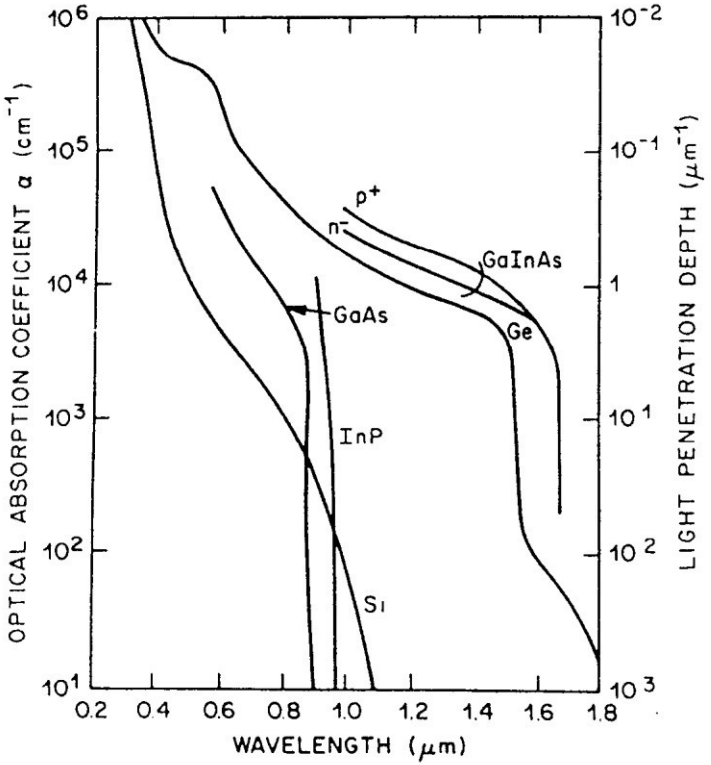
Unit-4

Lecture -6

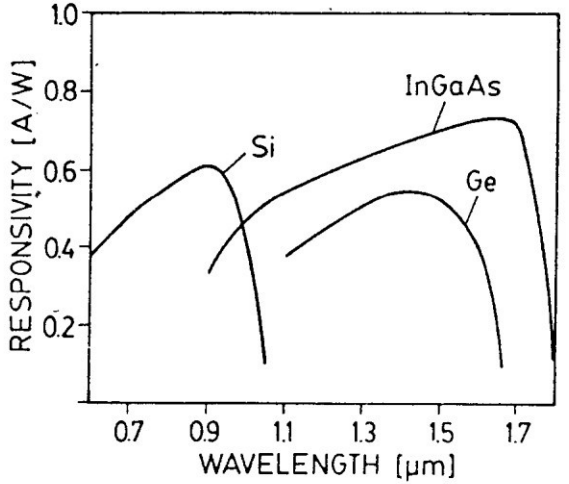
Sensitivity Vs wavelength, MSM detector, Noise Equivalent Power, Comparision

Detector Sensitivity vs. Wavelength



Absorption coefficient vs. Wavelength for several materials

(Bowers 1987)



Photodiode Responsivity vs. Wavelength for various materials

(Albrecht et al 1986)

MSM Detectors

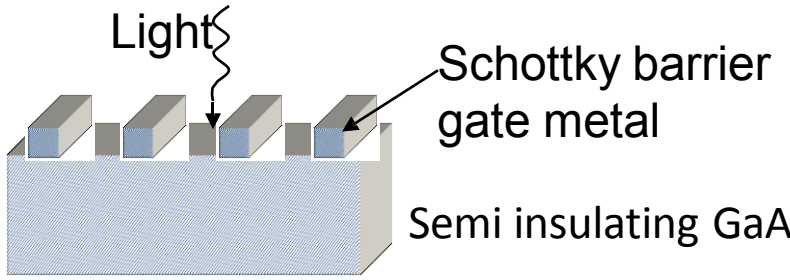
- ***Simple to fabricate***

- ***Quantum efficiency***: Medium
  Problem: Shadowing of absorption region by contacts

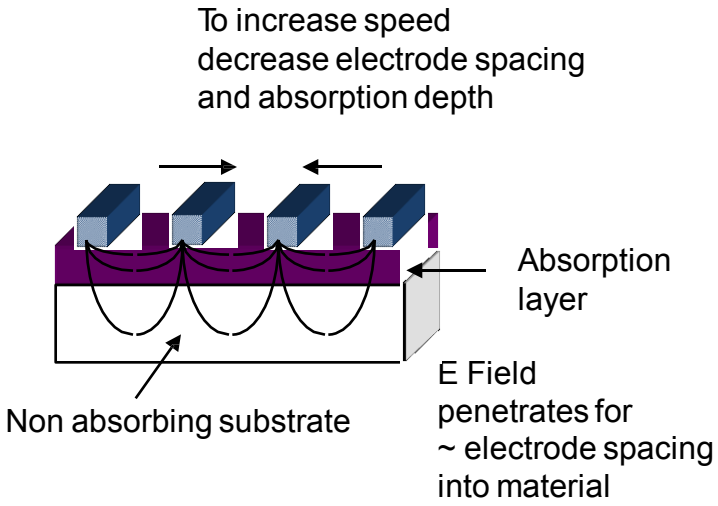
- ***Capacitance***: Low

- ***Bandwidth***: High
  Can be increased by thinning absorption layer and backing with a non absorbing material. Electrodes must be moved closer to reduce transit time.

- ***Compatible with standard electronic processes***
  GaAs FETS and HEMTs
  InGaAs/InAlAs/InP HEMTs



Simplest Version



Noise Equivalent Power (NEP)

Signal power where S/N=1

Units are W/Hz$^{1/2}$

$$NEP = \frac{h\nu}{\eta e}\sqrt{2eI_D M^x + \frac{4kT}{M^2 R_L}}$$

Typical Characteristics of P-I-N and Avalanche photodiodes

Parameter	Symbol	Unit	Type	Material		
				Si	Ge	InGaAs
Wavelength	λ	nm		0.4–1.1	0.8–1.8	1.0–1.7
Responsivity	R	A/W	*p-i-n*	0.4–0.45	0.8–0.87	0.5–0.95
Quantum efficiency	η	%	*p-i-n*	75–90	50–55	60–70
APD gain	M	—	APD	—	50–200	10–40
Dark current	I_d	nA	*p-i-n*	1–10	50–500	1–20
			APD	0.1–1	50–500	1–5
Bandwidth	BW	GHz	*p-i-n*	0.125–1.4	0–0.0015	0.0025–40
			APD	—	1.5	1.5–3.5
Bit rate	BR	Gbit/s	*p-i-n*	0.01	—	0.1555–53
			APD	—	—	2.5–4
Reverse voltage*	V	V	*p-i-n*	50–100	6–10	5–6
			APD	200–250	20–40	20–30
k-factor	k_A	—	APD	0.02–0.05	0.7–1.0	0.5–0.7

Comparisons

- PIN gives higher bandwidth and bit rate
- APD gives higher sensitivity
- Si works only up to 1100 nm; InGaAs up to 1700, Ge up to 1800
- InGaAs has higher η for PIN, but Ge has higher M for APD
- InGaAs has lower dark current