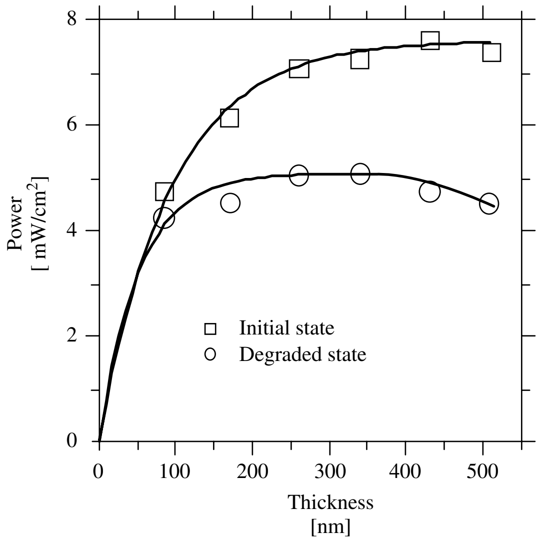

Figure 12.21 Power output (standard solar illumination) for a series of *nip* solar cells with varying intrinsic layer thickness [14]. The degraded state was obtained by 25 000 h of light soaking. The curves are guides only

12.5 MULTIPLE-JUNCTION SOLAR CELLS

12.5.1 Advantages of Multiple-junction Solar Cells

Amorphous silicon solar cells can be fabricated in a stacked structure to form multijunction solar cells. This strategy is particularly successful for amorphous materials, both because there is no need for lattice matching, as is required for crystalline heterojunctions, and also because the band gap is readily adjusted by alloying. Figure 12.4 illustrated the structure of a tandem cell with two junctions (i.e. two *pin* photodiodes) in series. Multijunction, a-Si-based solar cells can be fabricated with higher solar conversion efficiency than single-junction cells and are presently used in most commercial cells.

The fundamental concept underlying multijunction solar cells is "spectrum splitting." Consider what happens if we deposit a second *pin* junction structure on top of a first one. The second structure "filters" the sunlight: photons absorbed in the top junction are of course removed from the light that reaches the bottom cell. We illustrated this filtering effect in Figure 12.2, which shows that 500 nm of a-Si:H absorbs essentially all incident photons with energies greater than 2 eV, and passes photons with smaller energies. In practice, the thickness of the top *pin* junction is adjusted so that it filters out about half of the photons that would otherwise have been absorbed in the bottom *pin* junction.[11] Since the photons that are absorbed in the top junction have relatively large energies, we can use a material with a relatively large band gap as the absorber for this junction, and

[11] We discuss only "two-terminal" multijunction cells in this chapter in which a single electrical current flows through the series-connected cells. See Chapter 9 for further discussion of 2, 3 and 4 terminal multijunction cell operation.