Integration of Thin Film TPV Cells to CVD Diamond Heat Spreaders

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Abstract

In this work, techniques to isolate thermophotovoltaic (TPV) devices from the growth substrate and their subsequent integration with Chemical Vapor Deposition (CVD) diamond heat spreaders will be discussed, with the envisioned goal of fabricating thermally managed cells. CVD diamond heat spreaders are a great option for thermal management of TPV cells. The key requirement, however, is the bonding of the TPV cell directly onto the diamond wafer without the presence of thick (>350 μm) growth substrates, which can offer significant thermal resistance.

The first approach is to release GaSb epitaxial layers from GaSb substrates. However, this is challenging due lack of highly selective etchants for the GaSb/AlSb/InAs system. Nonetheless, small areas of GaSb films were released.

Another option is to grow GaSb TPVs on GaAs substrates. Taking full advantage of the highly selective etch chemistry of GaAs/AlAs systems, large area GaSb thin-films were released from GaAs substrates. However, the threading dislocations due to the 7.8 % mismatch between GaSb and GaAs resulted in devices with poor performance.

Finally, the fabrication and integration of thin film TPV cells to CVD diamond is demonstrated by growing InGaAs TPV cells on InP substrates. Lattice-matched InGaAs/InP is the ideal system since there are no threading dislocations and the system offers high etch selectivity. The many challenges in achieving freestanding thin film TPV devices are described along with structural and electrical characterization data.