Booth #222

NanoLEDs for Microdisplays and Covid Disinfection

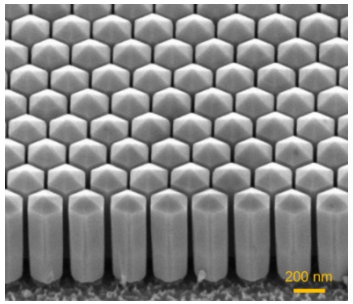
Seth Coe-Sullivan, CEO and Co-Founder
Victor Hsia, VP Global Sales
NS Nanotech, Inc.

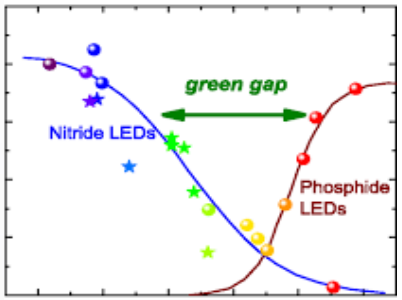
Display Week 2022

Introduction and Outline

Introduction

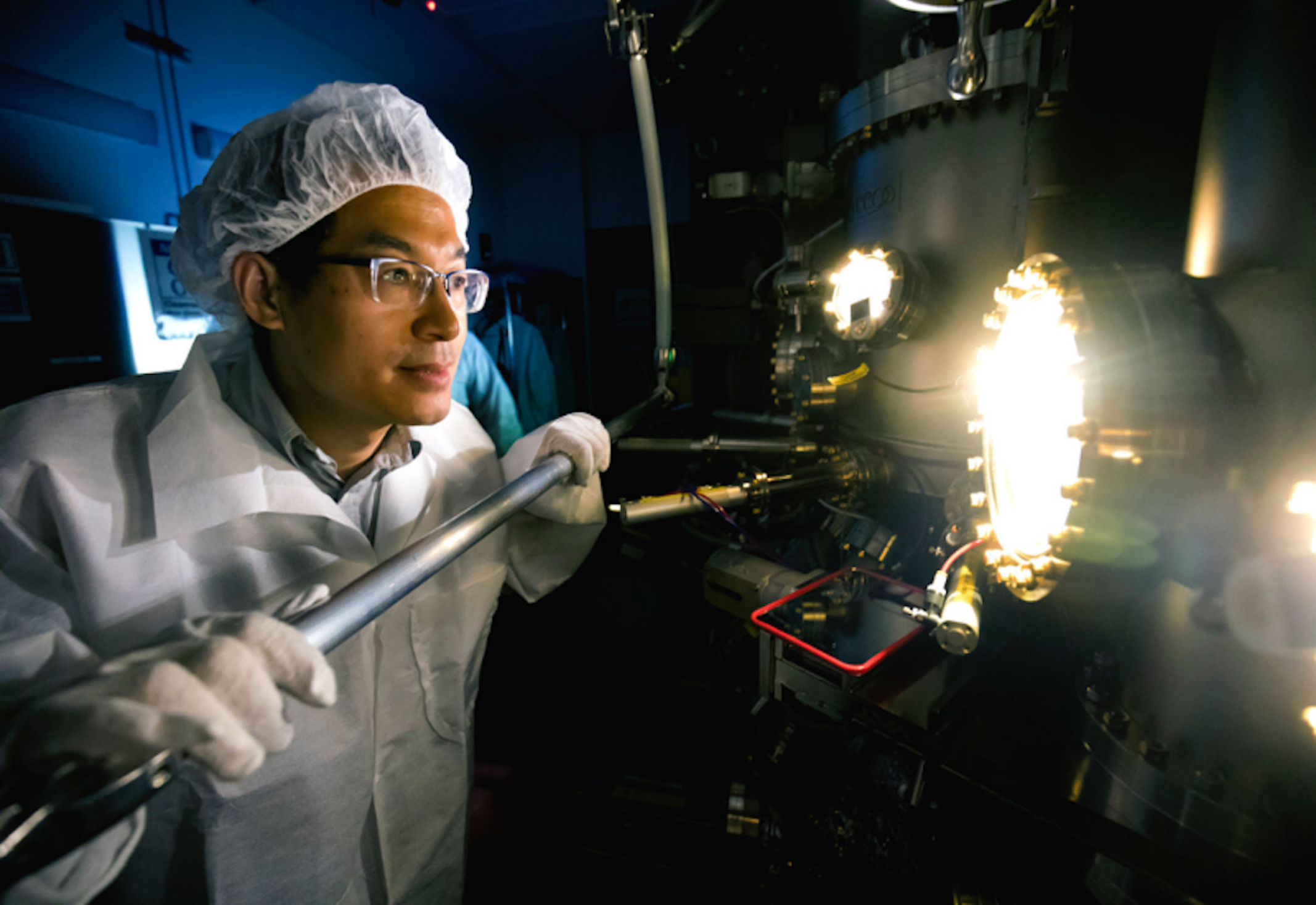
Breakthroughs in material science





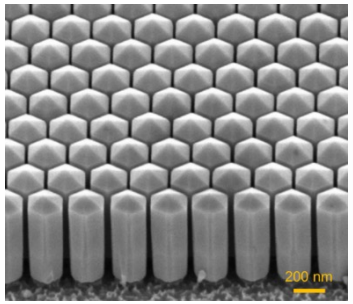
Breakthroughs in performance

Pivot to UVC product focus

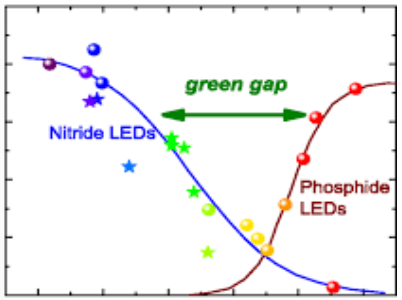


Outline

Introduction



Breakthroughs in material science

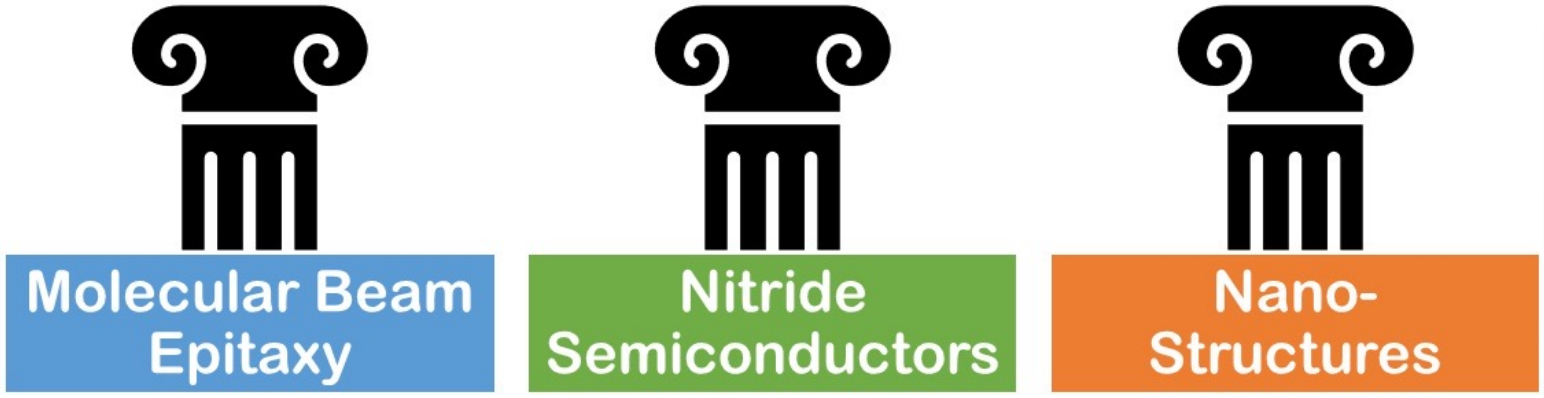


Breakthroughs in performance

Pivot to UVC product focus

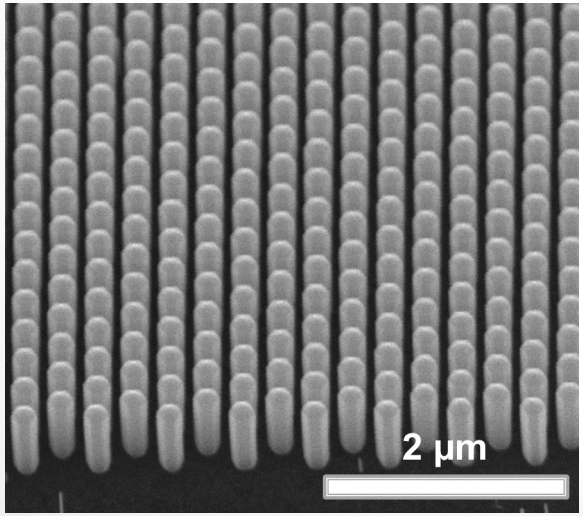
Breakthroughs in Material Science

- Catalyst-Free Growth
