

translate to 10% AM0 efficiency at 60°C. For cells on 0.05-mm-thick polyimide substrate at AM0 conditions, the 12% state-of-the-art and 10% typical cells should yield power-to-weight ratio of 1520 and 1100 W/kg, respectively. CdTe research and development for space applications, in which AM0 power-to-weight ratio greater than 1000 W/kg is desired, has followed three approaches with results as follows: (1) 6 to 7% AM1.5 efficiency for thin-film deposition in the *substrate* configuration on lightweight flexible substrates [25], (2) 11% AM1.5 efficiency for transfer of completed superstrate cells from rigid superstrates to lightweight flexible substrates [197], and (3) 11% efficiency for direct superstrate deposition onto 100- μm thick glass foils [105]. Encouraging results of CdTe/CdS cell stability were obtained under 1-MeV electron bombardment at fluences of 10^{14} to $10^{16}/\text{cm}^2$ [198].

For infrared detection and thermal imaging, devices using $\text{Cd}_{1-x}\text{Hg}_x\text{Te}$ alloys have been investigated intensively since the mid 1960s, leading to a significant technology base of sensor and charge-coupled device (CCD) imaging devices [199]. To achieve good sensitivity at wavelengths of 8 to 10 μm , long minority-carrier lifetime is required in the absorbing $\text{Cd}_{1-x}\text{Hg}_x\text{Te}$. To minimize trapping and Shockley–Read–Hall recombination centers, single crystals are fabricated using either a cast-recrystallization technique or the Bridgman growth technique. Schottky photodetecting arrays are fabricated on polished slices of the single crystals. High-quality $\text{Cd}_{1-x}\text{Hg}_x\text{Te}$ thin films have been deposited by both liquid-phase and vapor-phase epitaxy on CdTe and $\text{Cd}_{1-x}\text{Hg}_x\text{Te}$ single-crystal wafers [200].

Gamma ray detectors for tomographic applications based on CdTe have been investigated using two approaches: (1) direct detection by ionization in CdTe and (2) deposition of a CdTe/CdS thin-film photodetector on a scintillating superstrate such as cadmium tungstenate (CdWO_4). For direct detection, the gamma ray is stopped in CdTe in either a metal–semiconductor–metal or all-semiconductor *p-i-n* structure using CdTe single crystals [201]. In either design, the optimal detector is achieved with devices having the lowest possible leakage current and highest mobility-lifetime product.

Concerns have been raised about cadmium toxicity and the possibility of introducing significant amounts into the environment where the cells are manufactured and deployed. Managing cadmium in the manufacturing environment relies on a combination of appropriate engineering and chemical hygiene practices. Concerns over module deployment are being addressed at technical and policy levels. First, modules are environmentally well sealed, which serves to both protect the cell from environmental deterioration and to contain the semiconducting materials, in the event of mechanical failure. By recycling modules at the end of life in a manner consistent with metal products, it is estimated that nearly all the cadmium in a module can be recycled at a cost of roughly 5 cents/W [202]. Alternatively, module deployment by a leasing arrangement or by confinement to industrially managed energy farms could facilitate total control over installed cadmium distribution. The amount of cadmium used in thin-film CdTe modules is relatively modest. A CdTe module 1 m^2 in area, producing approximately 100 W of power using a CdTe layer less than 2 μm thick, contains less than 10 g of cadmium, or about the same as a single nickel–cadmium flashlight battery [203]. On a larger scale, it would take about 40 000 metric tons of cadmium to switch the entire US power grid to CdTe modules. Assuming a 30-year life cycle, about 7% of the current world output of cadmium would be required.