ROHINI
COLLEGE OF ENGINEERING AND TECHNOLOGY
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DEPARTMENT OF BIOMEDICAL ENGINEERING

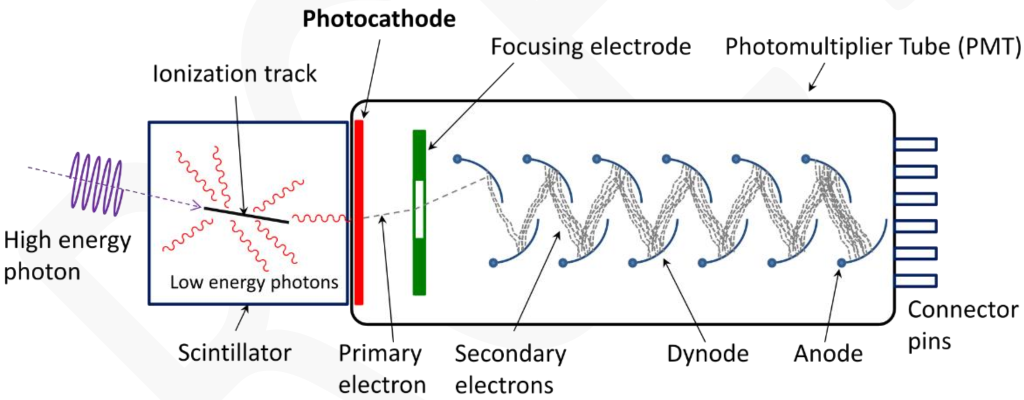
III Semester

BM3301 SENSORS AND MEASUREMENTS

UNIT – 3

3.2 Scintillation Counter

A scintillation counter is an instrument for detecting and measuring ionizing radiation by using the excitation effect of incident radiation on a scintillating material, and detecting the resultant light pulses.



A scintillation detector is made up of a scintillator and photodetector. It consists of a scintillator which generates photons in response to incident radiation, a sensitive photodetector (usually a photomultiplier tube (PMT), a charge-coupled device (CCD) camera, or a photodiode), which converts the light to electrical signal and electronics to process this signal.

A scintillator counter consists of the following instruments-

1. Scintillator – generates photons when the incident radiation hits the counter.
2. Sensitive photodetector – to convert signals for further processing
3. Charge-coupled device (CCD) – converts light to electrical and electronic signals for amplification.

Working of Scintillation Counter:

Scintillator Material: The heart of a scintillation counter is the scintillator material. This is a substance that emits light when it interacts with ionizing radiation. Common scintillator materials include organic crystals, inorganic crystals, and liquids. The choice of scintillator depends on factors like the type and energy of radiation being detected. The scintillation material used in this experiment is NaI(Tl) where (Tl) means that there are small amounts of Tl (Thallium) mixed into the NaI.

Ionization by Radiation: When ionizing radiation (such as alpha, beta, or gamma rays) interacts with the scintillator material, it transfers energy to the atoms or molecules in the material. This energy excites electrons to higher energy levels or even ionizes atoms.

De-Excitation and Light Emission: After being excited, the electrons in the scintillator material return to their lower energy state by releasing the excess energy in the form of visible or ultraviolet (UV) photons. This process is known as de-excitation.

Photomultiplier Tube (PMT): The emitted light photons are then collected and directed to a sensitive detector called a photomultiplier tube (PMT). The PMT consists of a photocathode, a series of dynodes, and an anode. The photocathode converts incoming photons into electrons through the photoelectric effect.

Electron Amplification: The emitted electrons are accelerated and multiplied as they pass through a series of dynodes. Each dynode is at a higher voltage than the previous one, causing the multiplication of electrons at each stage.

Anode and Signal Output: The multiplied electrons finally reach the anode, and the resulting electric current is proportional to the number of original photons generated by the scintillation process. This current pulse is then processed and converted into a measurable electronic signal.

Signal Processing: The electronic signal is processed, and the data can be analyzed to determine the type and energy of the incoming radiation. The signal can be further amplified and shaped to enhance the signal-to-noise ratio.

Advantages of Scintillation Counter

i. High Sensitivity
ii. Wide Energy Range

iii. Fast Response Time
iv. Compact and Portable Design
v. Low Background Noise
vi. Relatively Low Cost

Disadvantages of Scintillation Counter

i. Temperature and Humidity Sensitivity
ii. Limited Energy Resolution for Some Applications
iii. Continuous exposure to ionizing radiation can cause damage to the scintillator material over time.

Applications of Scintillation Counter

i. Nuclear Physics Research:
ii. Medical Imaging
iii. Radiation Monitoring and Dosimetry
iv. Scintillation counters are used to monitor environmental radiation levels
v. Nuclear Power Plants

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