- Disks-in-Nanocolumn
- Photonic Bandgap
- Monolithic Integration

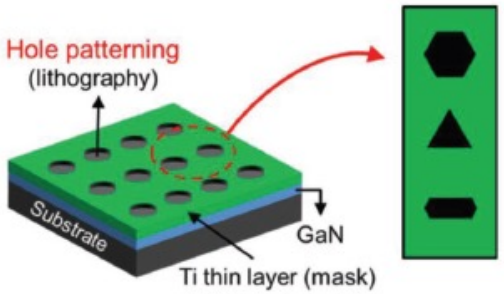


Catalyst-Free Nanocolumn Growth

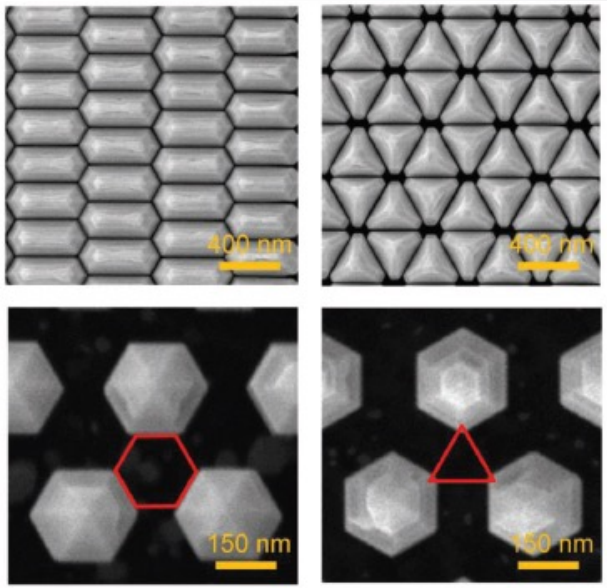
- Fixed to a surface
- No ligands, organics, Carbon, nor Hydrogen
- No foreign metals incorporated into columns
- Templated for complete control of size and shape



Laleyan, unpublished.



Ra, et al., Adv. Funct. Mater. 27, 1702364 (2017).



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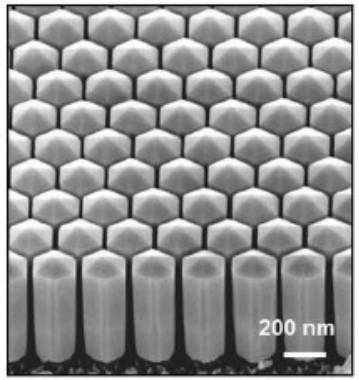

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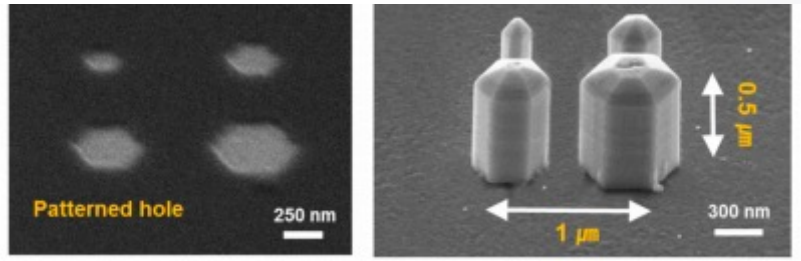
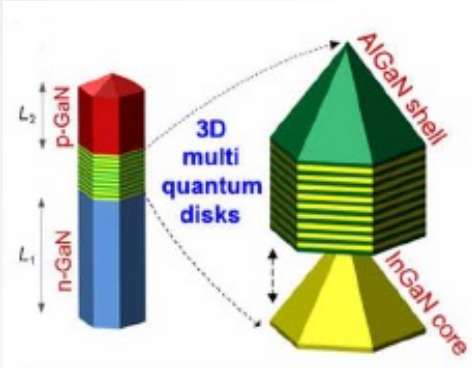
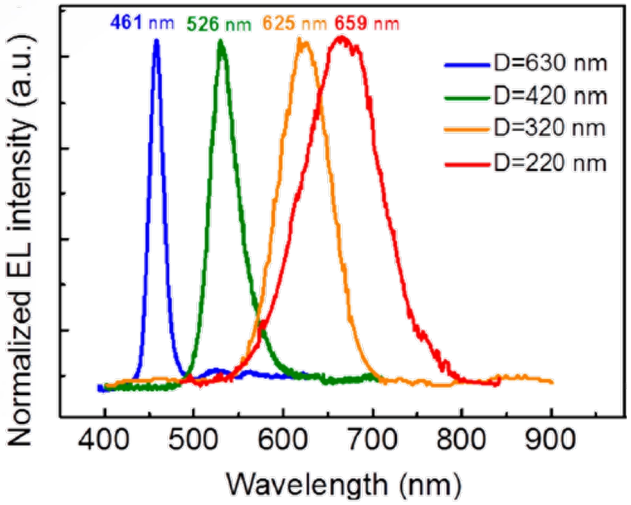
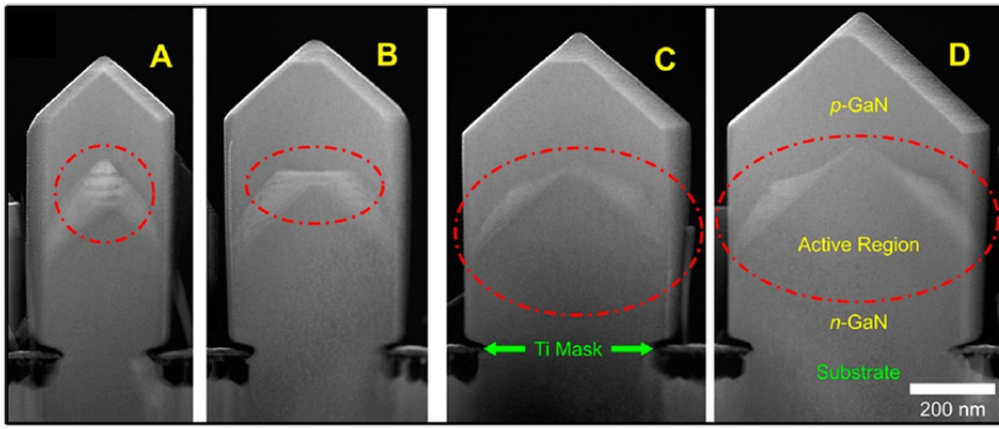


Ra, et al., Nano Lett. 16, 4608 (2016).

