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Machine learning enhanced analysis for compromised LiF:Mg,Ti. thermoluminescent glow-curves using an augmented seed dataset.

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Thermoluminescence dosimetry (TLD) enables the measurement of ionising radiation exposure by analysing the light emitted from an irradiated material after heating. This technique provides a retrospective assessment of absorbed radiation doses, which is particularly useful in health monitoring. Thermoluminescence (TL), or emitted light, is a result of trapped electron re-combination and is depicted typically by a glow curve of light intensity as a function of temperature. The fading of the TL response over time, the impact of material defects and composition, the restricted position of the dosimeter and the capture of low-dose exposure may compromise an accurate measurement of the absorbed dose.

This research presents the use of machine learning (ML) to model amended compromised glow-curve responses in LiF:Mg,Ti. TLD-100 and TLD-100H chips using an augmented experimental seed training dataset. The LiF:Mg,Ti. TLD-100 and TLD-100H chips were irradiated with a Sr^{90}/Y^{90} beta source with an activity of 37 MBq at a dose rate of 0.0155 Gy s^{-1} with maximum energies between 0.546-2.28 MeV at varied irradiation times with absorbed doses up to 2 Gy, pre-heat temperatures and thermoluminescence (TL) temperatures. The models source data from an ongoing extensive empirical labelled dataset and uses a noise augmentation method to change the photon intensity counts, while protecting the shape of the glow-curve arrays with integrals and peak-fitting methods. A data synchronisation method supports augmentation of the temperature, facilitating glow-curves to be fine-tuned across a broader range.

This work introduces a user-defined augmented dataset designed to resolve compromised glow curves at specific array indices. This method achieves a mean accuracy of 98% in plotting the augmented data array while maintaining the integrity of the glow-curve peak shapes. Assuming first-order kinetics, the Randall-Wilkins thermoluminescence (TL) intensity equation describes the thermally stimulated luminescence emission from a material as a function of temperature and time. This may be used to plot glow-peaks at various temperature ranges dependent on the frequency factor, instantaneous occupancy of the trap, shape factor and trap depth.

Future work will apply similar principles to analyse glow curves from silica beads across a range of irradiated doses, including those with compromised TL responses. This approach will generate a training dataset that enables machine learning techniques to explore the relationship between glow curve mathematical modelling and kinetic order. Ultimately improving the accuracy and broadening the application of silica beads as a reliable TLD material.

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