Impurity gettering can also play an important role in fabrication of high-efficiency TF-Si solar cells. The Si as deposited for TF-Si cells also contains high concentrations of impurities. Although it is possible to deposit high-purity a-Si or poly-Si for laboratory purposes, it is difficult to maintain “cleanliness” in a high-throughput deposition system. In addition, low-cost substrates such as glass or ceramics will release impurities through desorption or diffusion, which can contaminate the deposition system and the Si film. Because of the small thickness of the Si film, gettering times can be short and/or process temperatures can be low. A unique way to provide for impurity gettering in a TF-Si solar cell is to include a layer of Al in the device structure (see Figure 8.12). Another approach for low-temperature gettering may be to inject vacancies. Because the impurities that kill minority-carrier lifetime are typically interstitial transition metals, a region of vacancy injection can be a “sink” for the impurities. Sources of interstitial sinks can also be interfaces (such as heterointerfaces), GBs, and other crystal defects. However, it has been observed that such sites can lead to precipitation of metallic impurities. Because it is very difficult to getter precipitated impurities, it is desirable to maintain impurity concentrations below the saturation levels. Precipitated impurities form local shunts which can severely degrade V_{OC} and FF of the device.

Similar to impurities, defects are sites for high-carrier recombination, causing degradation in solar cell performance. In a polycrystalline TF-Si solar cell, the dominant defects are GBs and intragrain dislocations. In both mc-Si and poly-Si, one often finds that intragrain defects segregate in certain preferred grains. Most solar cell processing does not change the nature or density of crystal defects because these defects are generally tangled, which prevents them from gliding. Like impurities, defects introduce energy levels in the band gap. The nature of the levels in a real material is quite complex, because the defects represent a host of defect configurations. Crystal defects always appear to have detrimental effects on material quality.

Typical solar-cell processes do not fully remove impurities from Si. Even the impurities that are readily gettered remain in the solar cell in significant levels and produce strong harmful effects on solar cell performance. In addition to residual impurities, many crystallographic defects are stable at the processing temperatures used. It is often observed that defect concentrations remain essentially unaltered by solar cell processing. Therefore, it is important to identify methods of dealing with the residual impurities and defects. Fortunately, hydrogen passivation has proven to be a very valuable process to deal with residual impurities and defects.

H is known to be electronically very active in Si, and it interacts with nearly all impurities and defects. H saturates dangling bonds at interfaces, and at point and extended defects, thereby reducing the carrier recombination and improving device characteristics. H can also interact with impurities in Si. The nature of such interactions depends on the type of impurities. For example, it can deactivate shallow dopants, both acceptor and donor types, leading to changes in the resistivity of the wafer. Although this effect is an undesirable feature for most cases, it can be used to reversibly alter dopant activity and to form erasable p/n junctions in some future applications. Atomic H can interact with metallic impurities such as Fe, Cr, Ni, Cu, and Au to reduce their effectiveness for carrier recombination in Si. H interactions with O exhibit a very interesting behavior – it appears that H diffusivity is lowered by the O, whereas the diffusivity of oxygen donors is greatly enhanced.