PLA RENEWABLE BIO-POLYMER BASED SOLID-STATE GAMMA RADIATION DETECTOR- DOSIMETER FOR BIO-MEDICAL & NUCLEAR INDUSTRY APPLICATIONS

# Presenter Wen Jiang1

1. School of Nuclear Engineering, Purdue University, W. Lafayette, IN , USA Email: [Jiang568@purdue.edu](mailto:Jiang568@purdue.edu)

# Additional Authors

D. DiPrete2, R. P. Taleyarkhan1\*

1. – Savannah River National Laboratory, Aiken, SC, USA (\*) – Corresponding Author: [rusi@purdue.edu](mailto:rusi@purdue.edu)

Polylactic-acid (PLA) as a “green”, renewable corn-soy based polymer resin was assessed for potential as a novel solid-state detector for rapid-turnaround gamma radiation dosimetry in the 1-100 kGy range – of significant interest in bio-medical and general nuclear industry applications. Co-60 was used as the source of gamma photons. It is found that PLA resin responds well in terms of rheology and porosity metrics with absorbed gamma dose (Dg). For this work, rheological changes were ascertained via measuring the differential mass loss ratio (MLR) of irradiated PLA placed within PTFE framed (40mm x 20mm) cavities bearing ~0.9g PLA resin and pressed for 12-16 min. in a controlled force hot press under ~6.6 kN loading and platens heated to 2270C for the low Dg range: 0-11 kGy; and to 193oC for the extended Dg range: 11- 120 kGy. MLR varied quadratically from 0.05 to ~0.2 (1 ~0.007) in the 0-11 kGy experiments, and from

0.05 to ~0.5 (1 ~0.01) in the 0-120 kGy experiments. Rheological changes from gamma irradiation were modeled and simultaneously also correlated with void-pocket formations which increase with Dg. A single PLA resin bead (~0.4g) was compressed 5 minutes at 216℃ in 0-16 kGy experiments, and compressed 2 minutes at 232℃ in the 16-110 kGy experiments, to form sturdy ~100 µm thickness wafers in the same press. Aggregate coupon porosity was then readily measurable with a conventional optical microscope imaging, and analyzed with standard image processing; this provided complementary data to MLR. Average porosity vs dose varied quadratically from ~0 to ~15% in the 0-16 kGy range, and from ~0 to

~18% over the 16-114 kGy range. These results provide evidence for utilizing “green”/ renewable (under

$0.01)PLA resin beads for rapid, and accurate (+/-5-10%) gamma dosimetry over a wide 0-120 kGy range, using simple to deploy mass and void measuring techniques using common laboratory equipment.