



The Scintillation Materials Research Center (SMRC)

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The University of Tennessee (UT), CTI Molecular Imaging, and Oak Ridge National Laboratory are in the early stages of forming the Scintillation Materials Research Center (SMRC). The SMRC will be a unique multidisciplinary research facility located in the UT College of Engineering. The mission of the Center is the discovery and development of new high performance scintillation materials that will provide the foundation for the next generation of gamma-ray, x-ray, and neutron detectors. New radiation detectors will have a major impact on medical imaging systems, homeland security inspection and monitoring systems, neutron and high-energy particle physics experiments, and remote geophysical sensors. The center focuses on utilizing the extensive high technology resources of the Knoxville/Oak Ridge area to develop innovative materials for state-of-the-art radiation sensors and imaging systems. The mission encompasses education, research, and commercialization. Our first project has been partially funded through the UT/ORNL Chancellor's Summer Research Internship Program and is described here and highlights some of the capabilities of the SMRC.

Introduction

PET scanners are used to identify many forms of cancer, damaged heart tissues, and brain disorders (e.g. Alzheimer's, Parkinson's, and epilepsy). Disease changes the biochemistry of cells and tissues and PET scanners can help to detect abnormalities in cellular activity and can often identify diseases earlier and more specifically than other techniques (i.e. ultrasound, x-rays, MRI, etc.). In the 1970's PET emerged as a research tool and 1980's advances were made with the switch from digital coincidence to 3-D images. Then in the 1990's CTI Molecular Imaging introduced a new detector material, Lutetium Orthosilicate (LSO) or Lu₂SiO₅, which has improved diagnostic accuracy and image quality.

In the future it is desirable to find a new material that could perform better than LSO. Currently single crystals are used to test the properties of interest. Growing these single crystals is both costly and slow and this proposed project focuses on synthesizing materials using sol-gel techniques to obtain bulk samples. The physical properties such as the light output and decay time will then be compare to those of single crystals.

Experimental

For the synthesis of Y₂SiO₅, Gd₂SiO₅, and Lu₂SiO₅ with Ce added as an activator:

- 1) Lu₂O₃, Y₂O₃, Gd₂O₃, and Ce₂(C₂O₄)₃ •XH₂O were dissolved in HNO₃ and combined.
- 2) Tetraethyl orthosilicate (TEOS) was added using a pipette or a peristaltic pump to control the rate and slow the reaction.
- 3) The resulting solution was stirred and heated (70 °C) until gelation occurred.
- 4) The gels were dried overnight at 120 °C.
- 5) The resulting powders wer crushed and pressed into pellets for firing at temperature between 1200 and 1650 °C. .



← Solution heated and stirred. Gelation just starting to occur.

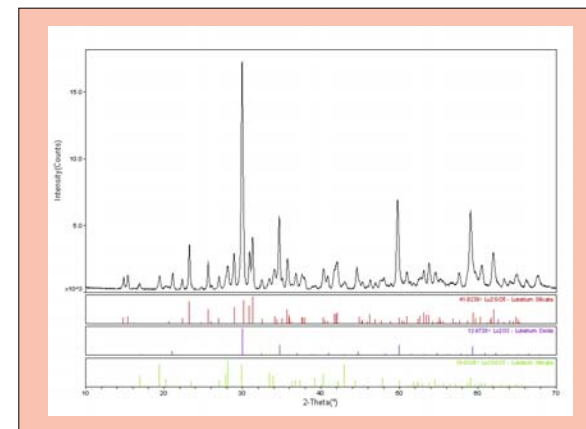
→ Addition of TEOS



X-ray powder diffraction measurements were conducted using a Scintag PAD V vertical $\theta/2\theta$ goniometer with CuK α radiation (45 kV and 40mA) and a Si(Li) Peltier-cooled solid state detector. The data were collected as continuous scans, with a step size of 0.02° 2 θ at a rate of 0.1 deg/min between 10 and 70° 2 θ . Specimens wer prepared by making a slurry mixture of powder and methanol and spreading the slurry on a quartz zero background plate.

Results

Using sol gel techniques multiphase samples have synthesized samples that contain Y₂SiO₅, Gd₂SiO₅, or Lu₂SiO₅. Shown below is the x-ray powder diffraction pattern for the Lu-analogue fired once at 1200 °C. The diffraction pattern contains Lu₂O₃, Lu₂SiO₅, Lu₂Si₂O₇ suggesting that equilibrium has not been reached. To synthesize single phase samples changes are being made in the starting amounts of the starting components and the firing temperature is being varied along with multiple firings.



The Gd₂SiO₅ sample fired at 1200 °C was not as crystalline as the Y₂SiO₅ and Lu₂SiO₅ samples.

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