PROCEEDINGS SERIES

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PROCEEDINGS OF A SYMPOSIUM ON
NEW DEVELOPMENTS IN
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FOREWORD

Radiation dosimetry is a fundamental part of all radiation protection work. The measurements are made with a variety of instruments, and health physicists, after professional interpretation of the data, can assess the levels of exposure which might be encountered in a given area or the individual doses received by workers, visitors and others at places where the possibility of radiation exposure exists. The types of radiation concerned here are photon radiations, ranging from soft X-rays to gamma rays, and particulate radiations such as β-rays, α-particles, protons, neutrons and fission fragments. The type of technique used depends not only on the type of radiation but also on such factors as whether the radiation is from a source internal or external to the body.

Radiation dosimetry is not only used at nuclear facilities; it has diverse applications, for example in determining doses when radiation sources are employed for medical diagnostics and therapy, in safeguarding workers in any industry where isotopes are used, and in assessing the effect of both naturally occurring and man-made radiations on the general public and the environment. The advances of modern technology have increased the variety of sources; an example can be given from colour television, where the high potential necessary in certain colour cathode-ray tubes generates a non-negligible amount of X-rays.

The Symposium on New Developments in Physical and Biological Radiation Detectors was one of a continuing series of meetings in which the International Atomic Energy Agency furthers the exchange of information on all aspects of personnel and area dosimetry. The Symposium was devoted in particular to a study of the dose meters themselves — their radiation-sensitive elements (both physical and biological), their instrumentation, and calibration and standardization.

Several speakers suggested that the situation in the standardization and calibration of measuring equipment and sources was unsatisfactory, and saw an important role for the Agency in furthering international intercomparison studies. This would in particular help the developing countries who were not able to set up specialized standards laboratories, while providing a check for all Member States on the reliability of quoted measurements and their associated accuracies.

The final section on biological dosimetry evidenced the growing interest in this topic. The use of physical dosimeters has certain shortcomings: it is, for example, difficult to determine the dose received by one part of the body from a reading of a dosimeter worn on another part. It is possible that biological changes in the body could be used as a direct measure of the radiation insult received, without the need for interpolating data obtained by physical dosimeters. Biological dosimetry is, however, already being used a a "null indicator" in cases of suspected high exposure. This section is rounded off by a brief discussion on general topics related to biological dosimetry.

The Symposium was attended by 170 participants from 29 Member States and 5 international organizations. The papers are given in full together with the discussions.

EDITORIAL NOTE

The papers and discussions incorporated in the proceedings published by the International Atomic Energy Agency are edited by the Agency's editorial staff to the extent considered necessary for the reader's assistance. The views expressed and the general style adopted remain, however, the responsibility of the named authors or participants.

For the sake of speed of publication the present Proceedings have been printed by composition typing and photo-offset lithography. Within the limitations imposed by this method, every effort has been made to maintain a high editorial standard; in particular, the units and symbols employed are to the fullest practicable extent those standardized or recommended by the competent international scientific bodies.

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Z. SPURNÝ (Czechoslovak Socialist Republic)
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LUMINESCENCE AND EXOELECTRON DOSIMETRY IN PERSONNEL MONITORING*

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Abstract

LUMINESCENCE AND EXOELECTRON DOSIMETRY IN PERSONNEL MONITORING.

The acceptance of luminescence (especially thermoluminescence) dosimeters for routine γ- and β-ray monitoring has been progressing in a number of establishments, and the development of automatic read-out equipment will no doubt accelerate this process. A number of useful dosimeter phosphors are available for this application; however, lithium fluoride continues to be the most widely employed. In the area of neutron dosimetry, luminescent dosimeters have not been so successful, because they are insensitive to fast neutrons. Various methods have been tried to overcome this deficiency, and these are discussed. It is pointed out that it should be possible to achieve a useful luminescent dosimeter for registering the combined γ-ray + intermediate neutron dose by adjusting the thermal-neutron/γ-ray response ratio. Several recent attempts at achieving a more acceptable fast-neutron response are discussed, including one based on an exoelectron emission dosimeter.

1. Introduction

In preparing this paper I was faced with a choice between a rather broad and detailed survey of the virtues and faults of the principal luminescence and exo-electron dosimetry systems, and a selective discussion of certain problem areas. I found myself attracted to the latter approach because the former has been done so many times before, and I feel that more can be gained at this time from reviewing specific aspects in depth. In particular I will devote most of this paper to a discussion of the neutron dosimetry problem, since this has been the area where luminescent dosimeters have been least successful so far.

2. Thermoluminescence Dosimeters

Lithium fluoride [1] is clearly in the lead among the TL phosphors, as evidenced by the fact that about half of all the TLD publications abstracted during 1969 dealt with that material (see Fig. 1). This results partly from its early start as a commercially available product, but there are other reasons as well. Table I summarizes some important characteristics of the principal TLD phosphors. It will be seen that only lithium fluoride, lithium borate [2], and beryllium oxide [3] approximate tissue in atomic number, thus not requiring a shield to avoid over-response for γ rays below 100 keV. Of course the techniques are well known for designing such shields, to provide a nearly constant response per

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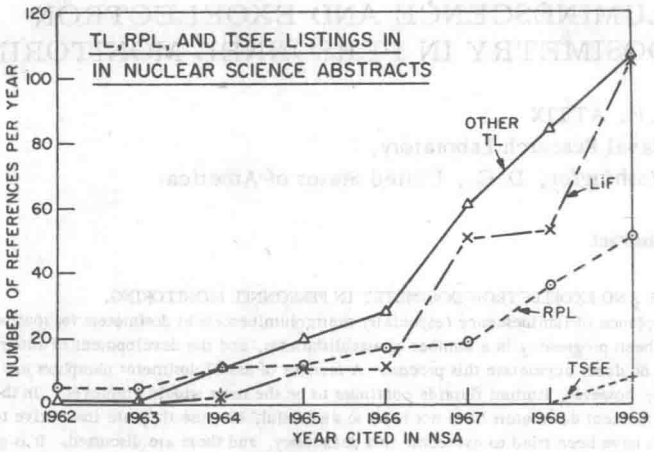

FIG. 1. Scientific publications on thermoluminescence (TL) radiophotoluminescence (RPL), and thermally-stimulated exoelectron emission (TSEE) dosimetry, as cited by the Nuclear Science Abstracts Subject Index for 1962-1969. References including specific mention of lithium fluoride thermoluminescence are represented by the "LiF TL" curve; "Other TL" includes all the others.

TABLE I. RESUMÉ OF CHARACTERISTICS OF PRINCIPAL TLD PHOSPHORS

Phosphor	Low Z	Utility at 10 mR	Low Fading	Low n_{th} Response	High n_{th} Response
LiF TLD-700	X	X	X	X	
LiF TLD-100,600	X	X	X		X
CaF_2:Mn		X	X	X	
CaF_2 (Fluorite)		X	X	X	
CaF_2:Dy		X		X	
$Li_2B_4O_7$:Mn	X	X	X		X
$CaSO_4$:Mn		X		X	
BeO	X	X	X	X	
$2MgO \cdot SiO_2$:Tb		X	X	X	

roentgen from 1.2 MeV down to about 40 keV for the TLD phosphors of higher atomic number. However such shielding has disadvantages in the context of personnel monitoring: (a) increased unit cost, (b) increased size and weight, (c) exaggerated dependence of response upon direction of incident radiation, especially at low γ-ray energies, and (d) elimination of β-ray response, whether desired or not.