This Week's Citation Classic®

A method was developed for the evaluation of activation energies and pre-exponential factors from thermoluminescence glow peaks, based on the measurement of the full width of the peak. The applicability of the method as well as previously developed ones were checked using numerically simulated peaks. [The *SCI®* indicates that this paper has been cited in more than 265 publications.]

Analysis of Thermally Stimulated Phenomena

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Reports on measurements of thermoluminescence (TL) go back as far as the seventeenth century: Robert Boyle reported in 1663 to the Royal Society of London on observing a strange glimmering light when he warmed a diamond in the dark "holding it upon a naked part of his body" (see, for example, reference 1). The theory of TL was first introduced in the pioneering paper by Randall and Wilkins.[2] In the thousands of papers published on TL during the years, two main aspects were stressed. The applications included TL dosimetry (TLD), which is quite widespread now, and TL dating of archaeological and geological samples. The other aspect, related to basic science, is to learn from TL "glow curves" about the physical parameters associated with the imperfections in the crystals involved.

Different methods have been suggested for extracting physical quantities such as the "activation energy" and the "frequency factor" from TL curves. One group of these is the "peak shape" methods. A simple method is to use the intensities and temperatures at some chosen points, say, the maximum and half intensity points, whereas a more elaborate method utilizes curve fitting.

When I started my work on the analysis of TL curves in the mid-1960s, work that was related to my PhD thesis on the TL properties of semiconducting diamonds (supervised by A. Halperin), the main "shape methods" known were those by Lushchik[3] and Halperin and Braner.[4] Both methods were developed for finding the activation energy in first and second order peaks, using some approximations in expressions derived from the initial equations governing the process. The validity of these approximations had not been tested at that time.

In the work leading to the paper, a somewhat new approach was taken. Within the framework of first and second order kinetics, TL peaks were simulated by a computer, and the variations in the shape parameters were checked while the physical parameters chosen varied in very broad ranges. The underlying idea was that before taking the experimental difficulties into account, one should be sure that the method in hand can retrieve the known parameters inserted in the first place into the simulated peak. Thus, for example, features nearly independent of the frequency factor were used to calculate the activation energy that, in turn, could be used to find the frequency factor. This way, systematic errors were found in the previous formulae[3,4] and were easily corrected by changing the numerical coefficients. Also, the method by Halperin and Braner[4] was further improved by introducing a straightforward formula rather than an iterative method. In addition, a new method, based on the full width at half intensity, was developed.

This work was followed by a number of papers on related subjects, including a paper dealing with the general order kinetics[5] and a book with Y. Kirsh[6] that gave a more general view on all thermally stimulated processes, showing the similarities of their behavior, and urging people working on different thermally stimulated processes to utilize analysis methods developed in one subfield for use in the others, rather than to try to "reinvent the wheel."

1. McKeever S W S. *Thermoluminescence of solids.* Cambridge, England: Cambridge University Press, 1985. 376 p. (Cited 55 times.)
2. Randall J T & Wilkins M H F. Phosphorescence and electron traps, I. The study of trap distribution. *Proc. Roy. Soc. London Ser. A* 184:366-89, 1945. (Cited 575 times.)
3. Lushchik C B. The investigation of trapping centers in crystals by the method of thermal bleaching. *JETP—Engl. Tr.* 3:390-9, 1956. (Cited 35 times.)
4. Halperin A & Braner A A. Evaluation of thermal activation energies from glow curves. *Phys. Rev.* 117:408-15, 1960. (Cited 285 times.)
5. Chen R. Glow curves with general order kinetics. *J. Electrochem. Soc.* 116:1254-7, 1969. (Cited 130 times.)
6. Chen R & Kirsh Y. *Analysis of thermally stimulated processes.* Oxford, England: Pergamon Press, 1981. 361 p. (Cited 120 times.)

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