



# CONCELL PROJECT: Investigation of coupling effects via PL

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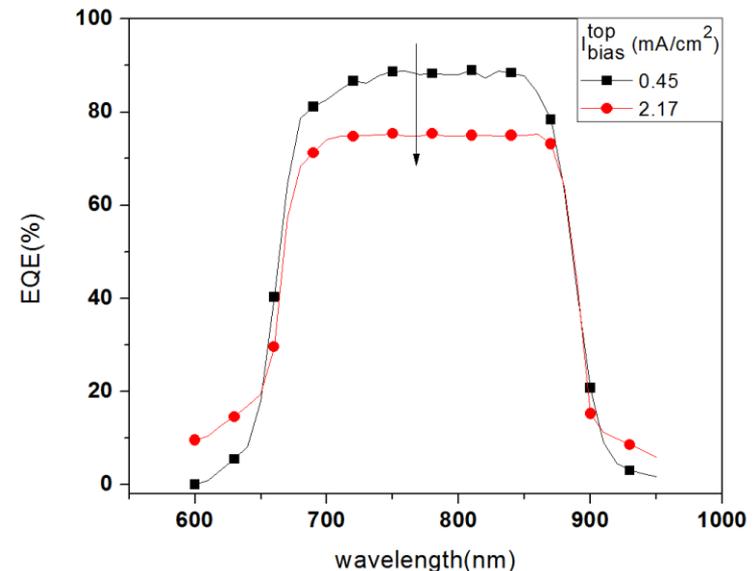
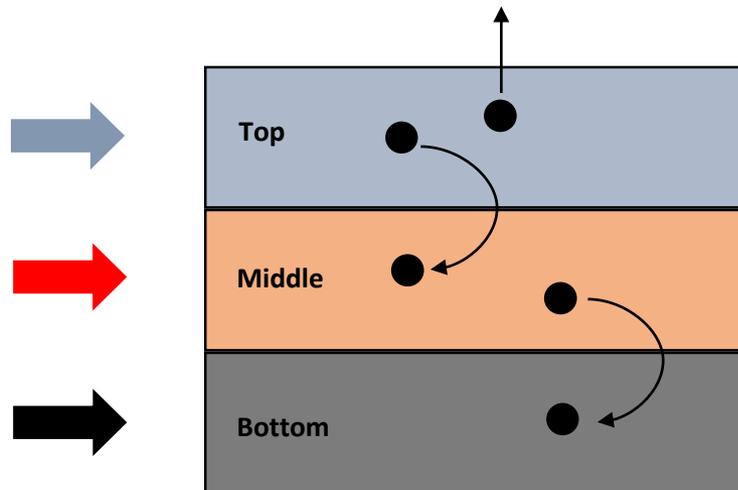
# Overview

- Introduction to coupling effects
- Scientific Innovation
- Experimental approach
- Preliminary results of PL measurements
- Conclusions

# Luminescent coupling effects

**Luminescent coupling effects:** Phenomenon in which a significant amount of photons originate from radiative recombination in the top junctions can be reabsorbed by the bottom ones.

- ✓ High band-to-band recombination in direct band-gap materials
- ✓ Affect the current matching between junctions
- ✓ Reduce or increase the efficiency of the triple-junction device



