Super Ceramics With Self-Dispersed Nanoparticles Via Casting

Tech ID: 29950 / UC Case 2018-593-0

SUMMARY

UCLA researchers in the Departments of Mechanical and Aerospace Engineering and Materials Science and Engineering have developed a novel casting method to fabricate high performance bulk ceramic materials containing dispersed nanoparticles.

BACKGROUND

The advanced ceramics market is expected to grow to over $10.4 billion by 2021 due to diverse applications in dishware, dental implants, electronics, and manufacturing. These materials have low density, high hardness, and good chemical stability, but suffer from brittleness and are susceptible to failure upon exposure to elastic strain. Materials with improved ceramic strength include single crystal and nanocrystalline ceramics, or dispersion of nanoelements within the ceramic matrix. However, these approaches are often small-scale, expensive, or difficult to control. Therefore, there is significant motivation to develop techniques that improve ceramic mechanical properties using cost effective and scalable methods.

INNOVATION

Professor Li and colleagues have developed a method of preparing high performance ceramics by casting from a ceramic melt containing a dispersion of thermodynamically stable nanoparticles. This process relies on good wetting between the ceramic melt and the selected nanoparticles, high thermal energy, and small attractive potential between the nanoparticles, allowing them to randomly move for uniform self-dispersion within the melt. Ceramic ingots have been produced up to at least 18 mm x 20 mm in size and display a 4x increase in stress limit (13.1 GPa) and 2x increase in strain limit (10.3%) compared to ceramics without embedded nanoparticles. Additionally, the stress-modulus relationship is E/14 (E=elastic modulus), close to the theoretical value of E/10 and significantly improved compared to other ceramics (E/30).

APPLICATIONS

- Advanced ceramic materials
- Bulk sample preparation

ADVANTAGES

- 4x increase in stress limit (13.1 GPa) compared to cast ceramics without dispersed nanoparticles
- 2x increase in strain limit (10.3%) compared to cast ceramics without dispersed nanoparticles
- Stress-modulus ratio close to E/14
- Scalable for production of bulk samples
- Casting method is less expensive than comparable technologies

STATE OF DEVELOPMENT

Materials have been cast at least 18 mm x 20 mm in size and their mechanical properties have been characterized.

RELATED MATERIALS

- Jiang, Qiang-Guo et al. Strong and Tough Glass with Self-Dispersed Nanoparticles via Solidification. Advanced Materials, 1901803, 1-5 (2019) - 06/20/2019
- Chen, L. et al. Processing and properties of magnesium containing a dense uniform dispersion of nanoparticles. Nature, 528, 539-543 (2015) - 12/24/2015

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INVENTORS

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OTHER INFORMATION

KEYWORDS

Ceramics, Nanoparticle, Casting, Dispersion, Ceramic melt

CATEGORIZED AS

- **Engineering**
  - Engineering
  - Other
- **Materials & Chemicals**
  - Ceramics
  - Nanomaterials
- **Nanotechnology**
  - Materials

RELATED CASES

2018-593-0

PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Published Application	20250083994	03/13/2025	2018-593

ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- Concentration Of Nanoparticles By Zone Heating Method
- Evaporation-Based Method For Manufacturing And Recycling Of Metal Matrix Nanocomposites

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