SNS COLLEGE OF TECHNOLOGY
(AN AUTONOMOUS INSTITUTION)
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Department of Biomedical Engineering

Course Name: 19BME301 – Medical Physics

III Year : V Semester

Unit IV –PRINCIPLES OF RADIATION DETECTOR

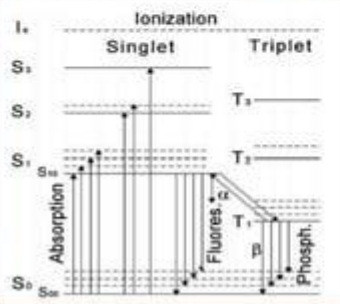
History

- The modern electronic scintillation counter was invented in 1944 by Sir Samuel Curran(UK)

- Previously *scintillation* events had to be laboriously *detected by eye* using a spinthariscope which was a simple *microscope to observe* light flashes in the scintillator

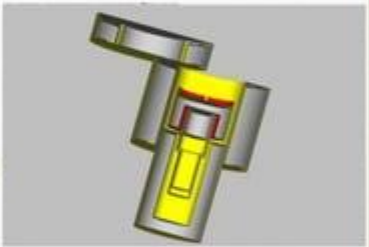
What is ***Scintillation?***

The *emission of flouroscene* in a phosphor by *absorption of charged particle* or high energy photons



Principle :

- Scintillation counter is an instrument that is used for *detect and measuring* ***ionising radiation***
- It comprises of the scintillator that *generates photons by* ***excitation effect*** in *response to incident radiation* and detecting the resultant light pulses



WORKING

Radiation strike the crystal

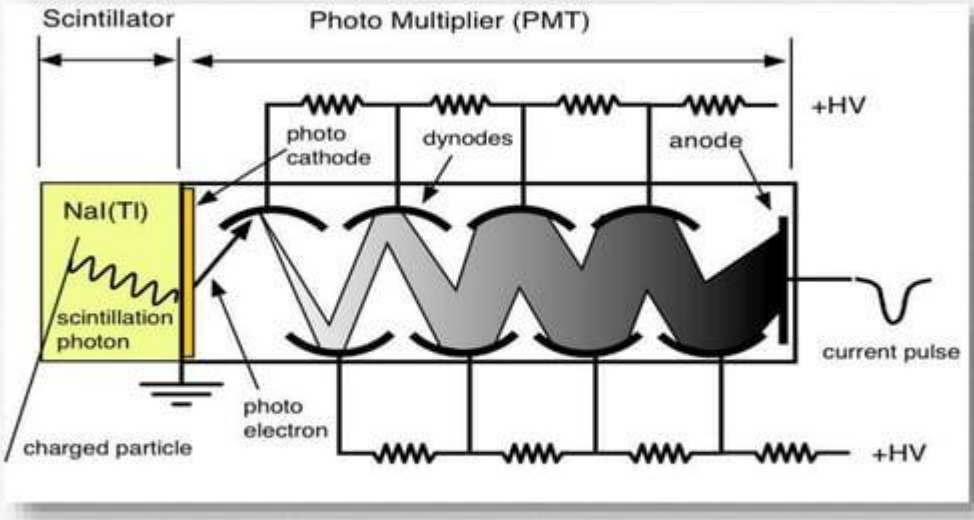
Photoelectron emitted by scintillator

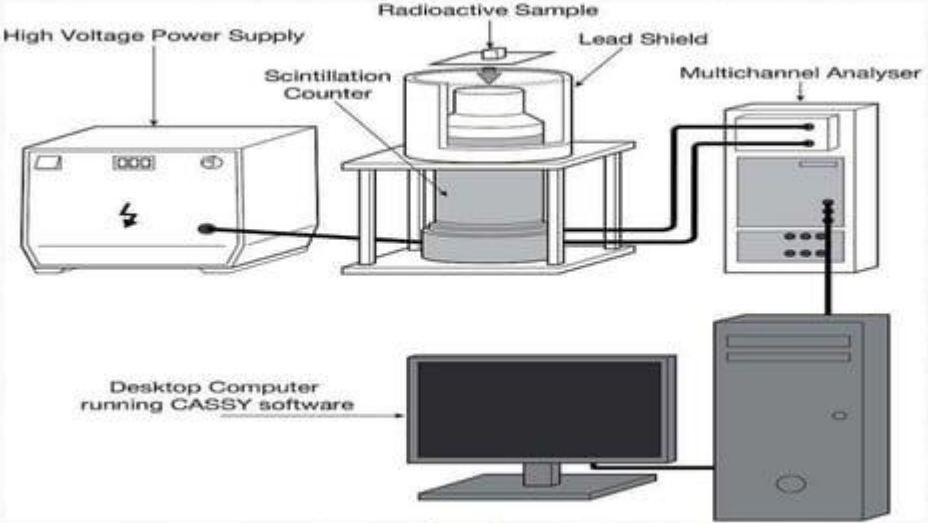
the electron move cathode to anode through dynode

Electric pulse delivered to PM tube

Electric pulse amplified and delivered

Scintillation Counter


Scintillator
Photo Multiplier (PMT)
+HV
photo cathode
dynodes
anode
NaI(Tl)
scintillation photon
current pulse
photo electron
charged particle
+HV


Radioactive Sample
High Voltage Power Supply
Lead Shield
Scintillation Counter
Multichannel Analyser
Desktop Computer running CASSY software

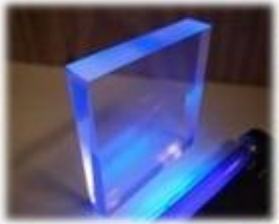
Types of scintillator :

Cesium iodide (CsI) detection of *protons and alpha particles*.

