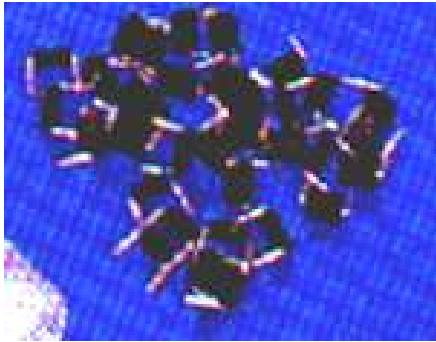


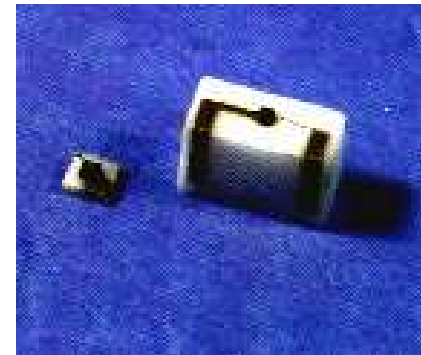
Photodiode's packaging



PLASTIC



METAL TO-5



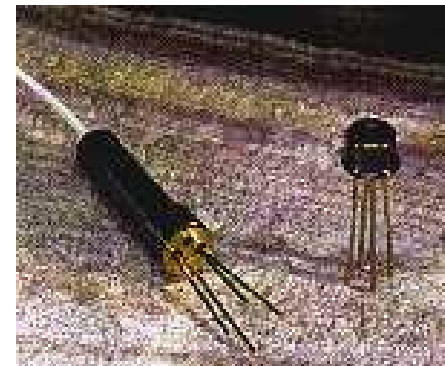
S UBMOUNT



METAL TO-18, 33



CON NECTORIZED



F IBER-PIGTAILED

PD parameters and performances

- *Spectral sensitivity σ* : typical reference values for design:
 $\sigma=0.3$ A/W in the visible, 0.1 A/W in UV, 0.8 A/W in near IR,
2-3 A/W in MIR/□ FIR;
- *Active area A* : wide range of sizes, from 50 μm dia. (lens-coupled PDs or fiber pigtailed for FOC) to ≥ 50 mm dia. for measurements;
general-purpose applications: $A=1-5$ mm².
Hint: choose the smallest A compatible with application; as PD acceptance $\mathbf{a}=\pi A$ is invariant, trade Ω for A using a lens.
Active surface shapes: round and square shapes common, special are strip PDs, linear arrays of closely spaced ($n=2-30$) PDs, and four-quadrants and spiral-sector PDs.
- *Dark current I_o* : typically, 10-50 pA per mm² of area (VIS, $T=300$ K).
Increases as $-E_g/kT \approx -44.8/\lambda_{s[\mu\text{m}]}$ with λ_s and E_g
tempco is +10-15%/°C (V□ IS, 300 K)

PD parameters and performances (2)

- *Barrier capacitance*: minimize it choosing the smallest A, and work at high reverse bias in pn PDs or with high W-pin-PDs. At $C_b \leq 1$ pF case capacitance C_p is relevant and package layout has to be properly designed.
- *Series and parallel resistances*: already seen, slide 11.
- *Linearity of power/current conversion*: PDs conformity to the basic law $I = \sigma P$ is very good over at least 3 decades (often 5-6 decades) with $\varepsilon < \pm 1\%$.
- *Bias voltage*: General purpose applications: V_{bb} of a few Volts (or $V_{bb} = 0$ in the short circuit mode) satisfactory
Commonly specified breakdown voltages: $V_{bd} = 10-100$ V, near which pn-PDs improves speed and sensitivity near λ_s
- *Response uniformity*: inside A, σ has small variations (typ. $< \pm 0.2\%$), but near edges may be typically 5-10%. Conformity error due to cosine law at incidence angle θ is $< 1\%$ up to $\theta \approx \pm 5^\circ$, but $\pm 10\%$ at $\theta \approx \pm 30^\circ$ (typ.).
- *Temperature coefficient $\alpha_\sigma = d\sigma/\sigma dT$* : Spectral sensitivity $\sigma(\lambda)$ shifts to larger λ as T increases. Tempco passes through zero around the peak λ_p of η . For $\lambda < \lambda_p$, α_σ is negative (typ. $-0.2 \dots -0.5\%/^\circ\text{C}$ in Si), and for $\lambda > \lambda_p$ up to the threshold λ_s , α_σ is > 0 and increasing with λ ($+0.2 \dots +1\%/^\circ\text{C}$ in Si).

PD parameters and performances (3)

- *Temperature range*: as PD power dissipation is small, T_{storage} and T_{working} coincide. Range depends on package, maybe: normal (-20...+80°C) or extended (-55...+120°C). Special units reach +250°C.
- *Reproducibility of the characteristics*: In nominally identical PDs, spread is typically: $\pm 1\%$ in $\sigma(\lambda_p)$, $\pm 50\%$ in $\sigma(\text{near } \lambda_{\text{th}})$, $\pm 50\%$ in I_o
- *Electrostatic damage*: ternary/quaternary are very sensitive, Si, Ge are not
- *Reliability and MTTF*: very good - comparable to a small-signal diode. For a pn $\square\square$ /pin Si PD of $A_o=1\text{mm}^2$ in a hermetic case ($T_o=300\text{ K}$, $V_{\text{bb}}\leq 0.6V_{\text{bd}}$) failure rate is $h_o=10\text{-}30\text{ fit}$ and $\text{MTTF}=1/h_o=1\text{-}3\cdot 10^7\text{ hs}$. In Si, acceleration is:

$$h = h_o' + h_o'' [\exp -E_{\text{Arr}}(1/kT - 1/kT_o)] (A/A_o) / [1 - (V_{\text{bb}}/V_{\text{bd}})^\beta] \quad (E_{\text{Arr}} \approx 1\text{ eV}, \beta = 0.5\text{-}2).$$
- *Ambient performances*: PDs can be qualified to ambient-stress tests (vibrations, shock, acceleration, thermal cycle, humidity, thermovacuum) of Standards Committees (IEC, ISO, MIL, etc.) for use in automotive, avionics, military, space, etc. Endurance to ionizing radiation is good, they can withstand exposures to 50 kRad (typical of dose for a low-orbit satellite during its life).