and the internal spectral response as

$$SR_{\text{int}} = \frac{I_{\text{SC}}(\lambda)}{qA(1-s)(1-r(\lambda))f(\lambda)(\mathrm{e}^{-\alpha(\lambda)W_{\text{opt}}}-1)}, \tag{3.147}$$

where W_{opt} is the optical thickness of the solar cell (technically, also a function of wavelength). Experimentally, the external spectral response is measured. The internal spectral response is determined from it along with the knowledge of the grid shadowing, reflectance, and optical thickness. W_{opt} can be greater than the cell thickness if light-trapping methods are used. Such methods include textured surfaces [20] and back-surface reflectors [21] and are discussed in Chapter 8. The short-circuit current can be written in terms of the external spectral response as

$$I_{\text{SC}} = \int_{\lambda} SR_{\text{ext}}(\lambda) f(\lambda)\, \mathrm{d}\lambda. \tag{3.148}$$

The internal spectral response gives an indication of which sources of recombination are affecting the cell performance. This is demonstrated in Figure 3.20 where the internal spectral response of the silicon solar cell described by the parameters of Table 3.2 is shown. Also shown is the spectral response when $S_{\text{F,eff}} = 100$ cm/s (a passivated front surface) and the spectral response when $S_{\text{BSF}} = 1 \times 10^7$ cm/s (in effect, no BSF). The short wavelength response improves dramatically when the front surface is passivated

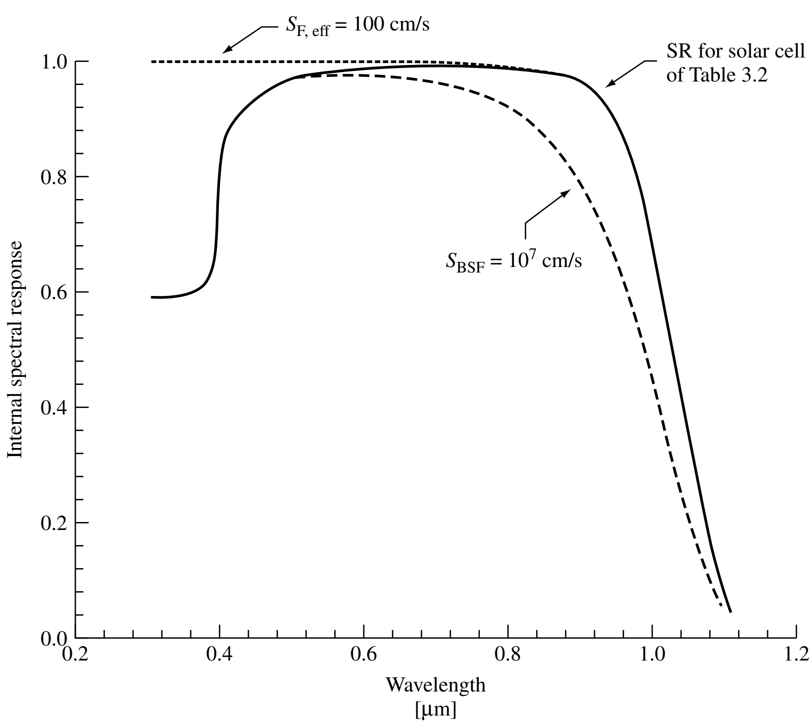

Figure 3.20 Internal spectral response of the silicon solar cell defined in Table 3.2