Disk-in-Nanocolumn

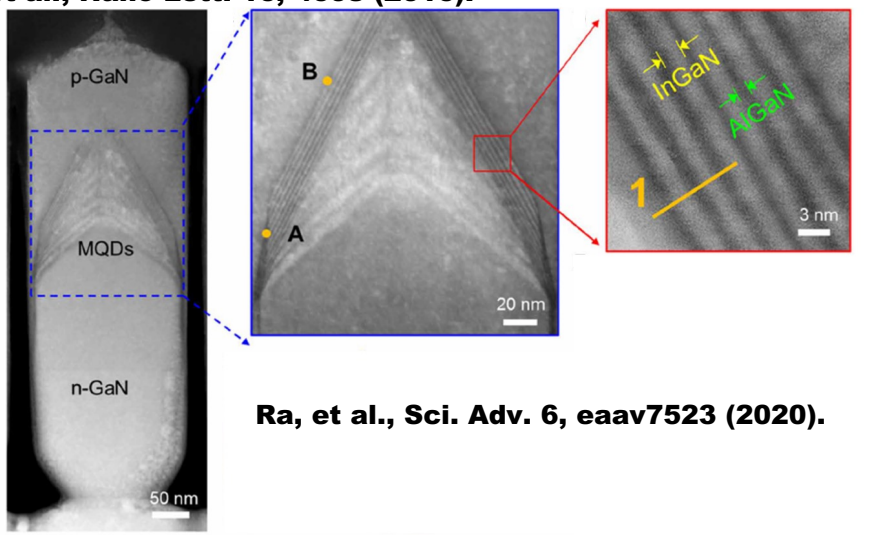






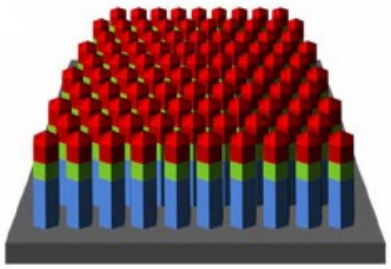
Ra, et al., Nano Lett. 16, 4608 (2016).

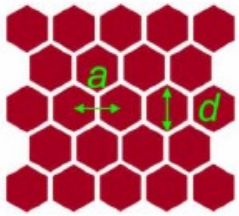
- Vertical quantum well design – “normal”
- MBE precision of alternating materials
- Recombination Zone protected from surface states, defects, by the “shell”
- Lower temperature growth allows for higher Indium or Aluminum incorporation
- Shell is formed during growth, without additional process steps or vacuum breaks



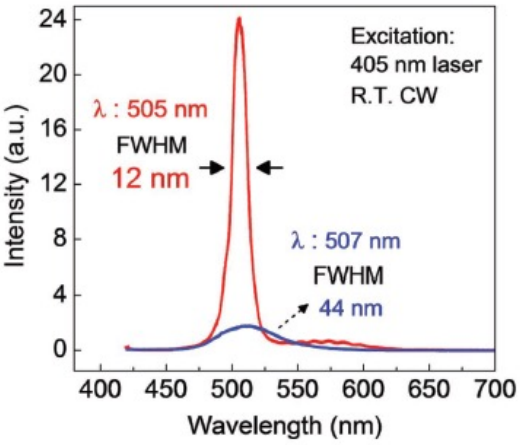
Ra, et al., Sci. Adv. 6, eaav7523 (2020).

Photonic Bandgap





- Periodic, close-packed photonic crystal structure
- Creates photonic bandgap that is independent of electronic bandgap
- Enhances emission spped
- Enhances emission directionality
- Locks in color
  - Versus Temperature, doping, current, etc.



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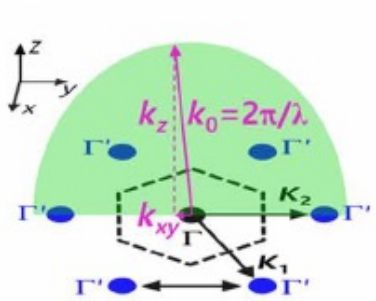

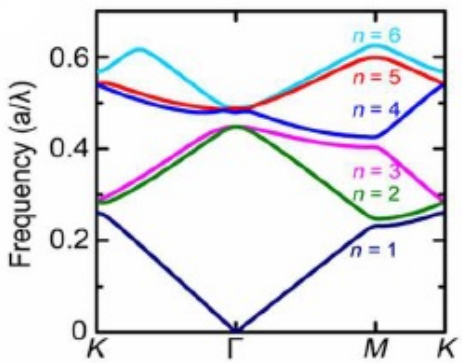

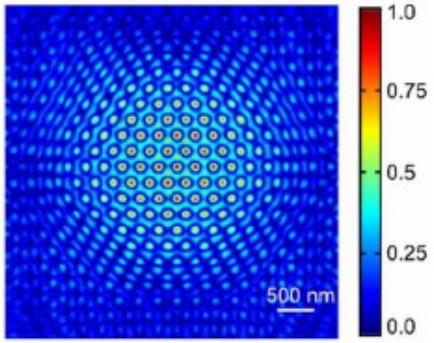

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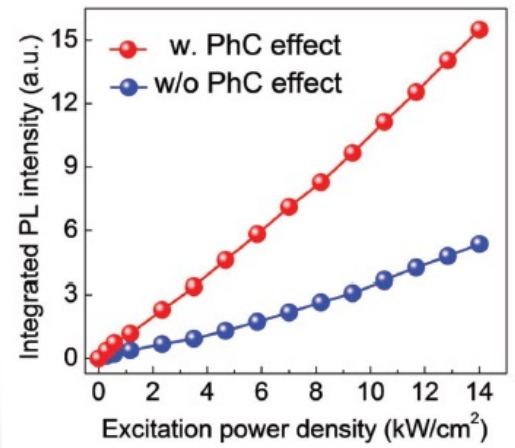
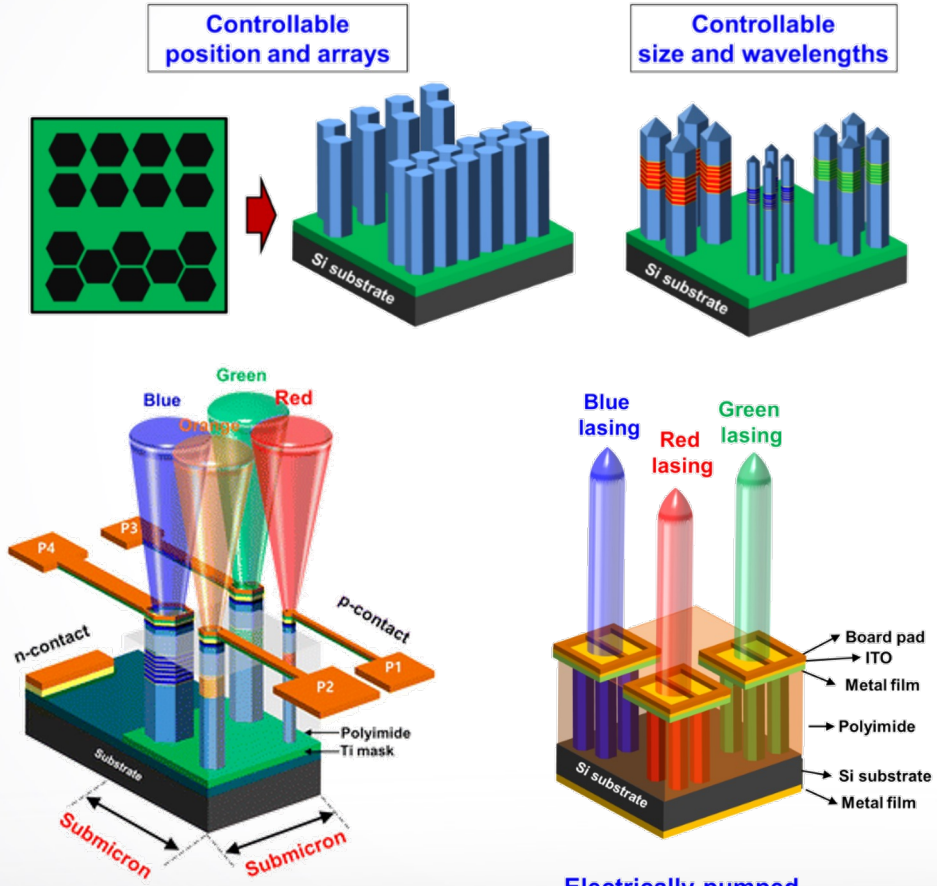


