Growth and application of quantum dot superlattice for high-efficiency intermediate band solar cells

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[Abstract]
Efficiency enhancements exceeding the Shockley-Queisser limit of a single junction solar cell is possible with an intermediate band solar cell (IBSC), which incorporates a quantum dot (QD) superlattice in the active region of a $p$-$i$-$n$ cell structure. The presence of IB leads to generation of a net electron-hole pair when two below-bandgap photons are absorbed, i.e. one photon pumps an electron from the valence band (VB) to IB, while a second photon pumps an electron from the IB to conduction band (CB). These electron-hole pairs add to those produced by band-to-band transitions with photons above the bandgap energy that excite electrons directly from VB to CB.

Experimental challenges to demonstrate IBSCs require fabrication of a close-packed QD superlattice. We have demonstrated the first QD solar cell with 30 multi-stacked InAs/AlGaInAs QD layers fabricated on InP (311)B substrate by using strain compensation technique. Recently, strain-compensation technique has been applied to demonstrate multi-stacked QDSCs with InAs/GaNAs on GaAs substrates.