7.9.4 Optical Properties

The encapsulation affects the optical properties of the cells in several ways. The optical properties of the cells must be optimized attending to cost and performance after encapsulation.

Some effects of encapsulation are [139] as follows:

- The refraction index of glass and EVA is similar, around 1.5, between those of air and Si. Encapsulation acts, then, as a thick AR. For well textured Si solar cells, this antireflection action is enough and sometimes no thin ARC is used.
- The design of the ARC coating must account for the fact that the cell is illuminated from a medium with this index. The optimum ARC refractive index is larger than in air.
- Glass and EVA absorb some light in the short-wavelength range.
- Typically, 4% reflection occurs at the air–glass interface [Figure 7.23 (1)]. ARC coatings and texturing can be applied to decrease this loss.
- The light reflected by the metal fingers and the cell surface, if the reflected rays are tilted with respect to the normal to the glass surface, can be partly recovered by total internal reflection at the glass–glass interface [Figure 7.23 (2)]. This effect could be enhanced by texturing the cell surface with tilted pyramids, instead of the upright pyramids obtained by alkaline etching of (1 0 0) surfaces [140].
- Though the trapping capabilities of the cell, due to the lower difference in refractive index, appear to worsen with encapsulation, the escaped rays are trapped in the glass so that the absorption enhancement in the ideal case is not affected.
- For cells without a back metal mirror, the transmitted light can be recovered by putting a reflector, detached from the cell, at the back of the module [Figure 7.23 (3)]. The back plastic layer, if white, serves this purpose.
- The same white layer, since it reflects diffusively, allows some of the light incident between the cells to be collected [Figure 7.23 (4)].

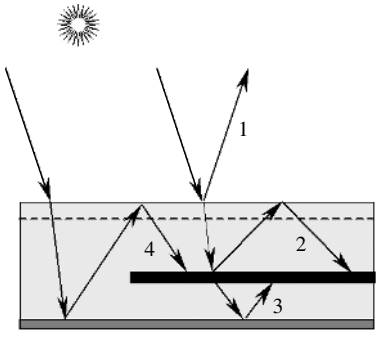

Figure 7.23 Optical effects of encapsulation: (1) glass reflection; (2) trapping of cell reflectance; (3) trapping of cell transmittance; (4) collection of peripheral light