Monolithic Integration

Any color, Any where, on Any substrate



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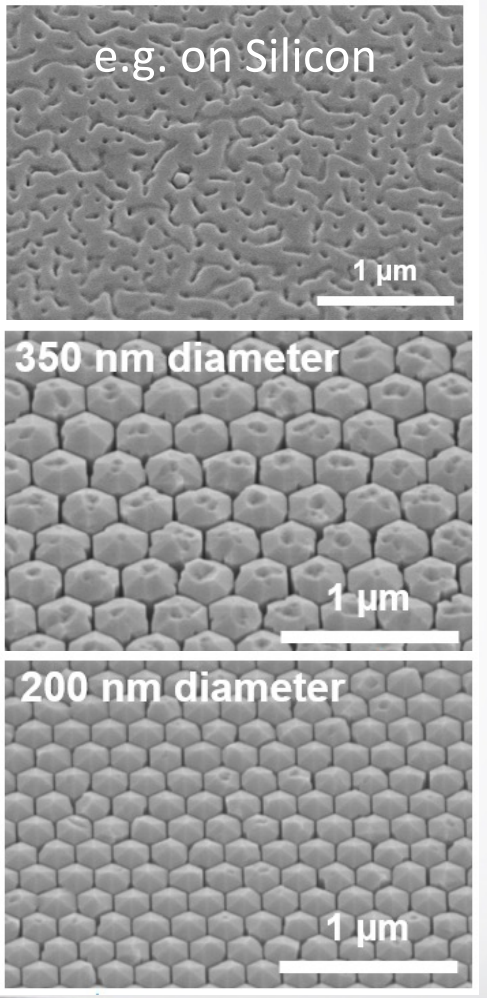

Laleyan, unpublished

Outline

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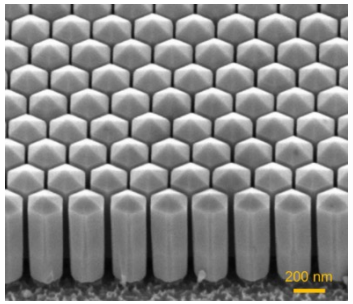
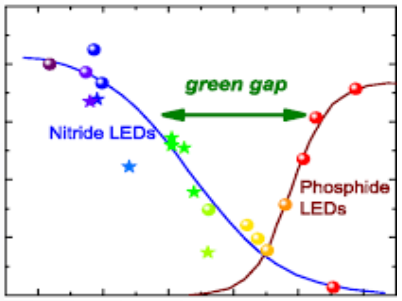
Breakthroughs in material science

