**Docket #:** S20-206

# Space Charge Trap-Assisted Recombination Suppressing Layer for Low-Voltage Light-Emitting Diode Operation

Researchers in the Fan group have developed a method for epitaxial growth of double heterojunction semiconductor diodes capable of suppressing parasitic non-radiative recombination effects. This enhances the performance of light emitting diodes (LEDs), photovoltaics, thermophotovoltaics, and p-i-n photodetectors. To achieve this, the method reduces trap-assisted non-radiative recombination in the depletion (i.e. space charge) regions of the optically active semiconductor layers. By circumventing these performance degrading effects, incident light can be more efficiently converted to electricity and electricity can be more efficiently converted into light. This effect is prominent at voltages where solar photovoltaic cells and photodetectors operate. The performance enhancement at these voltages is prominent in LEDs designed for extremely high efficiency extending into the regime wherein solid-state radiative cooling, also known as electro-luminescent refrigeration, is possible.

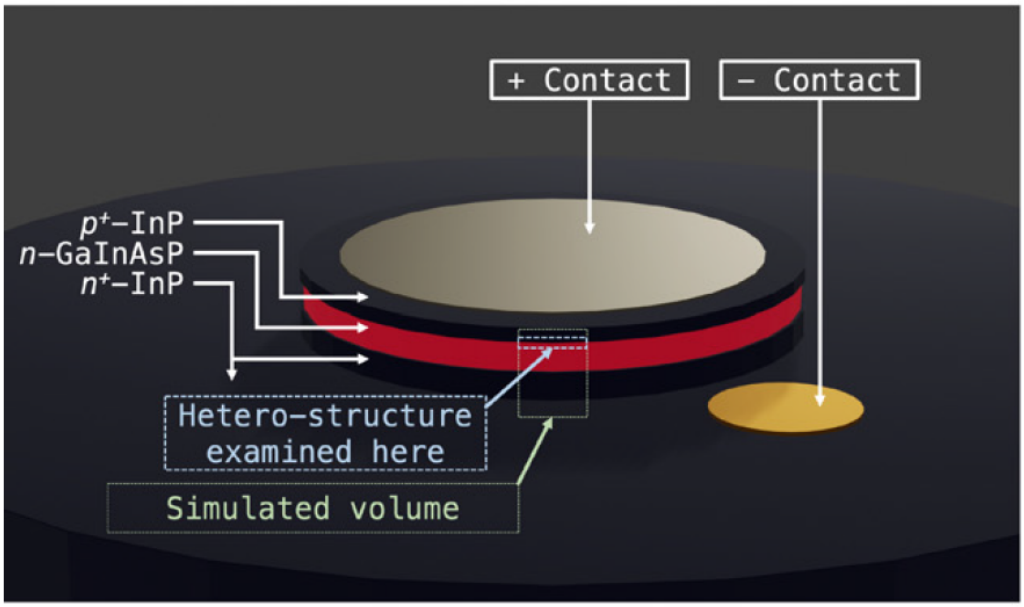



Image description: A depiction of the fabricated device highlighting the heterojunction used to enhance performance. Ref: Santhanam et al. Applied Physics Letters (2020)

**Stage of Research**

- Prototype

## Applications

- Multi-junction and thermo photovoltaic cells
- LEDs
- Photo-diode detectors
- Thermal management of handheld consumer electronics and low earth orbital satellites via new photonic heat transfer technology
- Infrared and thermal cameras

## Advantages

- Higher efficiency under dim illumination conditions for photovoltaics including IoT light harvesting
- More efficient LEDs for solid state lighting
- Increased sensitivity for ultra-low-noise photo-diode detectors
- Improved dark current noise in avalanche photo-diodes important for LiDaR

## Publications

- Santhanam et al. Applied Physics Letters (2020) Controlling the dopant profile for SRH suppression at low current densities in ?= 1330 nm GaInAsP light-emitting diodes
- Santhanam et al. Proceesings of SPIE (2021) Suppressing non-radiative generation and recombination in LEDs, PVs, and photodiode detectors via inhomogeneous doping around the depletion region co-located with a heterojunction

## Patents

- Published Application: 20210408318
- Issued: 11,715,809 (USA)

## Innovators

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