Al-Mustaqbal University
College of Science
Department of Medical Physics
The Fourth Stage
First Course

Radiation Protection

LECTURE SEVEN

A Radiation Dosimeter

Detectors for Radiation Protection

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LECTURE SEVEN: A Radiation Dosimeter

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LECTURE SEVEN: A Radiation Dosimeter

A radiation dosimeter: It is a device that measures does absorption of external ionizing radiation.

There are four major types of monitoring devices in use today are:

One : Film badge

Film badge features

1) It is used as a personnel monitor device for X- and gamma radiation and charged particles
2) It consists of i) photographic film and ii) film holder.
3) The film holder contains various filters (e.g. lead, aluminum, plastic).
4) Radiation passing through the filters will produce a density distribution on the film from which the energy range and type of the radiation can be determined.
5) The effect of radiation exposure is a darkening of the film, and the amount of darkening is proportional to the dose absorbed by the film.

Film badge

Film badge disadvantages

1) **Fogging** may result from **mechanical pressure, high temperatures or exposure to light** before development.
2) **Fading** of the latent image can occur, which is dependent on the time interval between exposure and development.
3) **Errors in the development process** can affect the reading, and cannot usually be corrected.
4) Isotopes such as H^3, C^{14} or S^{35} **have beta energies** below the sensitivity of the film and **cannot be detected.**

Two : Thermo-luminescent dosimeter (TLD)

TLD features

1) Thermo-luminescent dosimeters, or "TLD's", are used for **monitoring x-ray, beta, and gamma radiations**.
2) The **TLD is a better** indicator of radiation exposure **than film badge** because it is composed of elements of **low atomic number** (human tissue also contains elements of low atomic number).
3) **TLD's are affected less than film badge by environmental** conditions such as heat, light, and humidity, and are reusable.
4) The TLD crystals are **available in many sizes and shapes**, such as rods, ribbons, pellets and single crystals.

Thermo-luminescent dosimeter (TLD)

TLD disadvantages

1) The TLD **can only be read once**, since reading it erases it. Thus, **there is no permanent record of the dose**, and errors in the measurement process may lose the reading.
2) **Fading of the stored signal** can occur, which is dependent on the time interval between exposure and development.
3) **The accuracy of the reading depends on the light sensitivity** of the reader and heating rate of the TLD, but it can be difficult to maintain adequate reader constancy.
4) TLD's **do not give as much information about the energy** of the incident radiation as do film badge and optically stimulated luminescent (OSL) dosimeter.

How TLD works?

Energy absorbed from the incident radiation excites and ionizes the molecules of the thermo luminescent material. Some of the energy is trapped by impurities or deformations in the material, and remains trapped until the material is heated to a high

Once heated, the trapped energy is released as an emission of light. The amount of light emitted is proportional to the energy absorbed within the thermo luminescent material, which is proportional to the radiation dose absorbed. The emitted light is measured with a photomultiplier tube, the output of which is applied to a readout instrument.

Three : Optically Stimulated luminescent (OSL) dosimeter

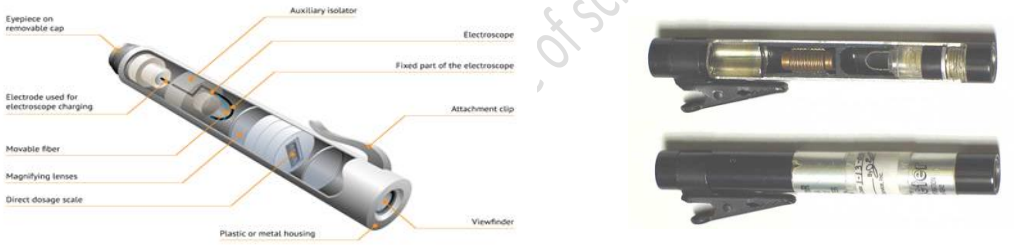
OSL features

- OSL are **more sensitive to a wider range of photon and beta particle energies**
- **It provides more information about the energy** of the incident radiation. This information is used to provide estimates of deep dose, dose to the lens of the eye, and shallow dose.
- **The good resolution** of the detector also allows analysis of whether the **exposure was dynamic or static** .
- OSL dosimeter are that it **can be read multiple times without remove all the information** and that the read-out process is faster and more accurate than with TLD's.
- OSL dosimeters are also relatively **unaffected by environmental** conditions such as heat, light, and humidity.

Optically Stimulated luminescent (OSL) dosimeter

Four : Pocket Dosimeters

Pocket dosimeters (ion chambers) may be required to be worn in addition to the film badge if other types of monitors are unsuitable in the judgment of the Radiation Control Officer or the Radiation Control Committee. This shall apply where the investigator is working with high level radioactive materials or other ionizing radiations. When these devices are used, the Principal Investigator is responsible for maintaining daily pocket ion chamber records. Copies of these records shall be submitted monthly to the Radiation Control Office.



Pocket Dosimeters

Use of Personnel Dosimeters

Personnel monitoring devices must be worn by personnel as specified below and/or in such instances as deemed necessary by the Radiation Control Department.

Whole Body Luxel/Film/TLD Badges

Whole body badges shall be worn when:

1) Working with beta emitters where the energy is 300 keV or higher and the quantity greater than 1 millicurie (37 MBq) in any month.
2) Working with any gamma emitters where the energy is 50 keV or higher and the quantity greater than 0.2 milliCuries (7.4 MBq) in any month.
3) Working with neutron sources. Special neutron badges may be required in addition to other badges.
4) Working with any apparatus capable of producing or emitting ionizing radiation as deemed necessary by the Radiation Control Department. For example, x-ray equipment, high power amplifying tubes, accelerators, etc.
5) Specified by the Radiation Control Department, the Radiation Control Officer, and/or the Radiation Control Committee or the Human Use of Radionuclides and Radiation Committee.

Bubble sheet questions

Q1- ---------- of the stored signal in the thermo-luminescent dosimeter can occur, which is dependent on the time interval between exposure and development.

A- reading effects B- film sensitivity C- fading D- fogging E- errors

Q2- ---------- does not provide much information about the energy of the incident radiation compared to other dosimeters.

A- film badge B- thermo-luminescent dosimeter C- optically stimulated luminescent dosimeter

D- pocket dosimeter E- all of them

Q3- ---------- is more sensitive to a wider range of photon and beta particle energies.

A- film badge B- thermo-luminescent dosimeter C- optically stimulated luminescent dosimeter

D- pocket dosimeter E- all of them

Q4 ---------- dosimeter are that it can be read multiple times without remove all the information and that the read-out process is faster compared to other dosimeters.

A- film badge B- thermo-luminescent dosimeter C- optically stimulated luminescent dosimeter

D- pocket dosimeter E- all of them

Q5- ---------- dosimeters are relatively unaffected by environmental conditions such as heat, light, and humidity compared to other dosimeters.

A- film badge B- thermo-luminescent dosimeter C- optically stimulated luminescent dosimeter

D- pocket dosimeter E- all of them