noise. This is due to random effects associated with surface traps and generally has $1/f$ characteristics that are more pronounced at low frequencies. The generation-recombination noise comes from the fluctuations of these generation and recombination events. Generation noise can originate from both optical and thermal processes.

Since all the noises are independent events, they can be added together as the total noise. A related figure-of-merit[2] is the noise-equivalent power (NEP) that corresponds to the incident rms optical power required to produce a signal-to-noise ratio of one in a 1-Hz bandwidth. To the first order, this is the minimum detectable light power. Finally, the detectivity D^* is defined as

$$D^* = \frac{\sqrt{AB}}{\text{NEP}} \qquad \text{cm-Hz}^{1/2}/W, \tag{4}$$

where A is the area and B is the bandwidth. This is also the signal-to-noise ratio when one watt of light power is incident on a detector of area 1 cm^2, and the noise is measured over a 1-Hz bandwidth. The parameter is normalized to the area since the device noise is generally proportional to the square root of area. The detectivity depends on the detector's sensitivity, spectral response, and noise. It is a function of wavelength, modulation frequency, and bandwidth, and is recommended to be expressed as $D^*(\lambda,f,B)$.

The last section of this chapter deals with solar cells which to some extent share some similarity with photodetectors in that they both convert light to electricity. The purpose of the solar cells, however, is for power generation from the sunlight, as opposed to detection of faint light. So one difference between them is the intensity of light involved. The second difference being that solar cells are power generators and as such no external bias is required, whereas photodetectors usually require some bias and the change of current is detected as signal.

13.2 PHOTOCONDUCTOR

A photoconductor consists simply of a slab of semiconductor, in bulk or thin-film form, with ohmic contacts affixed to the opposite ends (Fig. 2). When incident light falls on the surface of the photoconductor, carriers are generated either by band-to-band transitions (intrinsic) or by transitions involving forbidden-gap energy levels (extrinsic), resulting in an increase in conductivity. The processes of intrinsic and extrinsic photoexcitations of carriers are shown in Fig. 3.

For the intrinsic photoconductor, the conductivity is given by $\sigma = q(\mu_n n + \mu_p p)$, and the increase of conductivity under illumination is mainly due to the increase in the number of carriers. The wavelength cutoff is given by Eq. 1, where ΔE is the semiconductor bandgap E_g in this case. For shorter wavelengths, the incident radiation is absorbed by the semiconductor, and electron-hole pairs are generated. For the extrinsic photoconductor, photoexcitation occurs between a band edge and an impurity energy level in the energy gap.