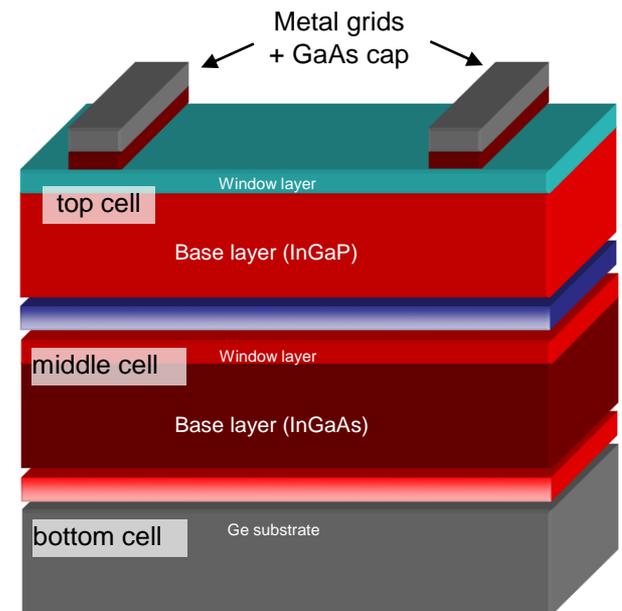
# Experimental set-up for PL

## ❑ Equipment Used:

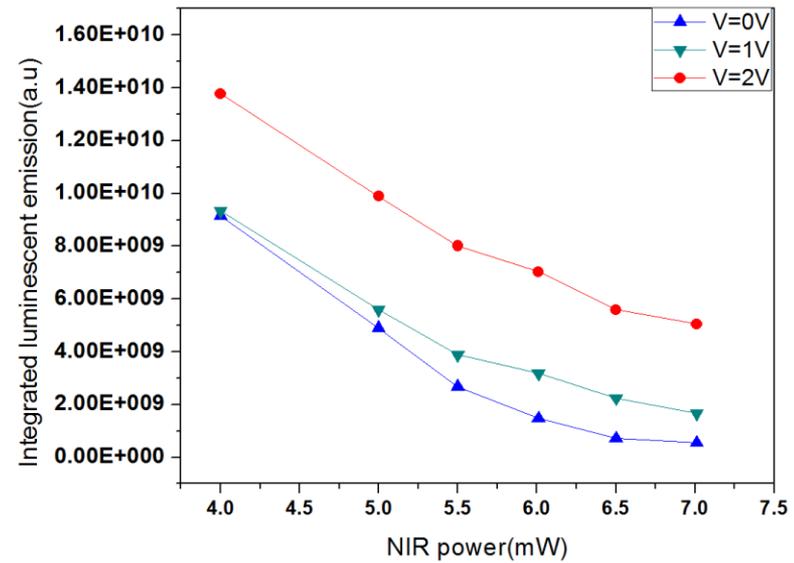
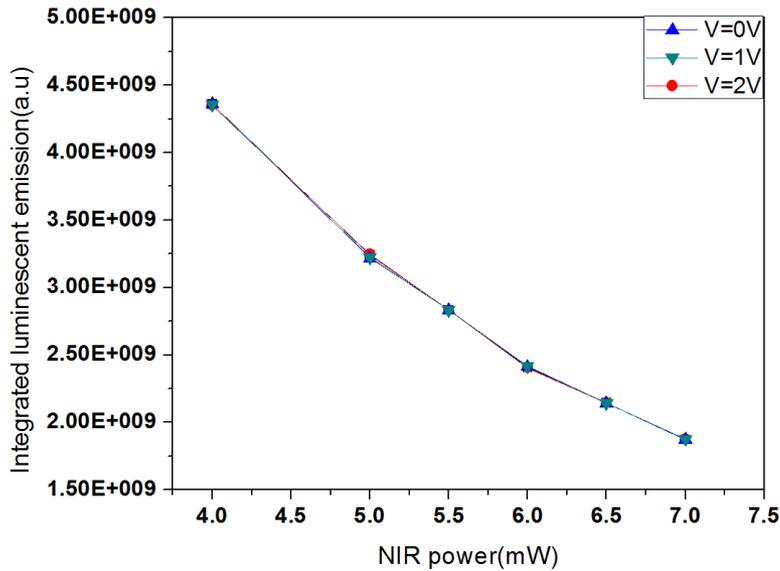
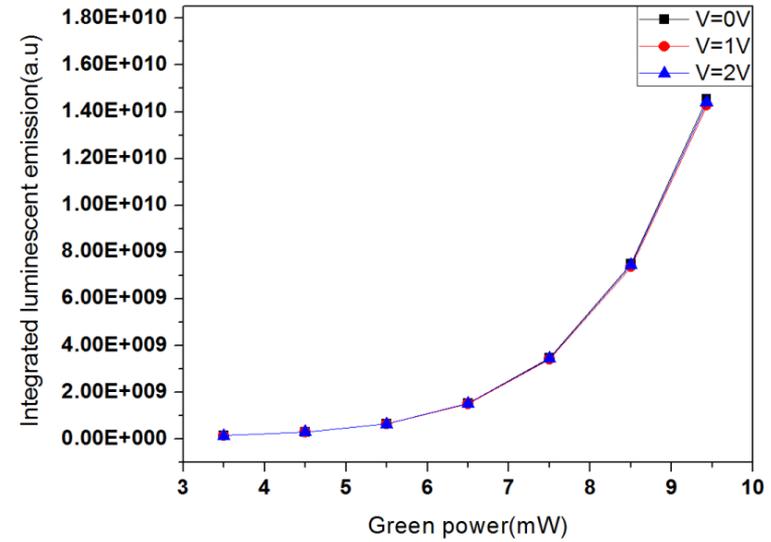
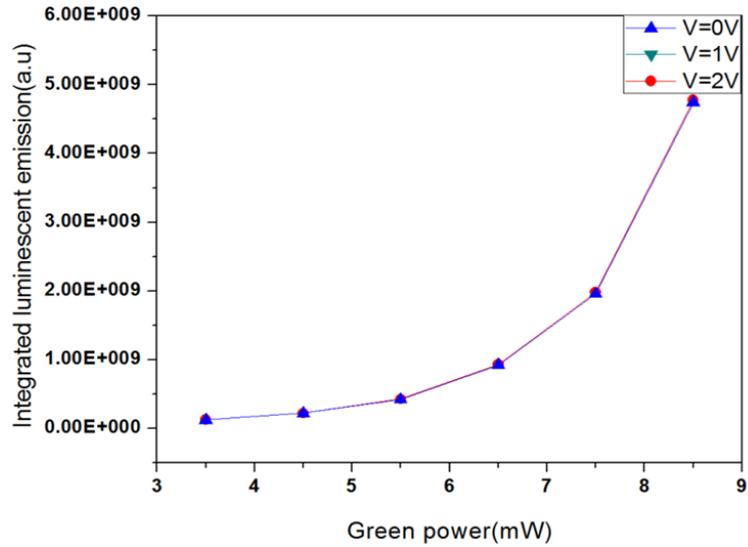
- Green laser (520 nm): 3.5-8.5 mW
- NIR laser (780nm): 4-7 mW
- Si Spectroradiometer: 300-1000 nm
- Voltage source: Keithley 2430