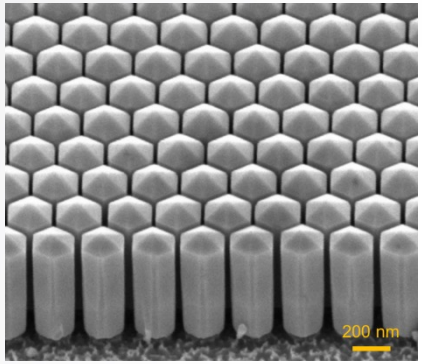


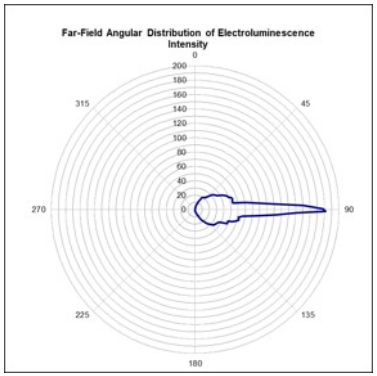


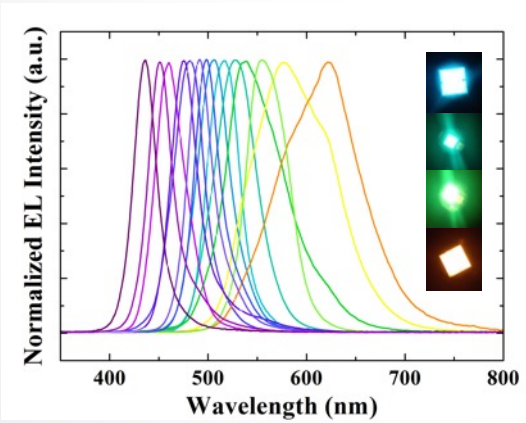
Breakthroughs in performance

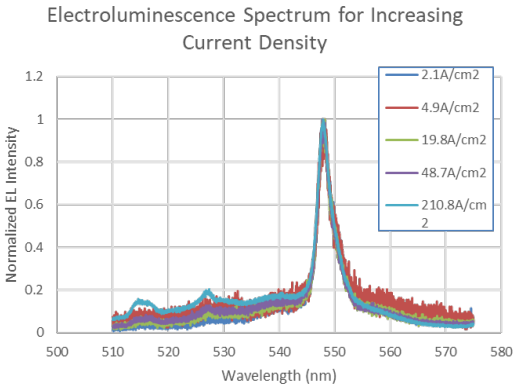
Pivot to UVC product focus

Green-Gap Breakthrough





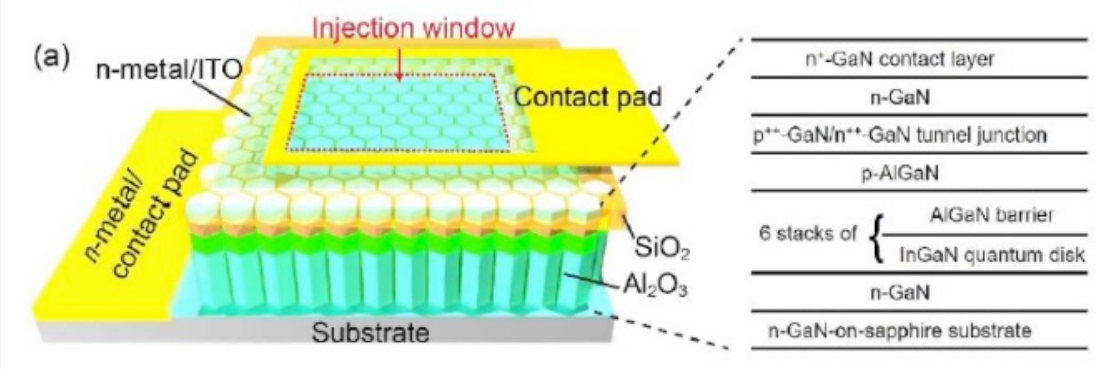


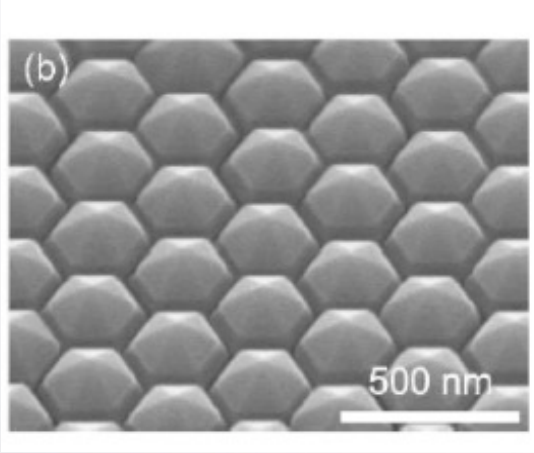


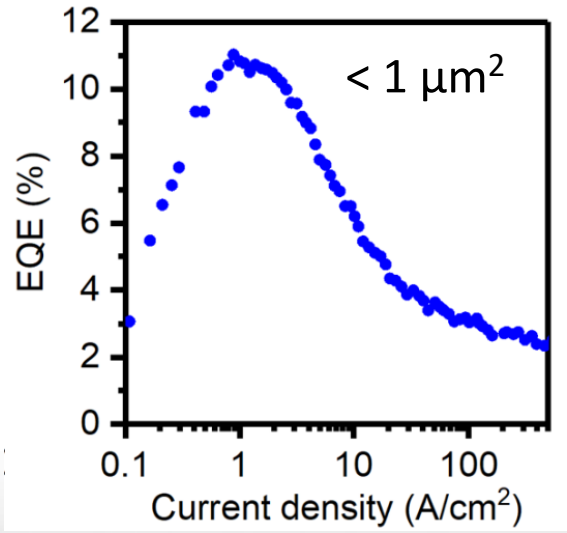
In 2020, we demonstrated a breakthrough in green LEDs began a process of continual improvement:

- Photonic bandgap LEDs
- World-record directional emission
- World-record narrow bandwidth
- Efficiency 6% EQE in 5um device

2021-22 Progress





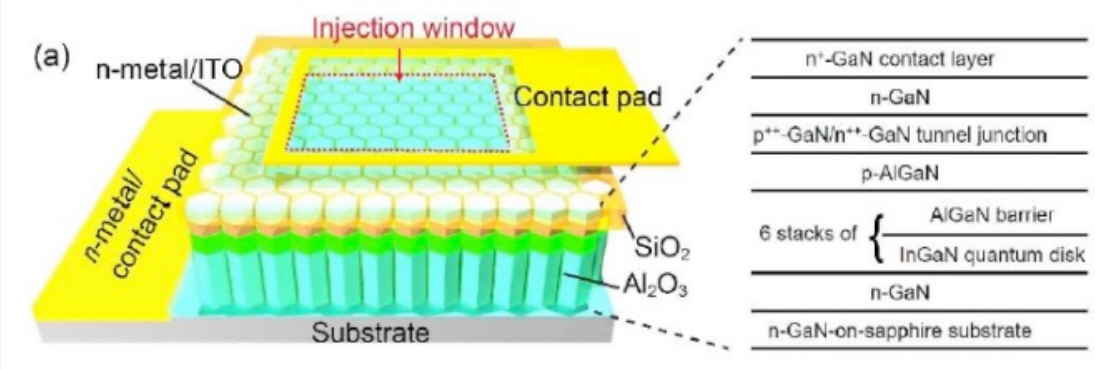


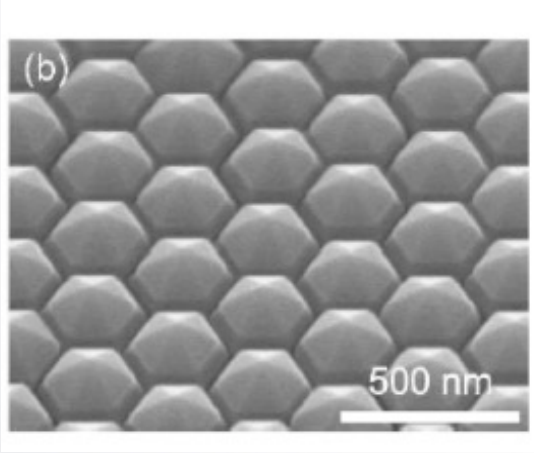
Source: Liu et.al, in draft.

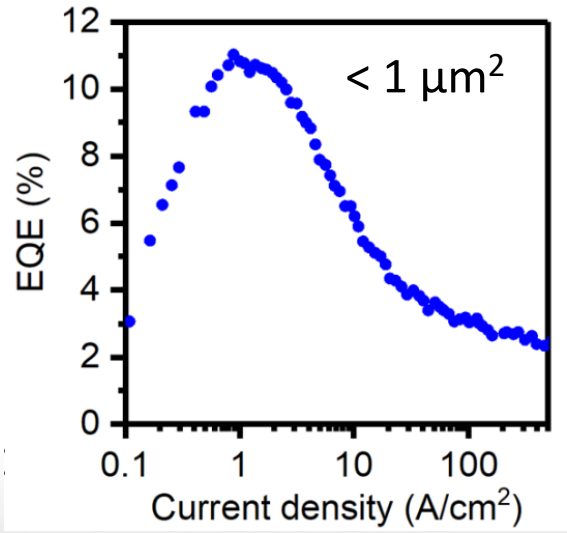
Since last year, we have:

- Emplaced production MBE foundry

2021 Progress





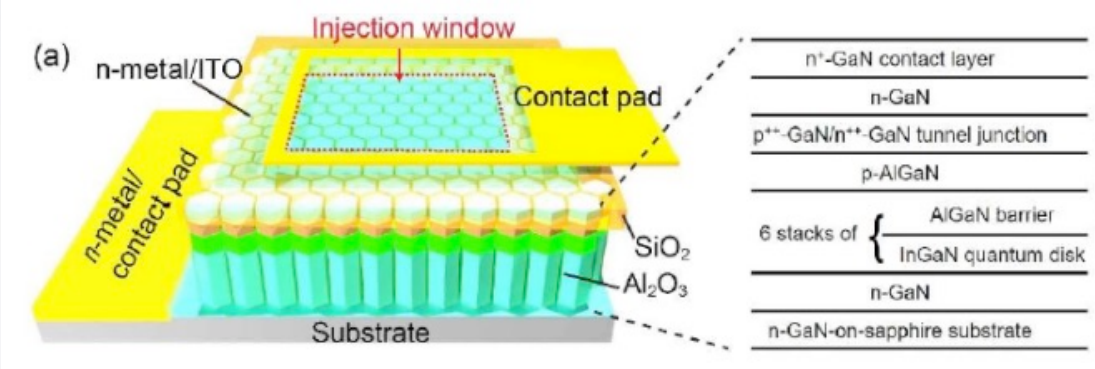


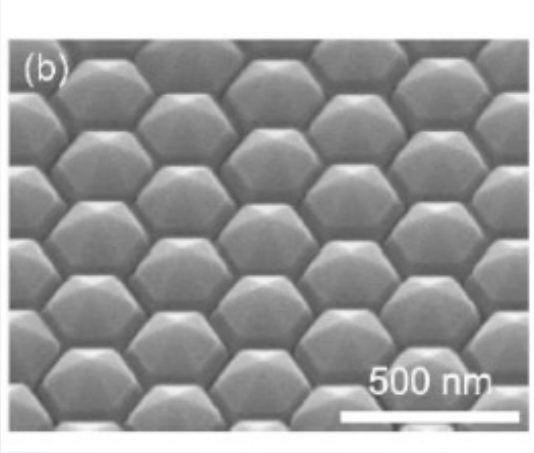
Source: Liu et.al, in draft.

