Title: Stress-induced phase change sintering: a novel approach to the fabrication of barium chloride transparent ceramic scintillators

In the current global political climate, the desire for higher resolution, cheaper, and more rugged gamma-ray spectroscopy scintillator detectors has pushed the community to investigate new compounds and processing techniques. One path forward is alkaline earth halide transparent ceramics, which are both birefringent and hygroscopic. Fundamental limits to optical transparency are determined by scattering due to mismatch in refractive index at grain boundaries as well as residual porosity. Additionally, air contamination and high processing temperatures favor the formation of defects, which interrupt the energy transfer in the scintillation process. These challenges have prevented halide gamma-ray scintillator ceramics, including Ce:LaBr3, Eu:SrI2, and Ce:Cs2LiYCl6, from reaching the performance of their single-crystalline counterparts. In an attempt to circumvent these issues, this work investigates a new sintering concept based on a stress-induced polymorphic phase transition to fabricate ceramics of Eu:BaCl2, a recently-identified high-performance gamma-ray scintillator. The experimental implementation of this method necessitated the design of a unique airtight hot-pressing device capable of developing conditions for this phase conversion and the synthesis of high purity powders. Systematic experiments on powder synthesis and on densification were carried out to demonstrate the feasibility of this approach and understand the conditions for phase change sintering. These experiments, supported by characterizations including x-ray diffraction, electron microscopy, and thermal analysis, lead to the production of optically isotropic cubic barium chloride ceramic samples. Finally, the optical and scintillation properties of Eu:BaCl2 ceramic samples were investigated, revealing an energy resolution of 6% at 662 keV, an unprecedented value for a halide ceramic scintillator.

Major: Materials Science and Engineering

Educational Career:
Bachelor’s of Ceramic and Materials Engineering, BS, 2011, Clemson University
Master's of Materials Science Engineering, MS, 2013, University of Central Florida

Committee in Charge:
Romain Gaume, Chair, CREOL/MSE/NSTC
Kathleen Richardson, CREOL/MSE
Aristide Dogariu, CREOL
Sudipta Seal, MSE/AMPAC/NSTC
Gregory Bizarri, Lawrence Berkeley National Laboratory

Approved for distribution by Romain Gaume, Committee Chair, on October 20, 2016.

The public is welcome to attend.