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Lattice-mismatched phosphide-based LEDs for color mixing white light applications

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The most promising means of achieving high efficiency white light emitting diodes (LEDs) with high color rendering indices (CRI) is to combine individual red (615 nm), yellow (573 nm), green (535 nm) and blue (459 nm) solid-state LEDs in a four color RYGB architecture. Due to their high bandgaps and the availability of bulk substrates, phosphide-based alloys are currently leading candidates for achieving the longer wavelengths, of which AlGaInP lattice-matched to GaAs has been extensively explored. In a departure from this approach, we investigate phosphide alloys at compositions that are lattice-mismatched with respect to GaAs for color mixing white light applications. Lifting the lattice-matching requirement extends the options for active and cladding layer design and optimization, thereby providing additional avenues for reducing carrier loss pathways and improving device efficiency. This talk covers our work on issues central to the success of this technology: metamorphic growth of high quality epilayers, the competing trade-off between operating wavelength and intervalley carrier transfer loss, and the availability of optimal cladding layers for high power operation. Support from the DOE EERE-SSL and BES-DMS programs and the LDRD program at NREL is gratefully acknowledged.