Red LEDs – AlInGaP VTF

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AllInGaP direct red enables:

Wider color gamut in displays

Achieving wider gamut:
- Narrow spectral width (higher spectral purity) for 3 channel solution
- Split light into 4 independent channels for wideband sources

Advantages of hybrid LEDs:
- vs. pc-LEDs: alternative to challenging narrow red phosphor target
- vs. direct-emitting LEDs: efficient green spectrum emission
Latest Lumileds AlInGaP products on the road; rear lighting
Why AlInGaP red?

Wide offering of automotive products for strong market position

Critical Success Factors

- High brightness
- High efficiency - lm/W
- Competitive lm/$
- Well-controlled color bins
- Long-term supportability

Product Platforms

- SMD SignalSure
- SnapLED and SnapLED Xtreme
- High Power LUXEON Rebel and LUXEON F

Technology building blocks

Epi: 3 color targets
Amber, Red Orange, Super Red

5 die types
Mid-power / high-power

Level 1 packages
VTF epi and device:

P-layer: GaP
MQW
N-layer
substrate

As grown p-layer on top

Vertical Thin Film (VTF) n-layer on top

• GaP has to be the last layer grown epitaxially due to lattice-mismatch
• Submount & metal bond go together
• Electrically & thermally conductive submount, preferably CTE matched to AlInGaP
• Bonding temperature needs to consider various CTEs

<table>
<thead>
<tr>
<th>Typical VTF device with dome - Nominal $T_j$, $I_f$</th>
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<tbody>
<tr>
<td>Internal Quantum Efficiency</td>
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<tr>
<td>0% 20% 40% 60% 80% 100%</td>
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Summary

**AllInGaP LED architectures – the good:**
- Multiple wavelength capability for wide range of applications/solutions
- Narrow emission linewidth – higher gamut
- No Stokes shift energy loss
- Better color tuning in mixed systems
- Color stability – over time
- Lower cost – materials, yields, binning

**AllInGaP LED management – not so good:**
- Thermal management – lower H/C factor than InGaN
- In hybrid systems:
  - Need good color mixing
  - Multiple channels – driver complexity
- Available die architectures (mostly VTF)
- Amber and shorter wavelengths (higher strain)
Thank you