Table 14.5 Properties of pseudobinary II^B-VI^A alloys suitable for absorber layers

Compound	Single crystal optical E_g range 300 K [eV]	Optical bowing parameter	Stable endpoint structure	Miscibility gap?
Cation substitution				
$Cd_{1-x}Zn_xTe$	1.49–2.25	0.20	ZB–ZB	N
$Hg_{1-x}Cd_xSe$	0.10–1.73	?	ZB–W	N
$Hg_{1-x}Zn_xTe$	0.15–2.25	0.10	ZB–ZB	N
Anion substitution				
$CdTe_{1-x}S_x$	1.49–2.42	1.70	ZB–W	Y
$CdTe_{1-x}Se_x$	1.49–1.73	0.85	ZB–W	?
$CdSe_{1-x}S_x$	1.73–2.42	0.31	W–W	N
$HgTe_{1-x}S_x$	0.15–2.00	?	ZB–ZB	?
$HgSe_{1-x}S_x$	0.10–2.00	?	ZB–ZB	?

devices. For terrestrial photovoltaic applications, in which a band gap of ~1.5 eV is desired, considerable progress has been made in the development of solar cells based on the CdS-CdTe heterojunction wherein $CdS_{1-y}Te_y$ and $CdTe_{1-x}S_x$ alloys have been shown to play a role in the device operation. For the development of next-generation, multijunction cells, top cells with an absorber band gap of ~1.7 eV are required [193, 194].

The alloy systems shown in Table 14.5, separated by cation and anion substitution in pseudobinary compounds, define a broad range of optical band gap suitable as absorber layers in terrestrial photovoltaic converters. The isostructural systems $Cd_{1-x}Zn_xTe$ and $Hg_{1-x}Zn_xTe$ offer tunable systems with a wide range of band gap and controllable p-type conductivity.

Thin-film solar cells based on $Cd_{1-x}Zn_xTe$ were the subject of study in the late 1980s, by several laboratories, including the Georgia Institute of Technology (GIT) and International Solar Energy Technology (ISET). Two approaches to depositing the $Cd_{1-x}Zn_xTe$ films had been considered in the previous work: synthesis by reaction of sequentially deposited metal layers (ISET) and metal organic chemical vapor deposition (GIT). CdS/$Cd_{1-x}Zn_xTe$ devices using $Cd_{1-x}Zn_xTe$ films made by the reaction of sequentially deposited metals with $x = 0.1$, corresponding to E_g~1.6 eV, yielded 3.8% efficiency and suffered from low V_{OC} and FF [195]. Although little follow-up work was conducted to explain the low performance, for CdS/ $Cd_{1-x}Zn_xTe$ devices made by MOCVD, it was found that the $CdCl_2+$ air treatment step reduced the band gap from 1.7 to 1.55 eV, owing to chemical conversion of the zinc alloy to volatile $ZnCl_2$. The best cells made with the 1.55 eV band gap yielded 4.4% conversion efficiency [196].

CdTe-based thin-film photovoltaic devices are also suited to applications beyond terrestrial power conversion, including space-power generation, infrared detectors, and gamma radiation detectors. Using the current–voltage characteristics of state-of-the-art and realistic devices on rigid glass superstrates, AM0 operation at 60°C can be determined by accounting for the temperature dependence of the band gap and differences in irradiance. State-of-the-art cells with 16.5% AM1.5 efficiency at 25°C translate to 13.9% AM0 efficiency at 60°C. Typical cells having 12% AM1.5 efficiency at 25°C