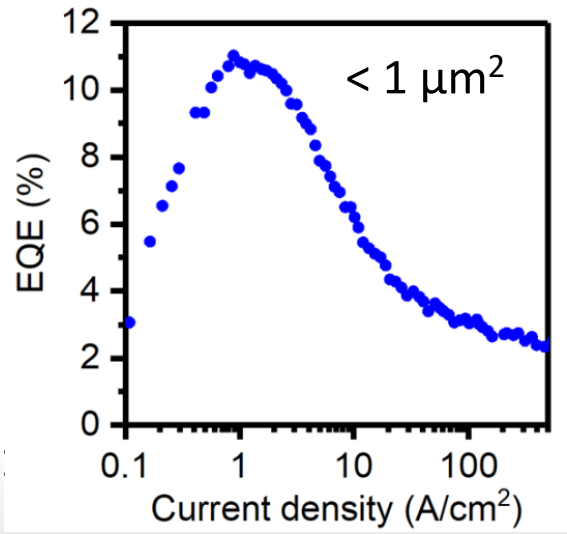
Since last year, we have:

- Emplaced production MBE foundry
- Developed inorganic passivation
- Allows for high temperature electrode deposition

2021 Progress







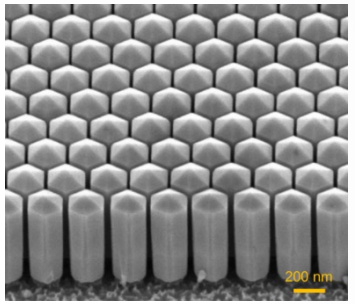
Source: Liu et.al, in draft.

Since last year, we have:

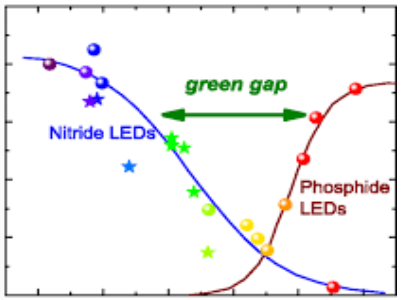
- Emplaced production MBE foundry
- Developed inorganic passivation
- Allows for high temperature electrode deposition
- Yielding higher efficiency, more stable LEDs – **11% EQE** at <1x1µm

2022 and Beyond

Introduction



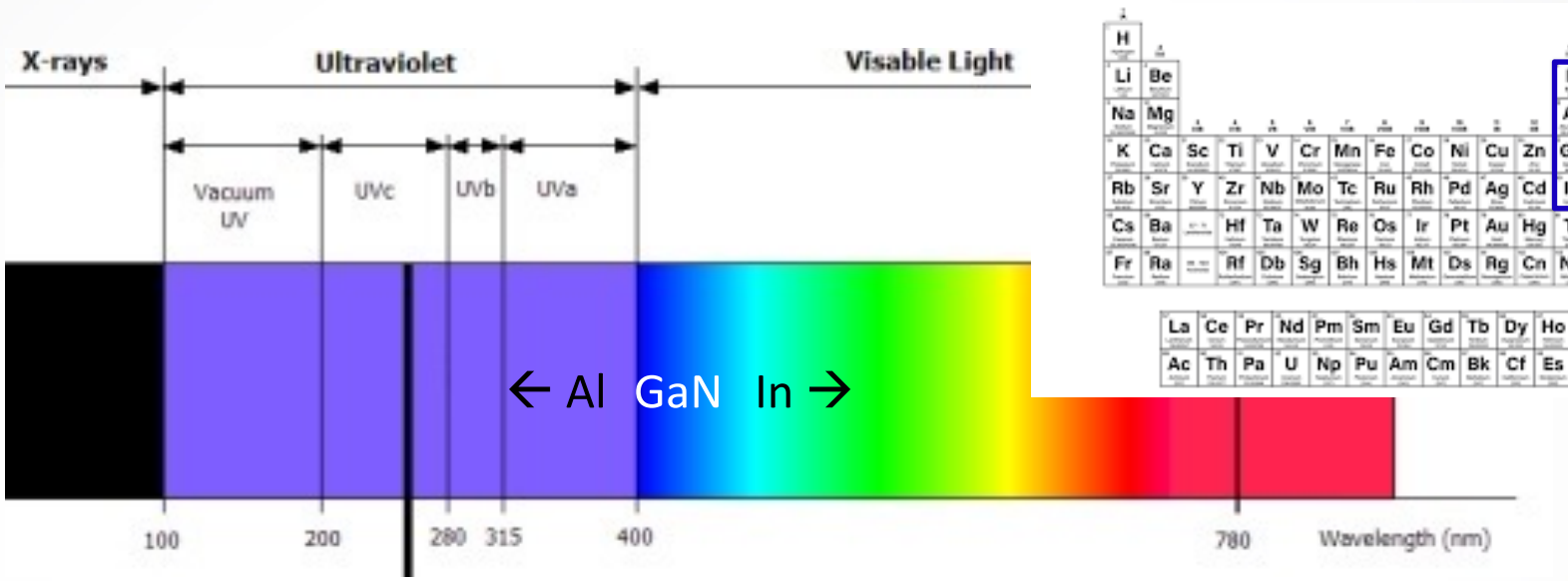
Breakthroughs in material science



Breakthroughs in performance

Pivot to UVC product focus

Nitride Semiconductors for UVC Disinfection



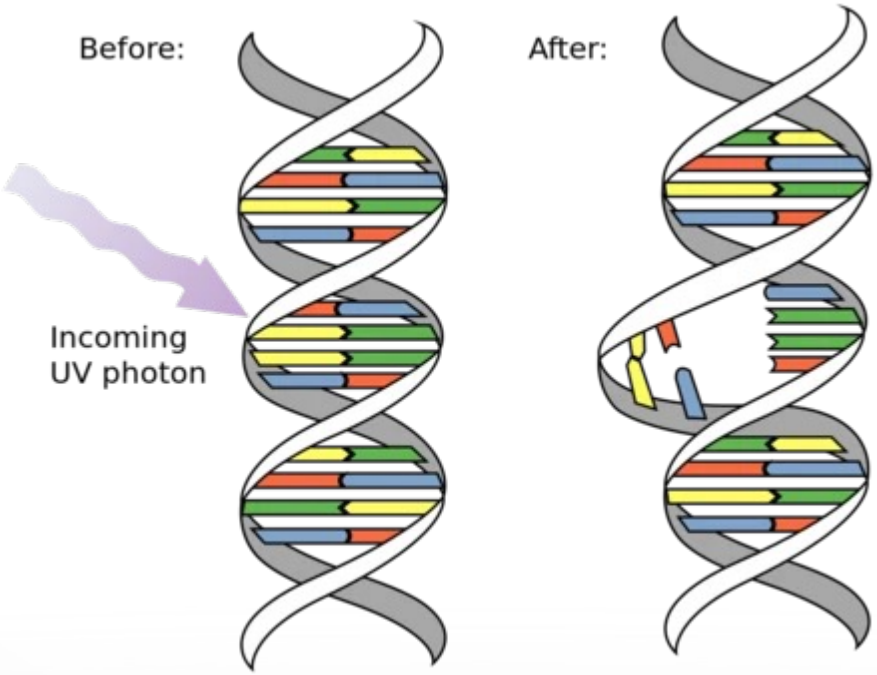
Aluminum Gallium Nitride (AlGaN)
UVC and far-UVC

