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# Field-Induced Texturing of Ceramic Materials for Unparalleled Properties

U.S. ARMY RDECOM

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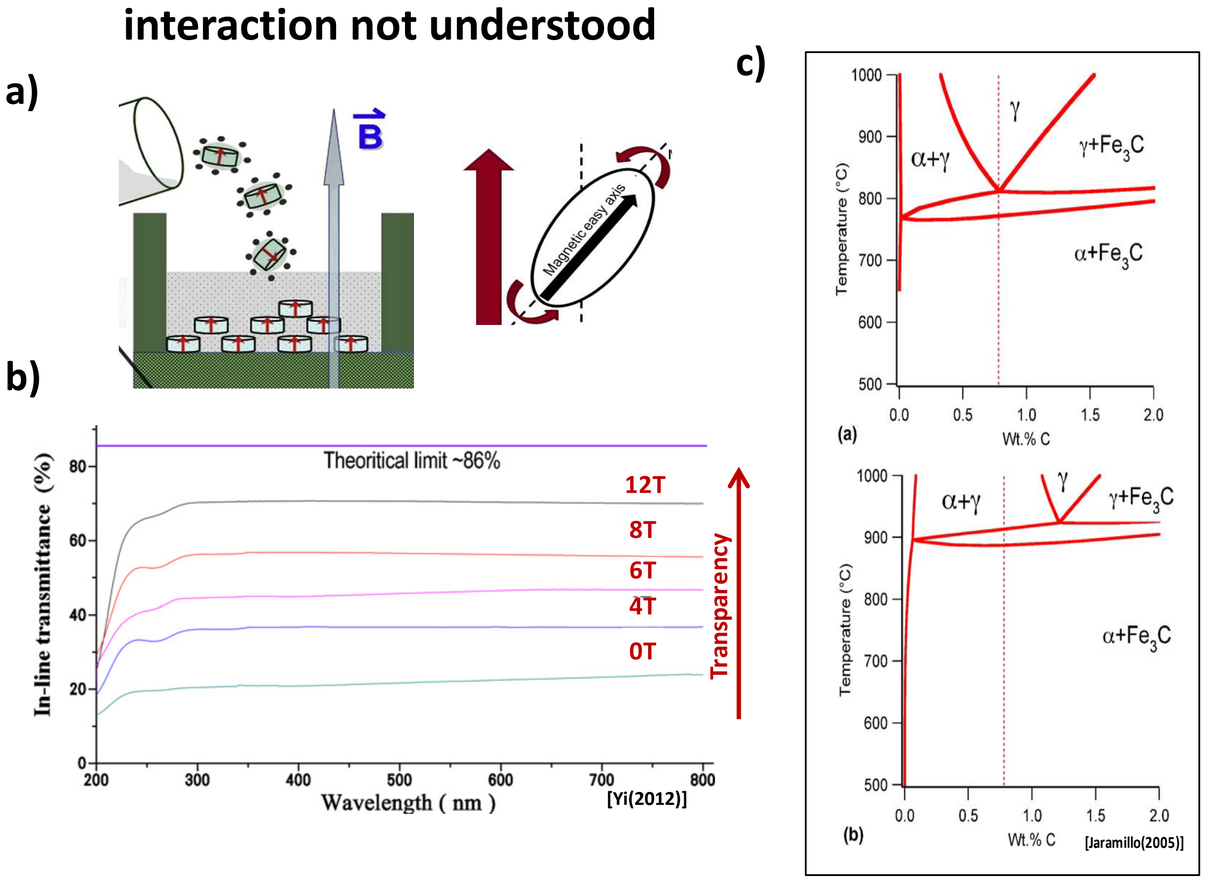
## S&T Campaign: Materials Research

