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## The Physics of the Solar Cell

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### 3.1 INTRODUCTION

Semiconductor solar cells are fundamentally quite simple devices. Semiconductors have the capacity to absorb light and to deliver a portion of the energy of the absorbed photons to carriers of electrical current – electrons and holes. A semiconductor diode separates and collects the carriers and conducts the generated electrical current preferentially in a specific direction. Thus, a solar cell is simply a semiconductor diode that has been carefully designed and constructed to efficiently absorb and convert light energy from the sun into electrical energy. A simple conventional solar cell structure is depicted in Figure 3.1. Sunlight is incident from the top on the front of the solar cell. A metallic grid forms one of the electrical contacts of the diode and allows light to fall on the semiconductor between the grid lines and thus be absorbed and converted into electrical energy. An antireflective layer between the grid lines increases the amount of light transmitted to the semiconductor. The semiconductor diode is fashioned when an *n*-type semiconductor and a *p*-type semiconductor are brought together to form a metallurgical junction. This is typically achieved through diffusion or implantation of specific impurities (dopants) or via a deposition process. The diode's other electrical contact is formed by a metallic layer on the back of the solar cell.

All electromagnetic radiation, including sunlight, is composed of particles called photons, which carry specific amounts of energy determined by the spectral properties of their source. Photons also exhibit a wavelike character with the wavelength,  $\lambda$ , being related to the photon energy,  $E_\lambda$ , by

$$E_\lambda = \frac{hc}{\lambda} \quad (3.1)$$

where  $h$  is Planck's constant and  $c$  is the speed of light. Only photons with sufficient energy to create an electron–hole pair, that is, those with energy greater than the semiconductor