Aluminum Indium Gallium Nitride (AlInGaN)
Blue, **Green**, and **Red**

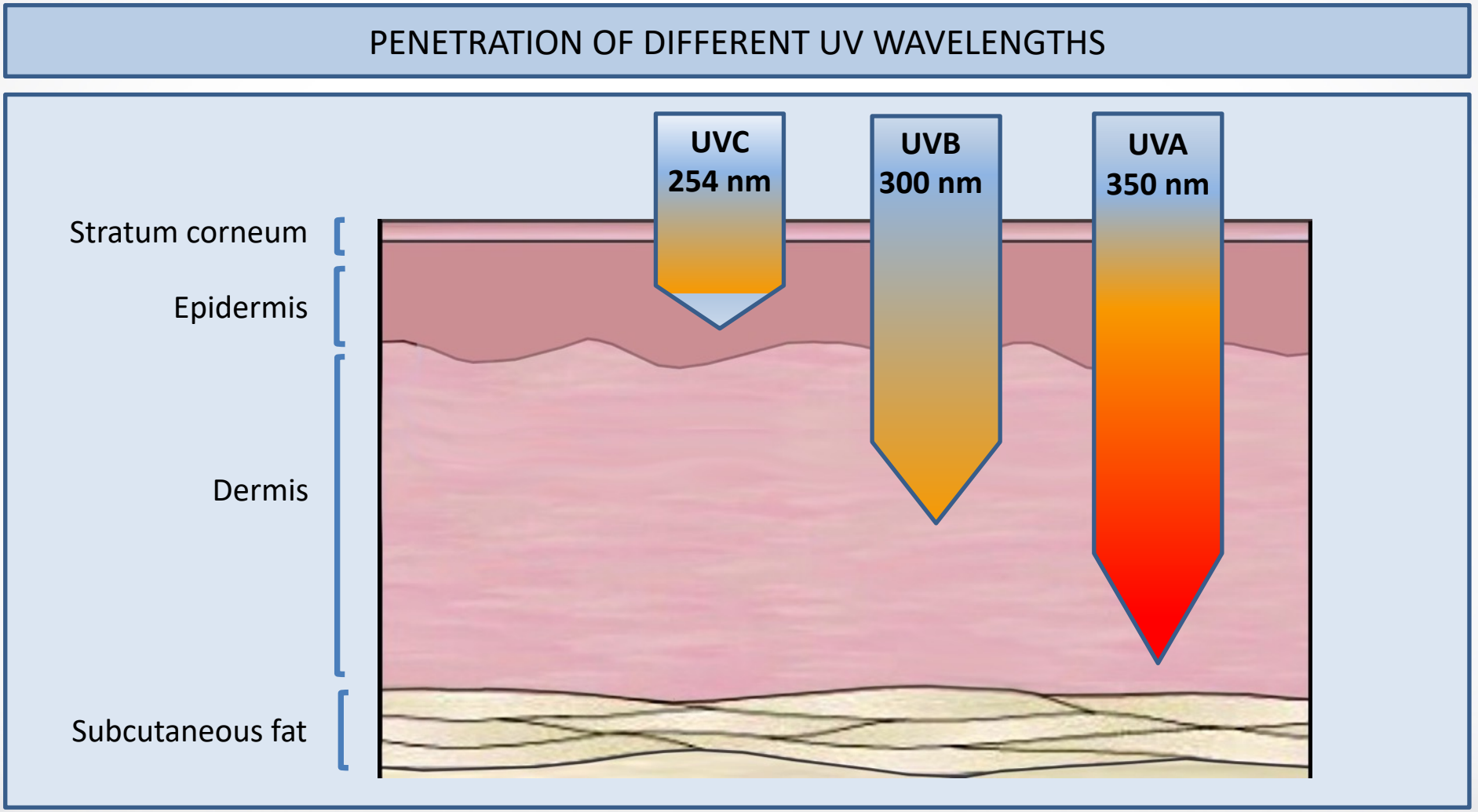
Far-UVC devices are needed now due to the massive dislocation in the value of germicides, brought about by the COVID-19 pandemic.

UVC Disinfection

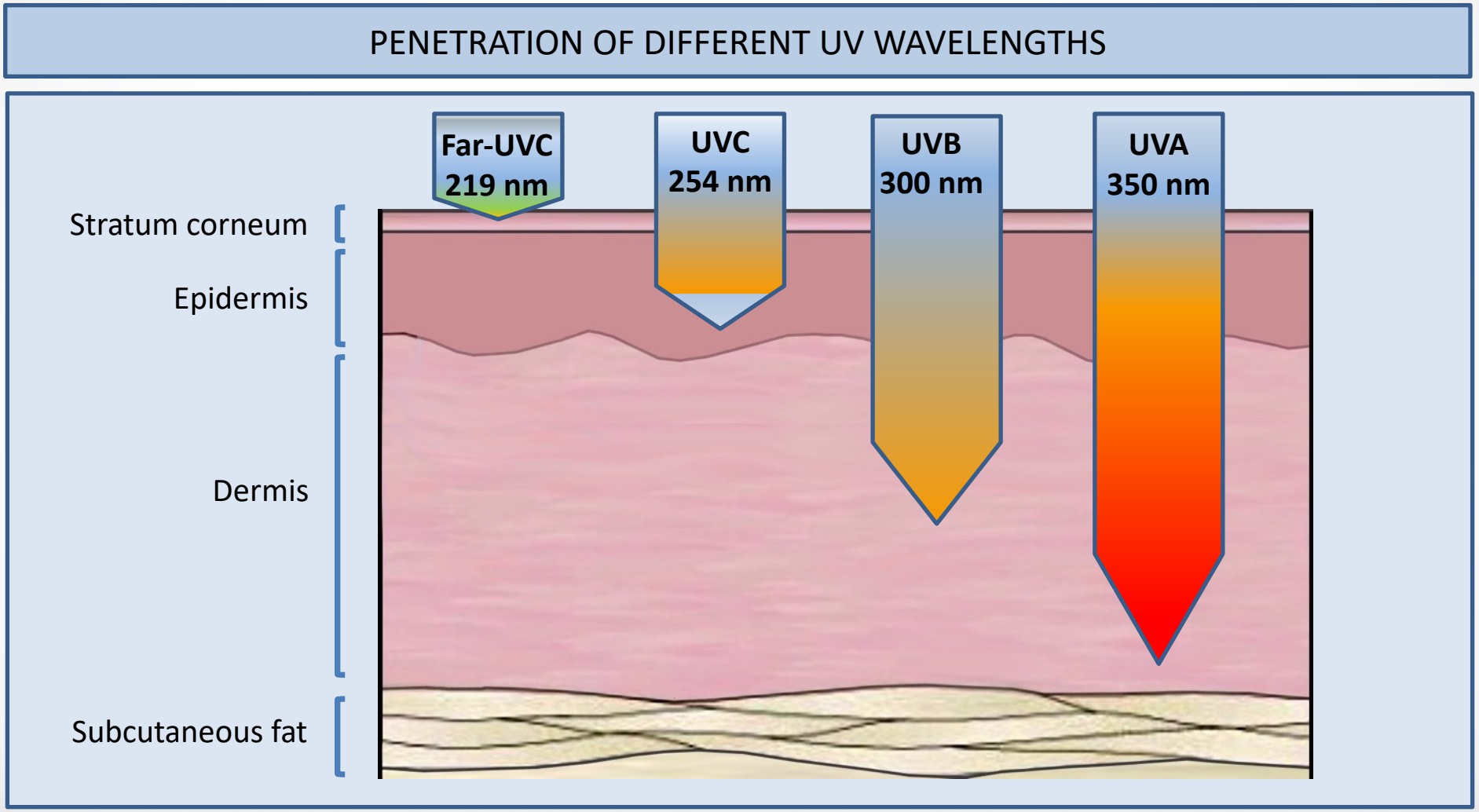
Photons disrupt RNA and prevent replication, stopping the virus in its tracks



