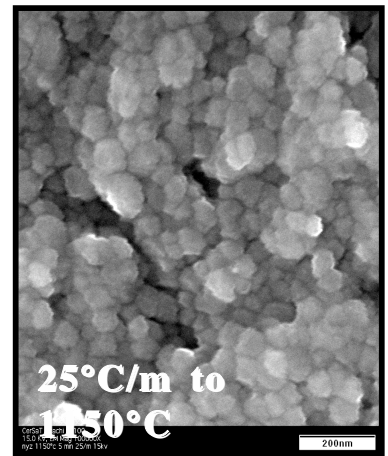
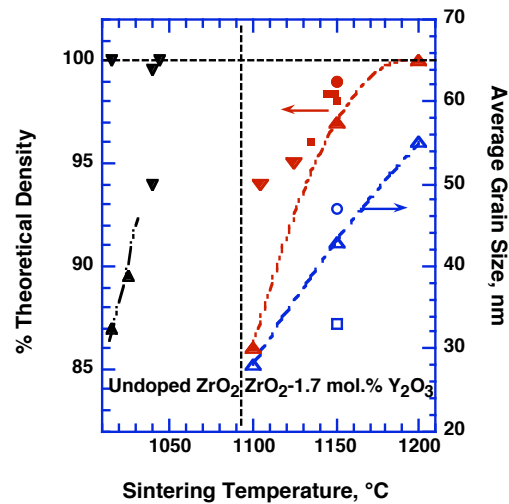
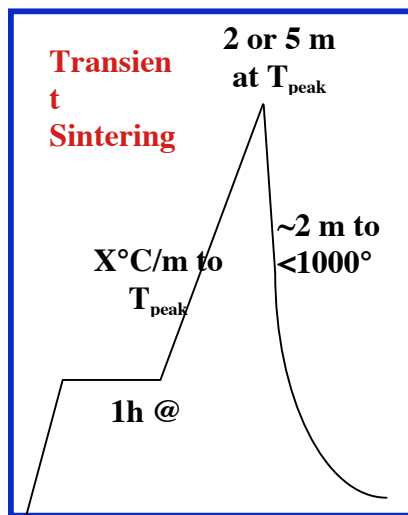
Paul F. Becher, Oak Ridge National Laboratory

Recent Results:

**Bulk dense  $ZrO_2$  with grain size < 100 nm typically fabricated using high applied pressures**

**One study achieved 60 to 90 nm grain sizes by pressureless sintering but with 5+ hour hold times.**

**Our studies reveal that sophisticated colloidal processing combined with transient**



- $\Delta$   $\blacktriangle$  -10°C/m, 2 m hold @ @  $T_{peak}$  in air
- $\circ$   $\bullet$  -10°C/m, 5 m hold @ 1150°C in air
- $\square$   $\blacksquare$  - 25°C/m, 5 m hold @ 1150°C in air

- $\nabla$   $\blacktriangledown$  Sintered in vacuum
- $\blacktriangle$  Sintered in air

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