*Tier 2 High Strain Rate & Ballistic Materials*

Claire Brennan, (410) 306-0773
claire.v.brennan.civ@mail.mil

## Research Objective

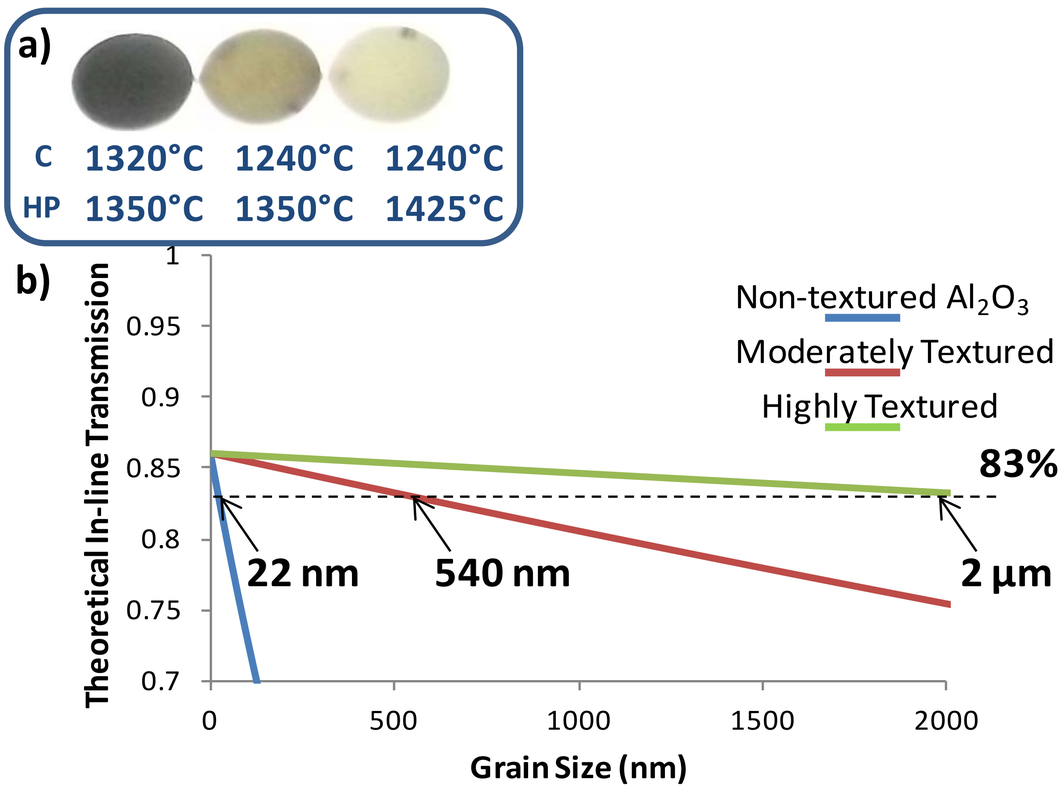
- Gain an understanding of the effects of external field-based processing on microstructural development through experiments, modeling, and establishment of a field-effects laboratory
- Field-effect processing in use, but physics of material interaction not understood




Schematic of magnetic field slip-casting (a), transmittance with magnetic field (b) and effect of magnetic field on phase diagrams (c)

## Challenges

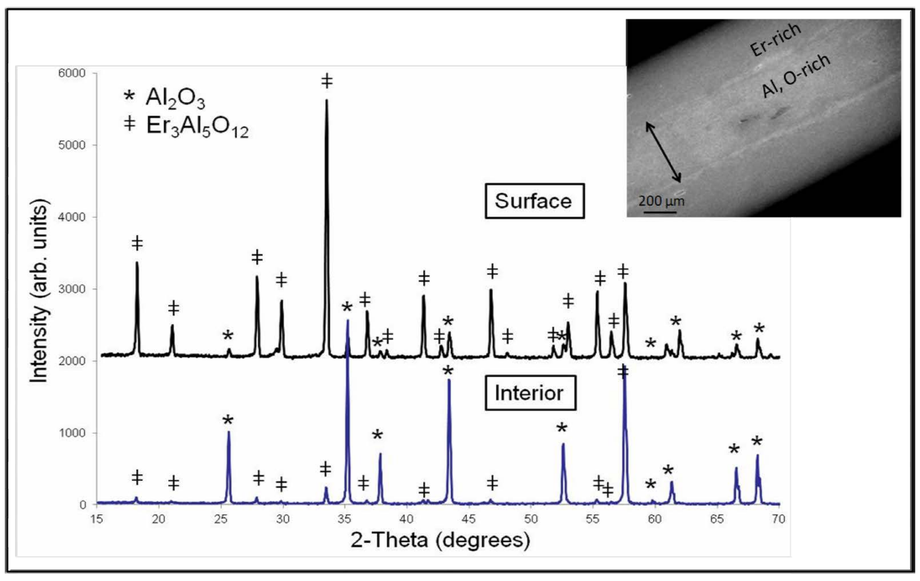
- Applied fields to induce texturing, and increase transparency of doped alumina
- For transparency: high density, small grains, texture
- No model to date on effect of EM fields on RE:Alumina



