

**BLUGLASS ANNUAL GENERAL MEETING**  
**19 NOVEMBER 2018**  
**SYDNEY, AUSTRALIA**

**2018**



Chairman's Report



Managing Director's Report



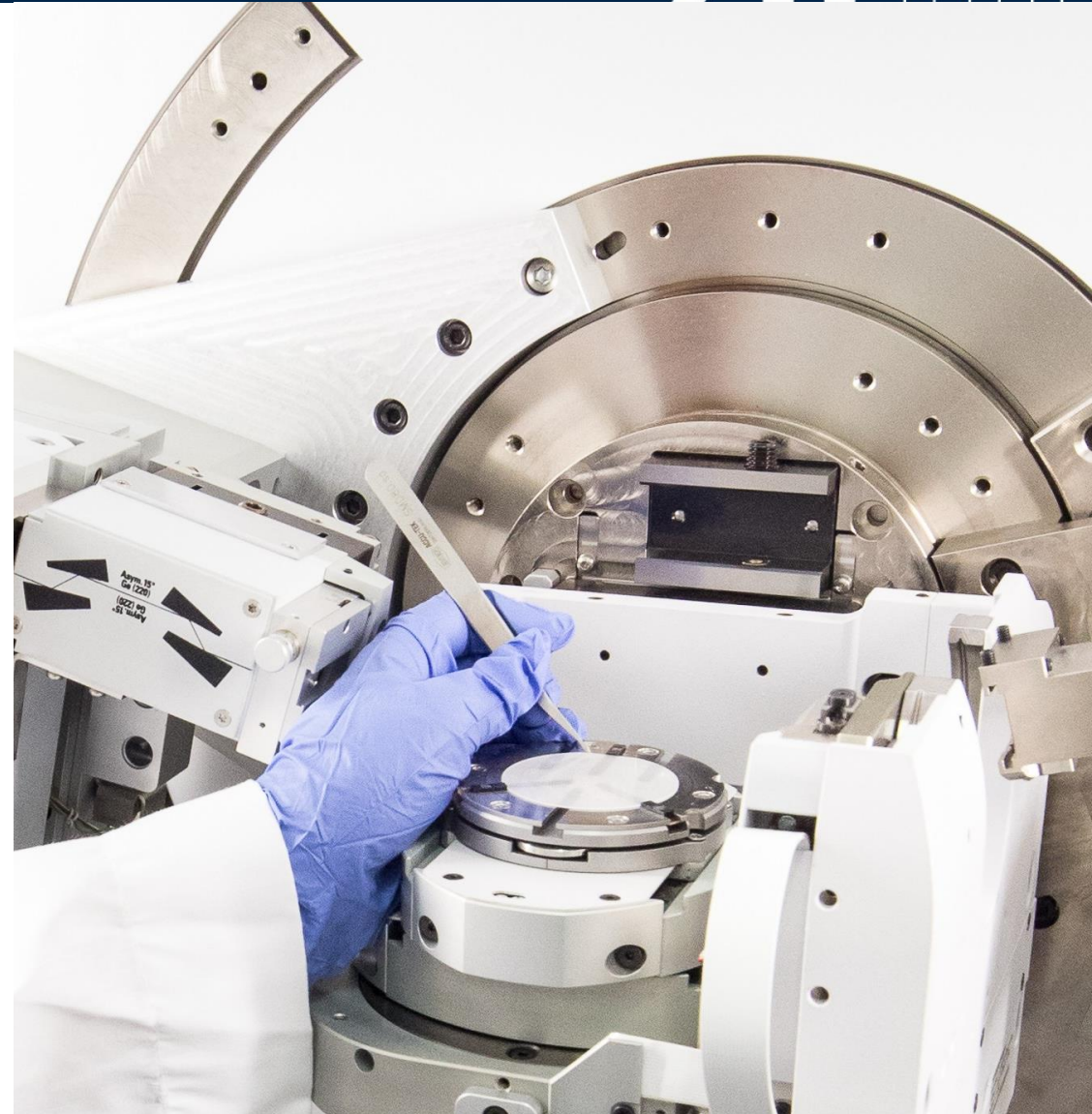
Chief Technology &  
Operations Officer's Report



Q & A



Formal Business





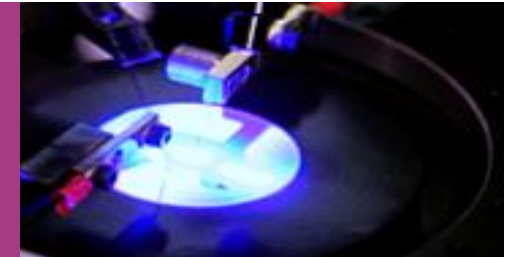
# CHAIRMAN'S REPORT



Dr. William Johnson

**OUR VISION**

Position BluGlass as a leading force in the rapidly growing global opto-electronics industry, by delivering RPCVD as a key enabling compound semiconductor deposition technology

