Table 12.4 Efficiency of small-area solar cells fabricated in different laboratories

Structure	Initial η [%]	Stable η [%]	Organization	References
a-Si/a-SiGe/a-SiGe	15.2	13.0	United Solar	[8]
a-Si/a-SiGe/a-SiGe	11.7	11.0	Fuji	[157]
a-Si/a-SiGe/a-SiGe	12.5	10.7	U. Toledo	[158]
a-Si/a-SiGe/a-SiGe		10.2	Sharp	[159]
a-Si/a-SiGe	11.6	10.6	BP Solar	[160]
a-Si/a-SiGe		10.6	Sanyo	[161]
a-Si/μc-Si		12.0	U. Neuchatel	[162]
a-Si/μc-Si	13.0	11.5	Canon	[163]
a-Si/poly-Si/poly-Si	12.3	11.5	Kaneka	[164]
a-Si/a-SiGe/μc-Si	11.4	10.7	ECD	[165]
a-Si/a-SiGe		12.4	United Solar	[166]

12.5.3.6 High-efficiency multiple-junction solar cells

Table 12.4 above lists some properties of multiple-junction solar cells fabricated in selected laboratories around the world. The degradation of multiple-junction solar cells is usually in the range of 10 to 20%, while the degradation of single-junction solar cells is usually in the range of 20 to 40%. These percentages apply to the cell's properties after 1000 h of light soaking under 1 sun light intensity at 50°C, which is the standard protocol used for gauging light degradation today. The degradation of triple cells is smaller because (1) the i-layers are thinner and (2) each i-layer absorbs only one-third of the total current, therefore having less photogenerated recombination in the i-layer. As one can see from the table, the highest stabilized cell efficiency is 13.0% for a triple-junction device structure made at United Solar Systems Corp. Table 12.4 also includes the best solar cells made using μc-Si as a component cell. The highest stable efficiency so far using a-Si/μc-Si tandem structure is 12% for a cell made at Univ. of Neuchatel using VHF plasma deposition.

12.5.4 Microcrystalline Silicon Solar Cells

Microcrystalline silicon (μc-Si) has been studied extensively for three decades [172] and has been used for doped layers in a-Si solar cells for over 15 years [134, 173]. Because of the difficulties in passivating the defects located at the grain boundaries, μc-Si was not actively considered as an intrinsic layer in the *pin* or *nip* type solar cells until 1992, when Faraji *et al*. [174] and Meier *et al*. [150] reported the fabrication of μc-Si–based *pin* solar cells using VHF PECVD. Since then, μc-Si and poly-Si solar cells have been fabricated by a number of research groups [163, 175–177].

A *QE* curve for such a μc-Si-based cell was presented in Figure 12.24. One can see that the μc-Si has a larger *QE* than the a-Si and a-SiGe cells at longer wavelengths (>850 nm). The total photocurrent generated from a μc-Si cell has reached 26 mA/cm^2 [150, 176]. Therefore, such cells are suitable for use as the bottom cell of a multijunction cell with a-Si-based cells as the top cell. The advantages of using μc-Si as the narrow band gap cell instead of a-SiGe are (1) the higher *QE* in the long-wavelength