Evaluation of Melt-Grown ZnO Single Crystals for Use as A-Particle Detectors

John S. Neal[a*], Nancy C. Giles[b], Dariusz J. Wisniewski[a], Lynn A. Boatner[a], Varathajan Rengarajan[c]

[a]*Center for Radiation Detection Materials and Systems, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831, USA*

[b]*Department of Physics, West Virginia University, Morgantown 26506, USA*

[c]*Cermet, Inc., Atlanta, 30318, USA*

As part of an ongoing investigation of the scintillation properties of zinc-oxide-based scintillators, several melt-grown ZnO single crystals have been characterized using α-particle excitation, γ-ray excitation, and temperature-dependent photoluminescence. The crystals were grown by Cermet, Inc., using a pressurized melt growth process. Many of the samples were doped or co-doped. The goals of these studies are to better understand the scintillation mechanisms associated with various members of the ZnO scintillator family and to then use this knowledge to improve the radiation detection capabilities of ZnO-based scintillators. One application for which ZnO is particularly well suited as a scintillator is as the associated particle detector in a deuterium-tritium (D-T) neutron generator. Application requirements include the exclusion of organic materials, outstanding timing resolution, and high radiation resistance. ZnO(Ga) and ZnO(In) have demonstrated fast (sub-nanosecond) decay times with relatively low light yields, and ZnO(Ga) has been used in a powder form as the associated particle detector for a D-T neutron generator. [1–3] In this study, Zn(Mg,Ga) and ZnO(Ga) samples were found to be the most promising materials, in terms of light yield under α-particle excitation, with measured light yields relative to BC-400 plastic of 56% and 49%, respectively. The ZnO(Mg,Ga) sample, however, demonstrated slow (μsec) decay components that would be incompatible with high-counting-rate applications.

Research carried out in the Center for Radiation Detection Materials and Systems at ORNL is supported by the NNSA Office of Nonproliferation Research and Engineering (NA-22), U.S. DOE and by the U.S. Department of Homeland Security, Domestic Nuclear Detection Office.

* *corresponding author e-mail: nealjs1@ornl.gov*

References

1. W. Lehmann, *Solid-State Electronics* **9**, 1107 (1966).
2. D. Luckey, *Nucl. Instr. and Meth.* **62**, 119 (1968).
3. T. Batsch, B. Bengston, M. Moszynski, *Nucl. Instr. and Meth.* **125**, 443 (1975).