Sodium iodide (NaI) containing a small amount of thalliumdetection of *gamma waves*

zinc sulfide (ZnS) detector of *alpha particles*(*Zinc sulfide is the material Rutherford used to perform his scattering experiment*.)

Lithium iodide (LiI) is used in *neutron* detectors.



Applications

Scintillation counters are used to measure radiation in a variety of applications.

- Hand held radiation survey meters
- Personnel and environmental monitoring for Radioactive contamination.
- Medical imaging.
- National and homeland security.
- Border security.
- Nuclear plant safety.
- Oil well lodging.

QUESTN.....

Which is the correct representation for "SINGLET" & "TRIPLET" ?

A) 

B) 

C)

D) 

E) 

F) 

Ans:

SINGLET =B

TRIPLET =D,E

SEMICONDUTOR DEDUCTOR

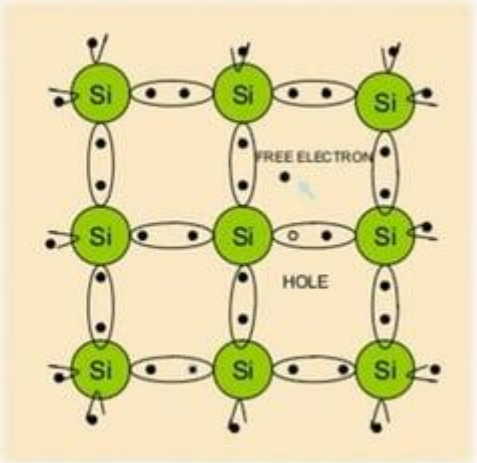
Semiconductor detector

- A detector which is used to *detect the ionising radiation by* using *semiondutors* (usually *silicon* or *germanium*)
- The detecting is a single crystal consisting of a sandwich of *intrinsic silicon* between a P-Type layer and N-Type layer forming *p-i-n diode*.

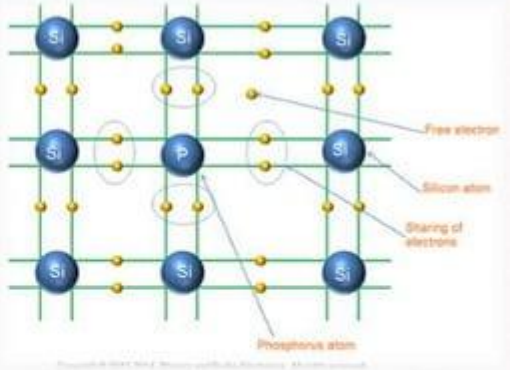
Semiconductor in *pure form* is known as *intrinsic* semiconductor

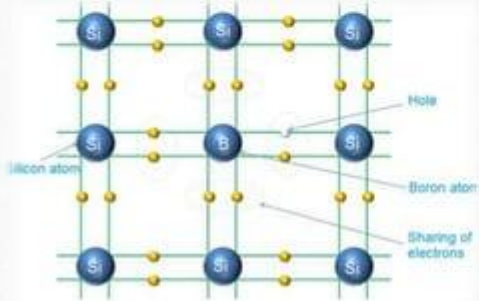
Ex : pure Silion and pure Germanium

at room temperature no of electron equal to number of holes



N- type


Si
Si
Si
Si
P
Si
Si
Si
Si
Free electron
Silicon atom
Sharing of electrons
Phosphorus atom

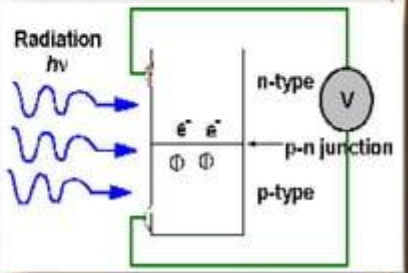

Si
Si
Si
Si
B
Si
Si
Si
Si
Hole
Silicon atom
Boron atom
Sharing of electrons

P-type

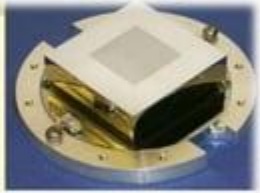
Detection mechanism

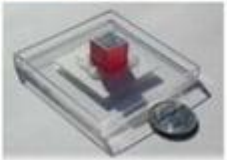
When the *radiation interact with silicon* crystal they excite elelctron from the valence band into the condution band *creating a eletron – hole pair.*

When a *reverse bias potential is applied* to the crystal,the *eletrons and holes are separated* and a charge pulse of *electrons can be measured*



- Generally used for detection of alpha and beta particles
- Very ***high resolution*** energy measurement
- *Doesnot depend* upon the *type of radiation* that deposites the energy
- Negligible absorption energy
- Act as a ***solid state ionization chamber***





Types

1) Silicon detectors
2) Diamond detectors
3) Germanium detectors
4) Cadmium telluride and
5) cadmium zinc telluride detectors
6) AIP – Aluminium Phosphide
7) AIAs – Aluminium Arsenide
8) GaP – Galium Phosphide
9) GaAs – Galium Arsenide
10) InP – Indium Phosphide

advantages

- *Minimum energy needed* to *create an eletron – hole pair*(3.6eV) for silicon.this leads to better detection resolution.
- Small *charge collection time (<10)*
- Very *small recombination* losses due to fast charge collection.

QUESTN...

In the ciruit diagram, the direction of eletron moves _____ direction to the current

a) Same b)opposite
c) +ve to –ve d) –ve to +ve

Ans : B & C

Thank you

Thank You