are used in laboratory high-efficiency cells. The low index of passivating SiO_x in contact with Si degrades the performance of the ARC. The SiO_x layer is then made as thin as is compatible with efficient passivation [63].

7.3.6.2 Texturing

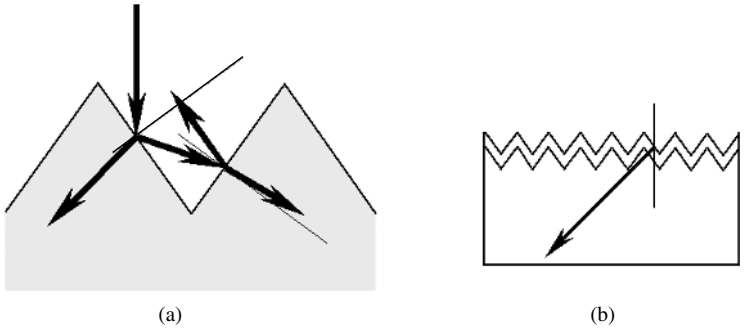
Alkaline (KOH or NaOH-based) solutions etch anisotropically a-Si crystal exposing {1 1 1} planes on which the etching rate is lowest. On [1 0 0]–oriented wafers, randomly distributed, square-base pyramids are formed, whose size is adjusted to a few microns by controlling etching time and temperature. In a textured face, a ray can be reflected toward a neighboring pyramid (Figure 7.5a) and hence absorption is enhanced. Though calculation of reflection requires ray tracing, a rough estimate of near-normal incidence can be derived, by assuming that each ray strikes twice the Si surface so that reflection is the square of the untextured case.

Texturing is incorporated into both industrial and laboratory Si solar cells, and, in combination with antireflection (AR) coating, reduces reflection losses to a few percent. In the latter case, in order to better control the pyramid geometry and to allow delineation of fine features on the surface, photolithographic techniques are used to define inverted or upright pyramids at the desired positions. It has to be noted that in this case the reflectivity is similar to that of a random texture [64].

Light entering the substrate at a textured surface is tilted with respect to the cell normal. This means that photogeneration takes place closer to the collection junction, which is very beneficial for low-diffusion length cells, by enhancing the collection efficiency of medium- to long wavelengths (Figure 7.5a). The effect is equivalent to an increase of the absorption coefficient. As a drawback, textured surfaces present higher SRVs.

7.3.6.3 Light-trapping

Long-wavelength photons are weakly absorbed in silicon, and, unless internal reflectances are high, they will escape the substrate without contributing to photogeneration. The aim of light-trapping or light confinement techniques is to achieve high internal reflectances.



(a) (b)

Figure 7.5 Effects of surface texturing: (a) decreased reflection; and (b) increased photogeneration in the base