Effect of Ga-Dangling Bonds at the GaSb/GaAs Interface of GaSb TPV Cells Grown on GaAs Substrates by IMF Technique

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The growth of metamorphic GaSb epitaxial layers on GaAs substrates has become of significant interest in the areas of mid to long wave infra-red (IR) optoelectronic devices. In the case of thermophotovoltaics (TPVs), GaAs substrates are an attractive alternative to GaSb substrates on account of their semi-insulating nature, relatively lower cost, and ability to scale up to large wafer sizes. Unfortunately, the mismatched growth of GaSb epitaxial layers on GaAs substrates results in significant threading dislocations in the GaSb epitaxial layer due to the 7.78% lattice mismatch between the two binary semiconductors. However, the threading dislocation density (TDD) on the GaSb epitaxial layer can be reduced by inducing arrays of 90° interfacial misfit dislocations (IMF) at the GaSb/GaAs interface [1]. This technique reduces the TDD in the GaSb epitaxial layer to the low 10^8 defects/cm^2, which has been sufficient to demonstrate a wide range of devices. However, for TPVs, the residual threading dislocations on the GaSb epitaxial layer severely affects the performance of the GaSb diodes under illumination. Although we are continuously working in optimizing the growth technique to further reduce the TDD, the 90° IMF are made of Ga-dangling bonds localized along the GaSb/GaAs interface which also affect the electronic properties of the devices [2]. These Ga-dangling bonds can act as trap carriers and further affect the performance of metamorphic GaSb TPVs. We have grown and processed a p-n GaSb TPV cell on GaAs substrates. To study the effect of the Ga-dangling bonds on the performance of the cell, we placed the n-type contacts above the IMF interface for some cells and below the IMF for other cells. The presentation will provide extensive characterization data including J-V characteristics of solar cells under dark and illumination.

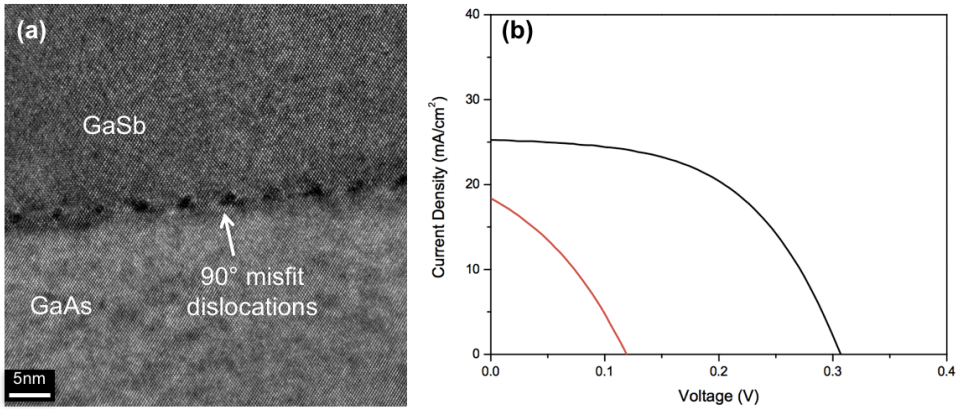

Fig 1. (a) High resolution transmission electron microscope image of GaSb/GaAs interface and J-V characteristics of metamorphic and lattice matched GaSb TPVs under 1 sun illumination

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[1] S. H. Huang, et al. Appl. Phys. Lett. **88**, 131911 (2006).
[2] A. Jallipalli, et al. Appl. Phys. Lett. **95**, 072109 (2009).