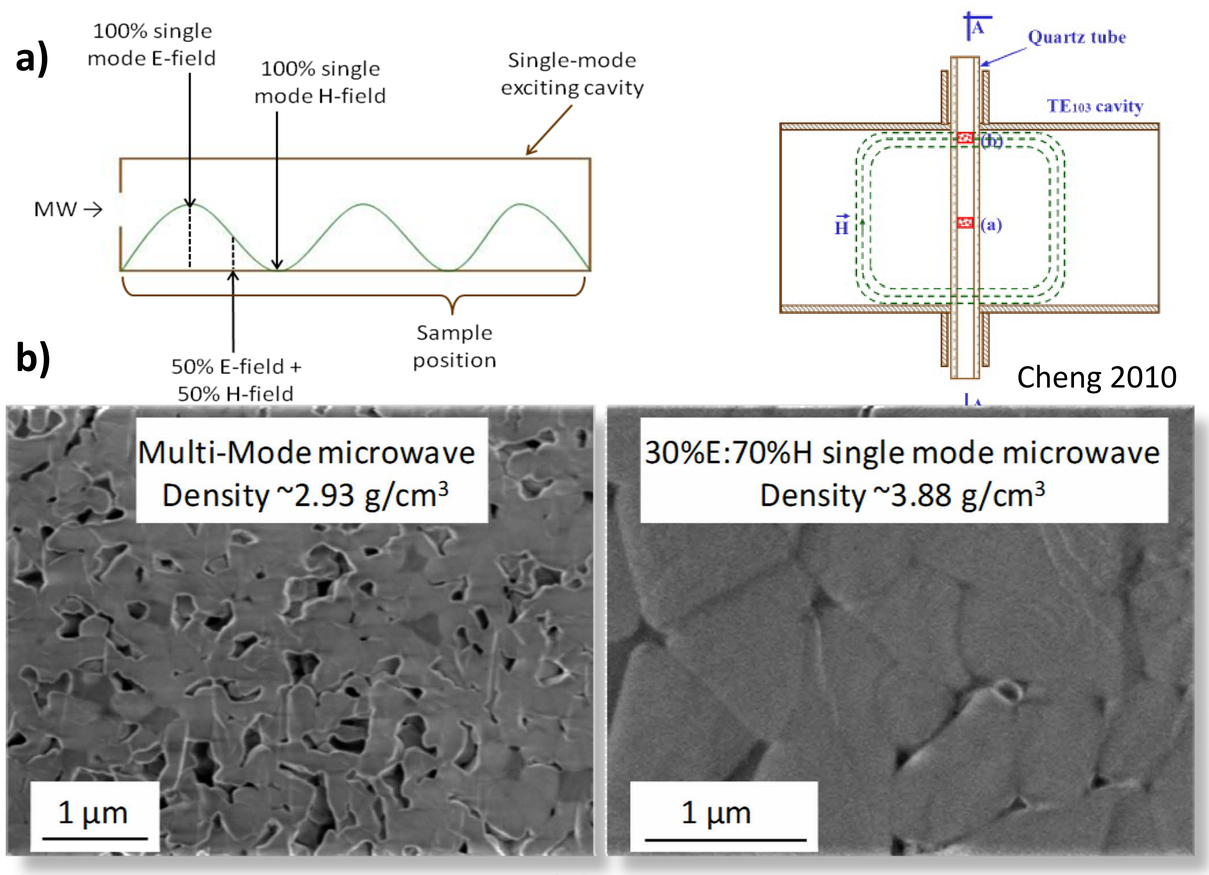

Er:Al2O3 samples, showing the translucency, (a), and transmission as a function of grain size for various textured $Al_2O_3$, (b)

## ARL Facilities and Capabilities Available to Support Collaborative Research

- 9T magnet with induction heating (2200°C) – *in progress*
- Single mode microwave (2.45 GHz & 5.8 GHz) – *in progress*
- SEDD: Thermal reflectance, fluorescence
- Modeling: ThermoCalc
- Techniques: atomic-scale co-doping for RE:Alumina




X-ray diffraction patterns and optical microscopy image showing the difference in phase and density in the interior versus surface of the pellets




Single mode microwave schematics, (a), and scanning electron microscopy images of multi-mode and single-mode microwave sintered Er:$Al_2O_3$, (b).

## Complementary Expertise/ Facilities/ Capabilities Sought in Collaboration

- Microwave processing facility at Penn State
- High magnetic field laboratory at Oak Ridge National Lab
- Other suggestions for innovative research approaches: ultra-high magnetic fields, new dopant materials, modeling of magnetic field interactions with dopants

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