across the device, the Fermi energy itself is constant. The original difference in Fermi energies becomes the "built-in potential" eV_{BI} across the device illustrated in the figure.[7] Electrons and holes that are generated by photon absorption will drift in the built-in electric field in the directions illustrated in Figure 12.14.

The profiles of Figure 12.14 were calculated assuming that the p-layer has an electrical band gap of 2.0 eV and that both the middle, intrinsic layer and the n-layer have band gaps of 1.8 eV. The use of a wider band gap p-layer, which is generally desirable in a-Si:H devices, can both increase V_{BI} and reduce optical absorption in this layer. Because illumination generally enters amorphous silicon cells through the p-layer, this layer is also called the cell's *window layer*.

12.4.2 Photocarrier Drift in Absorber Layers

The design of amorphous silicon–based solar cells is strongly affected by how rapidly electron and hole photocarriers drift in an electric field. Ideally, electrons and holes should drift across the cell without interacting with each other, with the electrons ultimately being collected in the n-layer and holes in the p-layer. If, however, electrons and holes annihilate each other (in other words, if they "recombine" and generate heat), then there will be a loss of power from the cell. In this section, we illustrate one aspect of this loss process, which is the "collapse" of the internal electric field that occurs when the densities of photogenerated, drifting holes and electrons become sufficiently large.

Figure 12.15 is a double logarithmic plot of the mean displacements $L(t)$ for electrons and for holes as a function of the time since their generation by a photon. The results are presented for an electric field $F = 3 \times 10^4$ V/cm, which is about the right magnitude for a 500-nm intrinsic layer under short-circuit conditions. It is important

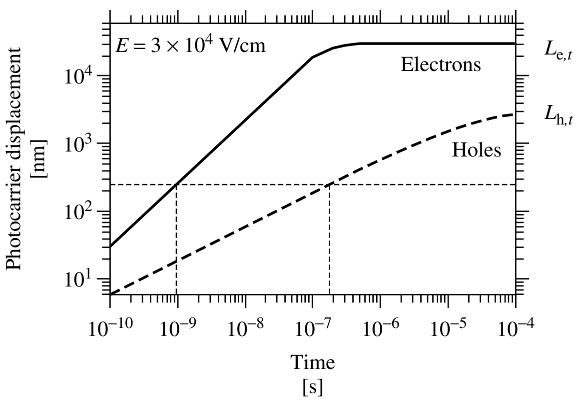

Figure 12.15 Displacements (or drift lengths) of electron and hole photocarriers in a-Si:H as a function of time following generation at room temperature [41]. Note that displacements are proportional to electric field. The saturation in the displacement for longer times (at $L_{e,t}$ and $L_{h,t}$) is due to deep trapping of electrons and holes by defects. Dotted lines illustrate the time required to drift 250 nm

[7] We neglect interface dipoles.