

Photoluminescence Characterization of CdTe/CdSe Superlattices Grown on GaSb for Solar Cell Applications

Jing-Jing Li¹, Shumin Wang¹, Xinyu Liu^{2,*}, Jin Fan¹,
Jin-Hui Tan¹, Ding Ding¹, Shane R. Johnson¹, Jacek
K. Furdyna², Yong-Hang Zhang^{1,*}

¹Arizona State University, Tempe, Arizona 85287
USA, ²University of Notre Dame, Notre Dame,
Indiana, 46556, USA

Monolithically integrated high-efficiency multijunction solar cells are highly desirable for both space and terrestrial applications [1-4]. Recently, we proposed the integration of the II/VI (CdZnMg)(SeTe) and III/V AlGaAsSb material systems grown lattice-matched on GaSb substrates for multijunction (MJ) solar cells [5, 6]. In order to cover the entire solar spectrum, it is necessary to grow the ternary alloy CdSe_xTe_{1-x} on GaSb. However, few successful attempts of growing random alloy CdSe_xTe_{1-x} by molecular beam epitaxy (MBE) have been reported. In this work, CdTe/CdSe superlattice samples are grown by MBE on undoped GaSb substrates and their optical properties are studied using photoluminescence (PL) measurements. Fig. 1 shows the cross section of the. It consists of 50 periods of CdTe and CdSe layers with nominal thicknesses of 1.5 nm and 12 nm, respectively.

The samples are annealed at temperatures ranging from 300 to 400 °C for 10 minutes using post-growth thermal annealing. The PL spectra of the samples are measured at room temperature using an Ar⁺ laser with excitation powers ranging from 30 to 300 mW at a pump wavelength of 488 nm, as shown in Fig. 2.

Fig. 3 and 4 shows the PL peak intensities and positions of the samples annealed at temperatures ranging from 300 to 400 °C. The sample annealed at 350 °C has the strongest PL intensity, and its peak position shifts from 1.24 eV (as grown) to 1.26 eV (annealed). The PL peak energy shifts linearly with anneal temperature and has a slope of 0.4 meV/°C over the anneal temperatures studied. This shift is most likely due to the interdiffusion and exchange of Te and Se atoms from their respective layers; this modifies the effective width and depth of the potential well for the holes in the CdTe layer, resulting in the increase of the ground state energy of

the holes. In general, PL intensity is improved by annealing up to 375 °C, where over the 350 to 375 °C range the PL intensity is a factor of six greater than the as-grown material, indicating a substantial improvement in the quantum efficiency; the PL intensity and hence quantum efficiency rapidly degrades with anneal temperature beyond 375 °C.

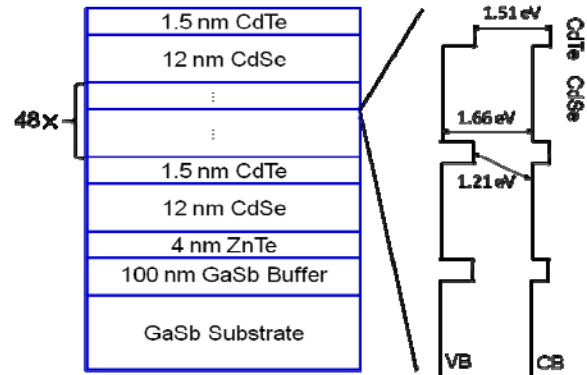


Fig. 1 The cross section of the sample and the band structure of the superlattice. The sample is a CdTe/CdSe superlattice grown on an undoped GaSb substrate. The band structure shows that it is a type II superlattice.

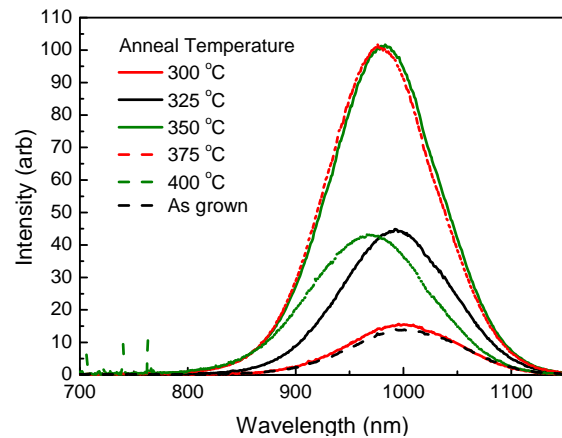


Fig. 2 The PL spectra of the samples annealed at temperatures ranging from 300 to 400 °C using an Ar⁺ laser with the excitation power of 50 mW at a pump wavelength of 488 nm.

* Email: yhzhang@asu.edu

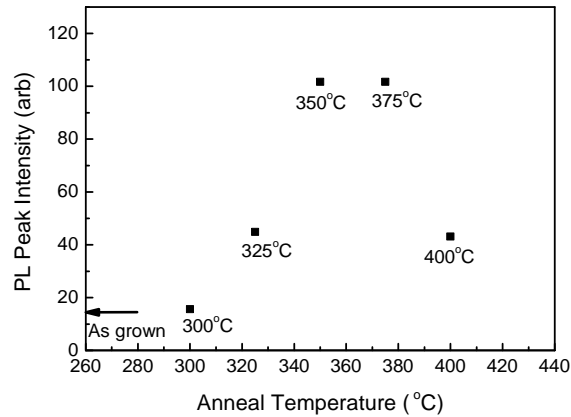


Fig. 3 The PL peak intensities of the samples annealed at temperatures ranging from 300 to 400 °C. The PL intensity is improved by annealing up to 375 °C, where over the 350 to 375 °C range the PL intensity is a factor of six greater than the as-grown material.

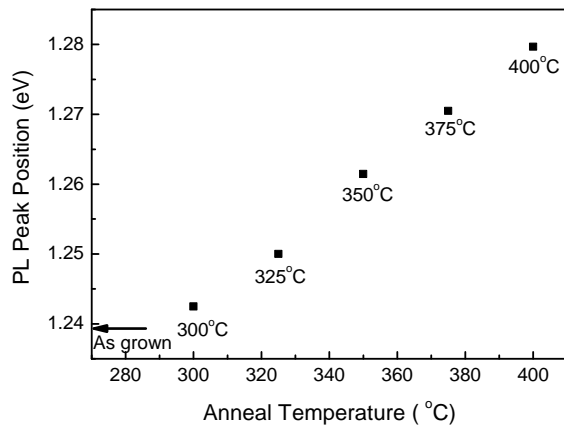


Fig.4 The PL peak positions of the samples annealed at temperatures ranging from 300 to 400 °C. The PL peak energy shifts linearly with anneal temperature and has a slope of 0.4 meV/°C over the anneal temperatures studied.

- [1] J. M. Olson et al., APL, 56 623, 1990
- [2] R. R. King et al., Proc. 28th IEEE PVSC, p. 998, 2000
- [3] J. F. Geisz et al., APL, 91 023502, 2007
- [4] R. R. King et al., APL, 90 183516, 2007
- [5] Y.-H. Zhang et al., Proc. 33rd IEEE PVSC, 2008, in press
- [6] Y.-H. Zhang et al., Proc. 33rd IEEE PVSC, 2008, in press