Light emitting diodes using $\text{In}_x\text{Ga}_{1-x}\text{P}$ quantum well structures for wound healing

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Outline

• Motivation and background
• Simulation results
• Final Structure
• Summary
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Motivation and background

- Light therapy used to treat skin wounds
  - Traditional methods → thermal damage
- 610 – 650 nm wavelengths for difficult to heal wounds
- LEDs → tunable emission
  - Forward biased p-n junction
  - low-cost, mobile, safe

*BioPhotas (2015).*

*Sparkfun (2018).*
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- Simulation results
  - Indium composition in wells
  - Number of quantum wells
  - Well thickness

- Final Structure

- Summary
Lateral LED structure

- Target emission wavelength: 610 – 650 nm
- $\text{In}_x\text{Ga}_{1-x}\text{P}$ active region material
- $(\text{Al}_{0.6}\text{Ga}_{0.4})_{0.5}\text{In}_{0.5}\text{P}$ barriers
- Wavelength tunability: well composition, width

Indium composition

- Increasing In red-shifts spectrum
- Turn-on voltage decreases with increasing In
Indium composition

- Increasing In red-shifts spectrum
- Turn-on voltage decreases with increasing In
- Internal quantum efficiency increases with In
- Maximum radiative recombination increases with In
Number of quantum wells

- Increasing number of wells increases emission intensity
- Turn-on voltage decreases with number of wells
Number of quantum wells

- Increasing number of wells increases emission intensity
- Turn-on voltage decreases with number of wells
- Decrease in internal quantum efficiency with more wells
- Total radiative recombination evenly distributed between wells
Well thickness

- Increasing well width red-shifts peak emission
- Turn-on voltage decreases with increasing width
Well thickness

- Increasing well width red-shifts peak emission
- Turn-on voltage decreases with increasing width
- Internal quantum efficiency decreases with increasing width
- Radiative recombination decreases with increasing width
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Final LED structure

- 5 quantum wells
- 5 nm thick wells and barrier
- In\(_{0.55}\)Ga\(_{0.45}\)P composition
Final LED structure

- 5 quantum wells
- 5 nm thick wells and barrier
- $\text{In}_{0.55}\text{Ga}_{0.45}\text{P}$ composition

- Peak emission = 647 nm
- Turn-on voltage = 1.8 V
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Summary

- 610 – 650 nm light required for difficult to heal wounds
- InGaP/(AlGa)InP multiple quantum well LED
- Composition and well width tunes emission wavelength
- 55% In, 5 nm well, 5 wells optimum for 647 nm emission
Thank you!