Undergraduate Research on Fully-Automated Thermoluminescent Dosimeter Glow Curve Analysis Software

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Introduction and Motivation

Thermoluminescent dosimeters are in widespread use for personnel and environmental dosimetry as well as geological dating. The statistical significance of thermoluminescent dosimetric measurements is affected by the exact composition and fading time of a specific dosimeter. The error resulting from these two factors can be estimated and corrected through a curve-fitting process known as glow curve analysis.

The Radiation Health Engineering Laboratory is developing a glow curve software to improve dosimetry at the University of Michigan. The first iteration of this program performed rapid, autonomous, accurate analysis for LiF dosimeters at relatively high doses*. The current iteration is more general, designed to work for seven common dosimeter materials with less dependence on dose.

Mission Relevance

Radiation safety is essential for all workers in the nuclear sector. Our software aims to provide improved dosimetric statistics for human work than comparable programs.

* Thiesen JH, Hepker JM, Yu Wenjin, Pombier KD, Kearfott KJ. Preliminary Thermoluminescent Dosimeter Glow Curve Analysis with Automated Glow Peak Identification for LiF:Mg,Ti. Health Phys, accepted February 9, 2021.

Technical Approach

Pre-processing

The pre-processing step is a three step de-noising of the raw glow curve data:

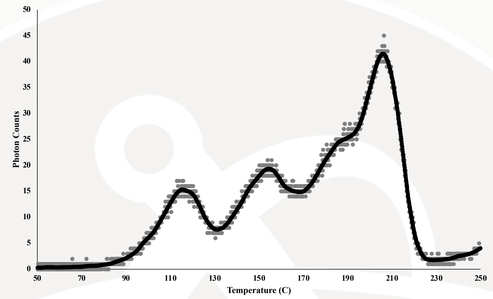

Figure 1: Glow curve after pre-processing step (black)

Glow Curve Identification

The glow curve identification step compares the smoothed data to common thermoluminescent dosimeter waveforms and identifies the best fit to generate peak locations:

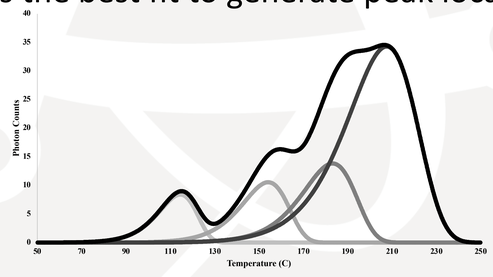

Figure 2: Initial peaks after identification step

Glow Curve Fitting

The identified material peaks are then optimized using the Levenberg-Marquardt algorithm:

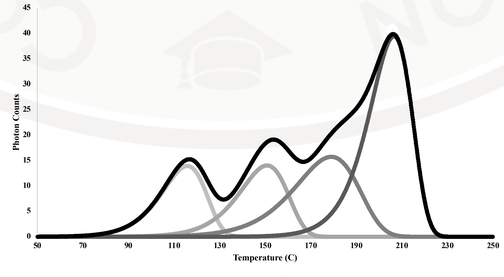

Figure 3: Final peaks after fitting step (black)

Expected Impact

Researchers measuring dose and studying materials, personnel dosimeter processors, and geologists performing dating will be able to use this code to produce better dose statistics automatically.

MTV Impact

- More than seven undergraduate students receive(d) valuable research experience as a result of the relationship with MTV
- 2 journal publications and 18 posters
- Work is being integrated into a graduate class at the University of Michigan
- Researchers at Los Alamos National Laboratory have reached out to our lab requesting access to our software
- 3 undergraduate students working on dosimetry matriculated to become MTV doctoral students

Conclusion

This software advances environmental and personnel dosimetry by lessening the amount of human work required to generate quality glow curves.

Current undergraduate students are moving towards graduate programs

Two future publications are in the works for this project.

This work was funded in-part by the Consortium for Monitoring, Technology, and Verification under Department of Energy National Nuclear Security Administration award number DE-NA0003920

National Nuclear Security Administration