## ❑ Cells under examination:

- ✓ Lattice-matched (LM)  
 $\text{In}_{0.50}\text{Ga}_{0.50}\text{P}/\text{In}_{0.01}\text{Ga}_{0.99}\text{As}/\text{Ge}$
- ✓ Upright metamorphic (UMM)  
 $\text{In}_{0.65}\text{Ga}_{0.35}\text{P}/\text{In}_{0.17}\text{Ga}_{0.83}\text{As}/\text{Ge}$
- ✓ Lattice matched  $\text{In}_{0.50}\text{Ga}_{0.50}\text{P}/\text{In}_{0.01}\text{Ga}_{0.99}\text{As}/\text{Ge}$  of different thickness on the top junction base layers (p-type InGaP): 800 nm & 1500 nm



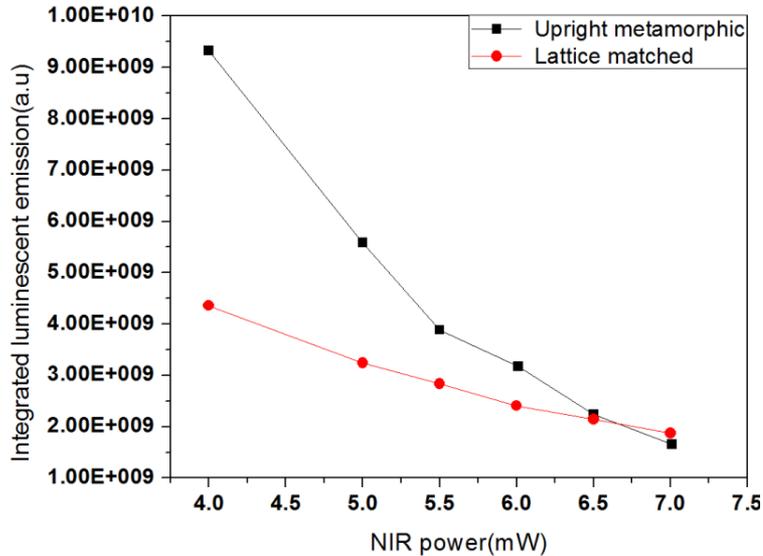
# PL Results



Lattice matched InGaP/InGaAs/Ge

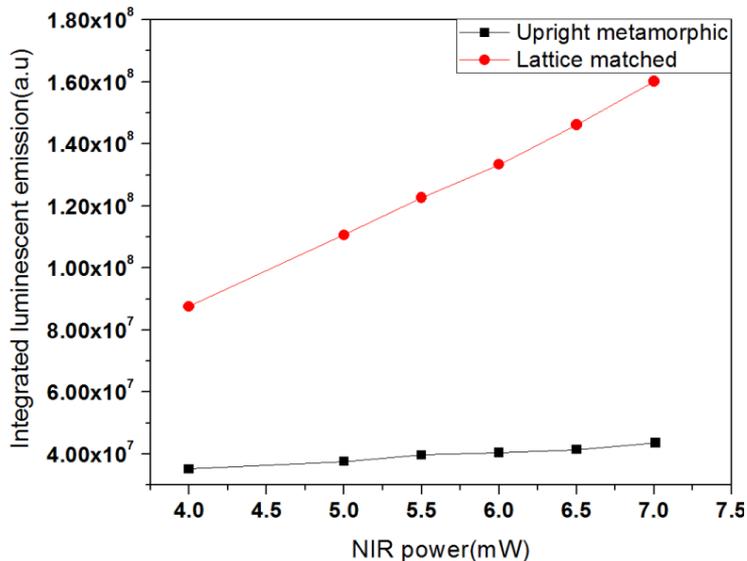
Upright metamorphic InGaP/InGaAs/Ge

# PL Results



Emission quenching:

- Upright metamorphic multi-junction: 82.2%
- Lattice matched multi-junction: 57%



InGaAs emission linear increase:

- Lattice matched: 82%
- Upright metamorphic: 24%



More pronounced coupling effects in lattice matched structure

# Conclusions

- Consistent exponential emission quenching of the InGaP peak against NIR laser power is obtained at all voltage bias in LM cell.
- In UMM cell, exponential quenching of the InGaP peak in the presence of NIR laser power is obtained only at lower voltage bias. At higher voltage biases the reduction of the peak is linear.
- Higher emission quenching of the InGaP junction peak is obtained against NIR light intensity in UMM cell.
- Lower emission increase of the InGaAs junction is obtained against NIR light in UMM cell.
- Linear increase of the middle junction indicates that the operating point of the junction is in the flat region.