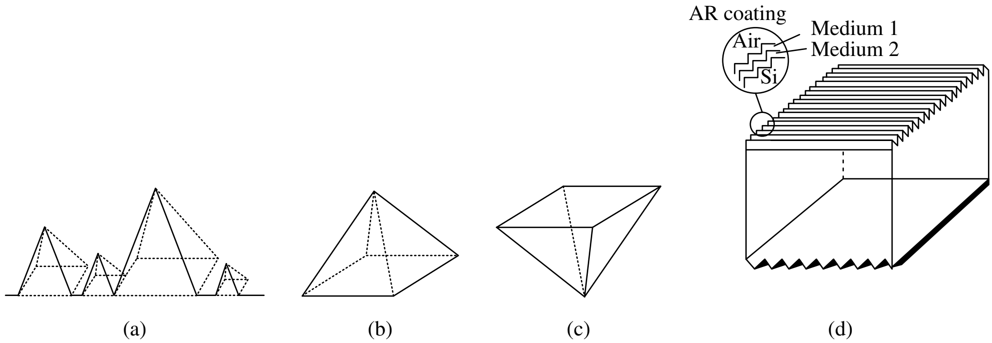

Figure 8.4 Sketches of various surface structures used in calculations shown in Figure. 8.3: (a) chemically textured random pyramids; (b) uniformly textured pyramids; (c) inverted pyramids; and (d) perpendicular slats

texture. A suitable approach for producing texture in TF-Si may be intrinsic to the use of polycrystalline material. This method has worked well for transparent conducting oxides used in thin-film a-Si.

Surface texturing naturally occurs in polycrystalline films deposited from a Si-bearing gas phase, as well as in thin and thick films grown at or near the melting point. Although exact mechanisms are not well established, texturing appears to be a grain-boundary effect. In a gas-phase growth, the high-energy grain-boundary sites allow migration of Si atoms away from the grain-boundary regions into the main grains, leading to a loss of material (thickness of the Si film) in the vicinity of the grain boundary [15, 16]. In a melt regime, such as in the growth of Si ribbons, there are local variations in the solidification temperature between the intragrain and grain-boundary regions. Because the surface tension of liquid Si or Si at high temperatures is quite high, it has the tendency to ball up at the free surfaces. This process results in grooving at the grain boundaries [17, 18]. Texturing is also observed in Si thin films crystallized by metal-induced crystallization [19]. A natural formation of texture in a Si film can play an important role in cost-effectiveness of TF-Si solar cells by obviating the need for a separate layer to enhance light-trapping. Because texturing is related to the growth or deposition process, it is important to note that texture shape and depth can change with a change in grain size. Brief discussions of the effects of texture height and texture angle are given in the next section. One of the drawbacks of texturing is that it greatly increases the surface area, thereby increasing dark current and reducing V_{OC}.

As pointed out in the previous section, interfaces (surfaces) attain a particularly significant role in a TF-Si solar cell because, for a given solar spectrum, a thinner cell has higher-generated carrier density near the surface due to enhanced light trapping. A simple way to envision increased sensitivity to surface recombination is to examine the distribution of absorbed photon flux in a thick wafer and a thin film. Figures 8.5(a) and 8.5(b) compare the distribution of absorbed photon flux in a 300-μm wafer and a 10-μm thin film of Si, respectively. Both cells have front and back texture, with an Al back-reflector. The texture heights for thick and thin cells are 3 μm and 0.6 μm, respectively. It is seen that the thin cell has an absorbed photon flux density about 3