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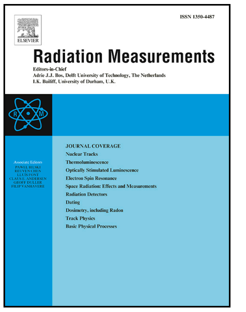

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Automatic Detection of Anomalous Thermoluminescent Dosimeter Glow Curves Using Machine Learning

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Abstract — **Computerized Glow Curve Analysis (CGCA) has been, and still is, an intensively-investigated subject for the past two decades. CGCA has applied different methods for various applications, from glow curve deconvolution into isolated peaks, through semi-automatic software tools for detecting outliers, to software that discovers exceptional curves by using predefined rules. The method presented herein addresses the subject using a new approach in which a completely automatic algorithm is used for the accurate detection of anomalies in thermoluminescent dosimeter (TLD) glow curves. A Support Vector Machines (SVM) technique, which is a machine learning classification algorithm, is used for the first time for radiation dosimetry applications. The algorithm classifies glow curves into two categories: an acceptable i.e. 'regular' curve, or a curve that exhibits any kind of anomaly i.e. an 'anomalous' curve. The classification method treats the glow curves raw data as a large ensemble of statistical data, and tries to identify exceptional glow curve shapes by statistical means. This classification method is performed in three steps. First, a library of glow curves is manually classified by a human user of the system into the above two classes. Then an iterative training algorithm is applied to these glow curves. The final stage applies a method of comparison between an unidentified glow curve and these two pre-classified sets, and assesses a classification probability to each of the two classes. The results show between 96.2% to 97.7% accuracy of the correct classification to either one of the classes, depending on the admissible false negatives rate.**

Index Terms— **Anomaly Detection, Glow Curve, Machine Learning, Thermoluminescent Dosimetry**

INTRODUCTION

Thermoluminescent dosimetry (TLD) is the most commonly used personal dosimetry method world-wide. Different dosimetry laboratories use various readers and various TL materials such as LiF:Mg,Cu,P and LiF:Mg,Ti. Different time-temperature profiles (TTPs) are often used during readout. The specific shape of the glow curve, I(t), depends on many parameters such as energy response, the TTP, the number of re-uses prior to replacement, the type of filtration, the duration of irradiation,the time between the end of irradiation and readout, and electrical interferences. All these parameters introduce uncertainty into the resulting dose estimation process.

Quality assurance is of critical significance to the estimation of radiation dose from I(t). External dosimetry laboratories have little or no control over the majority of the parameters introducing uncertainty listed above, except for the uncertainty introduced by the glow curve analysis or total lack thereof. Large scale personal dosimetry laboratories may need to evaluate thousands of TLDs monthly. In many cases, for pragmatic reasons, the estimate of the TL signal will be simply taken as the integral of I(t). Under ideal measurement conditions one might expect the glow curve shapes to be identical or nearly identical. However, this is hardly the case.

Variations in I(t) are caused by numerous reasons including pre- and post-irradiation annealing procedures, inadequate heating rate, irregularities in the nitrogen flow during readout,

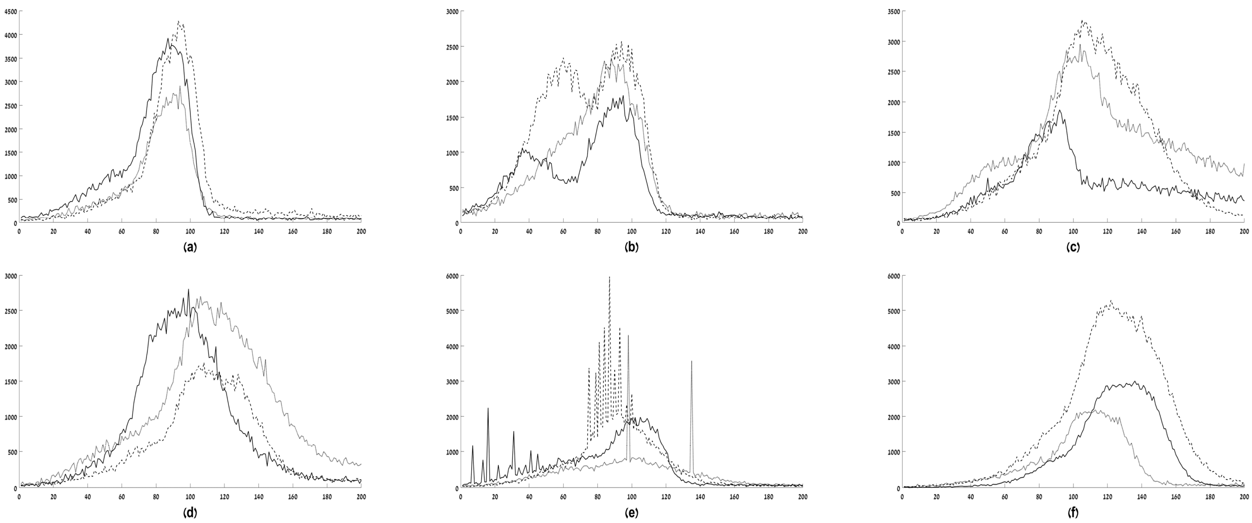

Fig. 1 Six sets of glow curves recorded at the Soreq Nuclear Research Center and readout by a Thermo Harshaw 8800 reader. The first set (a) are "regular" curves, and the rest are examples of different kinds of anomalous glow curves: (b) curves with high TL in the low temperature region, (c) curves with high TL in the high temperature region, (d) wide curves, (e) spiked curves and (f) curves with a shift of the entire glow curve to higher temperatures.

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