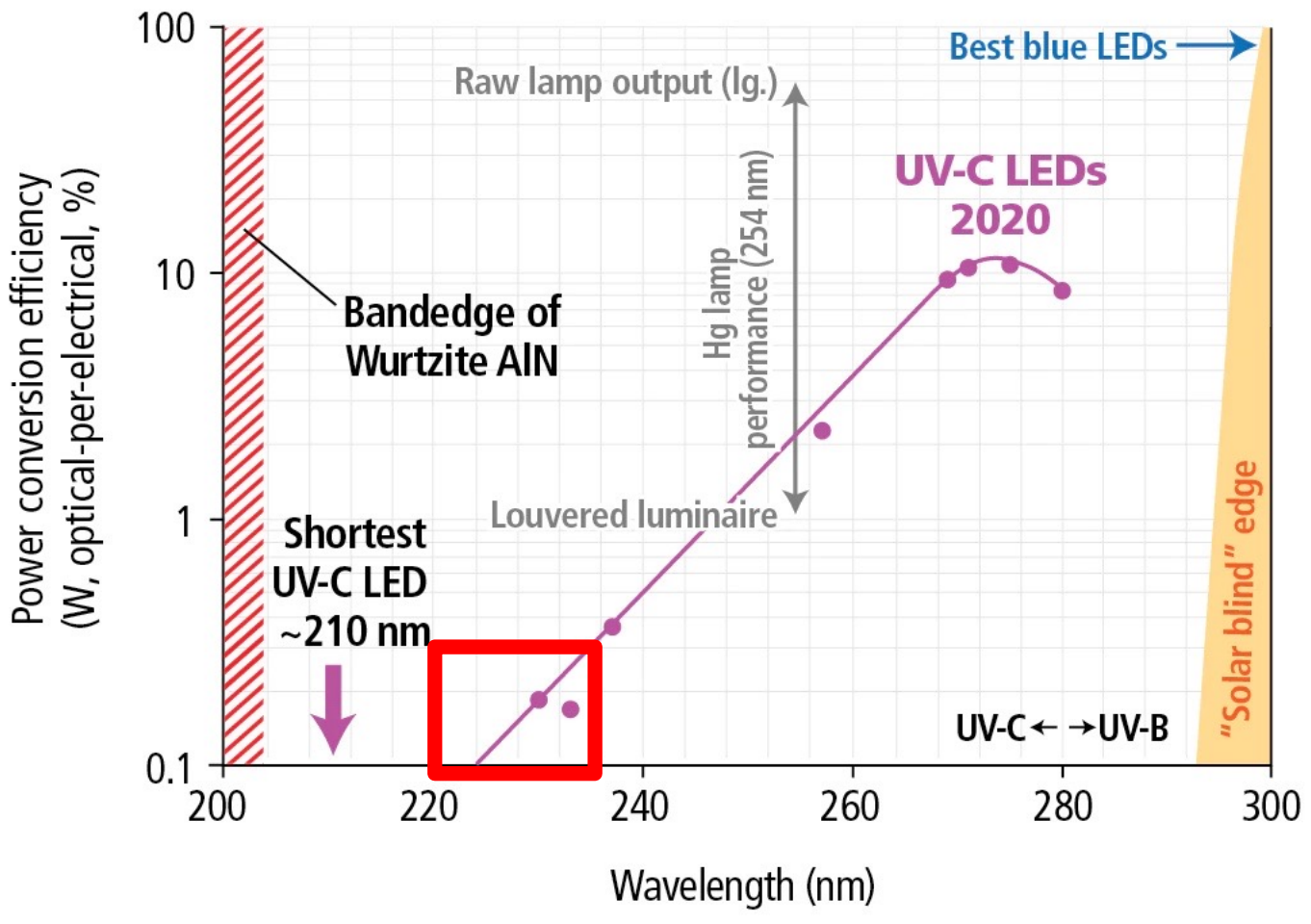
Standard UV Wavelengths Damage Skin and Eyes



But “Far-UVC” Light is Human-Safe



Far-UVC LEDs Aren't Effective Yet



Source: Mike Krames, LEDs Magazine

ShortWaveLight™ Emitter

Booth #222

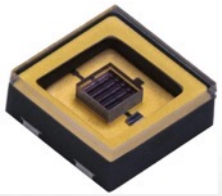
The world's first solid-state semiconductor to emit far-UVC sanitizing light

2022 and Beyond

Ultraviolet
(Product Focus)

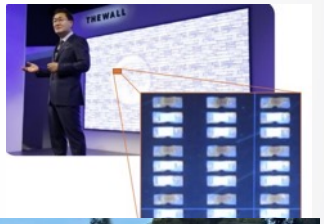
Far-UVC Lamps

Consumer Appliance

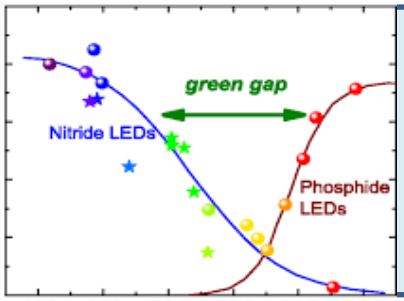


Far-UVC LEDs

Visible
(Partnerships & Licensing)

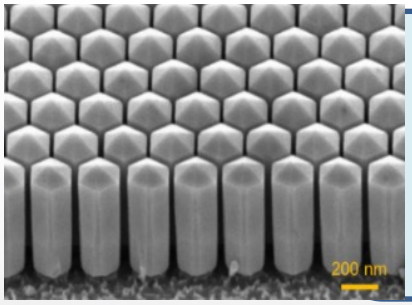


The Nano-LED Future



Nano-LEDs will disrupt the $20B LED market, solving several persistent, industry defining problems of efficiency and yield.

Our team is uniquely experienced in introducing new display technologies that succeed as products in the market.



Our technology will deliver efficiency breakthroughs required for the world's first far-UVC nano-LEDs disinfection applications.

Booth #222

NanoLEDs for Microdisplays and Covid Disinfection

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