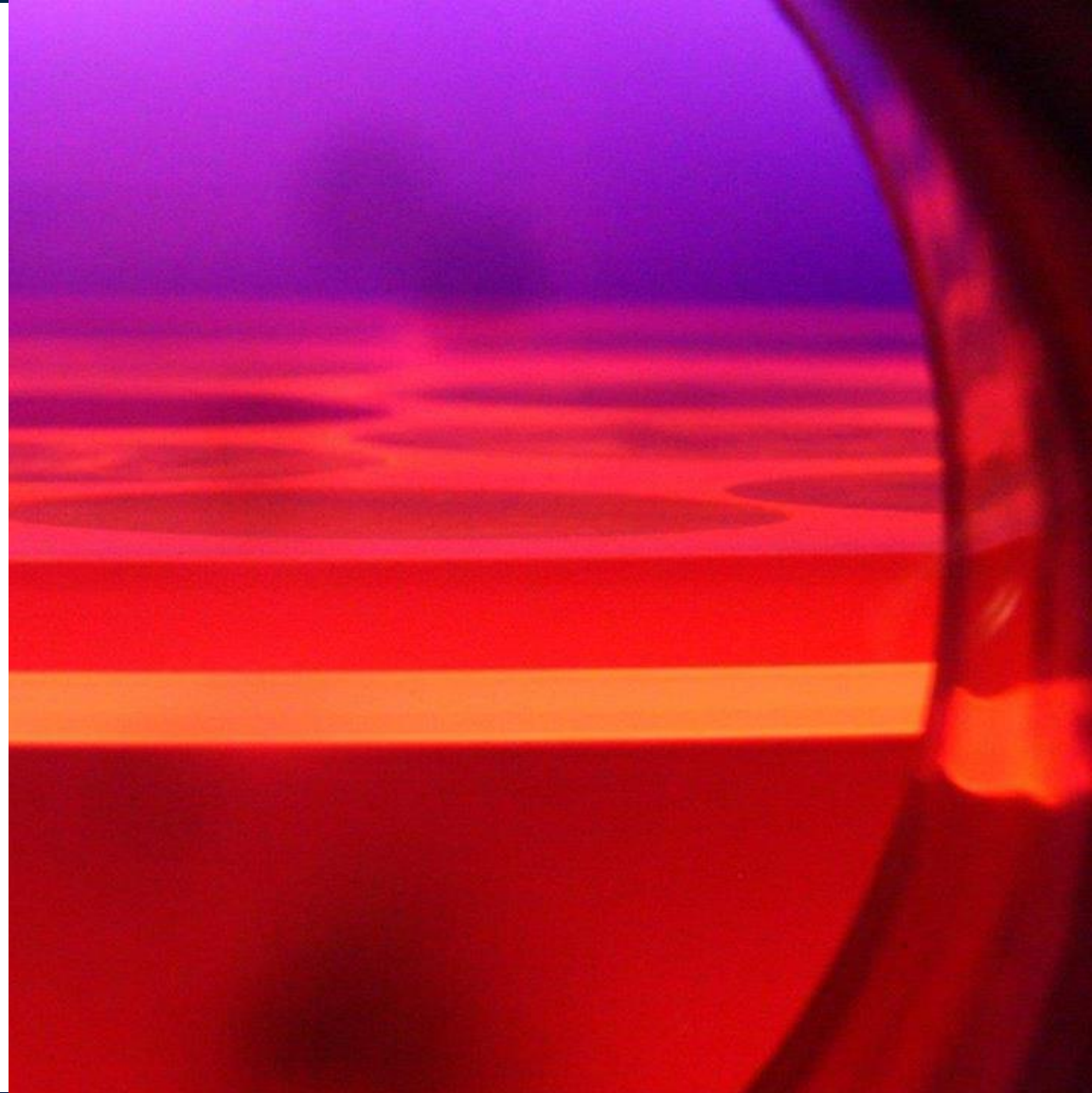
**OUR OBJECTIVE**

Our objective is to deliver high-growth commercial outcomes for the RPCVD technology in the LED, microLED and power electronics industries, using a diverse range of go-to-market options



We have focused on the following areas to maximise the opportunity of delivering commercial solutions at scale:

- development of the RPCVD technology to create a commercially viable manufacturing technique
- joint development of applications with industry partners for high-performance LEDs, microLEDs and power electronics applications
- continued protection of associated intellectual property using global patents



## Global LED market



**2024**

CAGR of  
15.9+% to  
US \$96B

**2018**

## Global microLED market



**2025**

CAGR of  
80+% to  
US \$20.5B

**2019**

## GaN power electronics market



**2021**

CAGR of  
80.1% to  
US \$270M

**2017**

Sources: LED: Allied Market Research, microLED: Yol  Development and Markets and Markets, Power: Yol  Development

Major market trends driving rapid growth:

## Automotive & HB Lighting (HB-LED opportunity)

CAGR of 19.9%  
2017-2023<sup>1</sup>



Market scale: 300 million LEDs in automotive Head Up Display (HUDs) by 2023<sup>4</sup>

## Displays (microLED opportunity)

CAGR of 89.2%  
2018-2025<sup>2</sup>



Market scale: 330 million units by 2025<sup>5</sup>

## Power Electronics (GaN HEMT opportunity)

CAGR of +80%  
2016-2020<sup>3</sup>



GaN on Si for power electronics is preferred choice for high frequency applications<sup>6</sup>

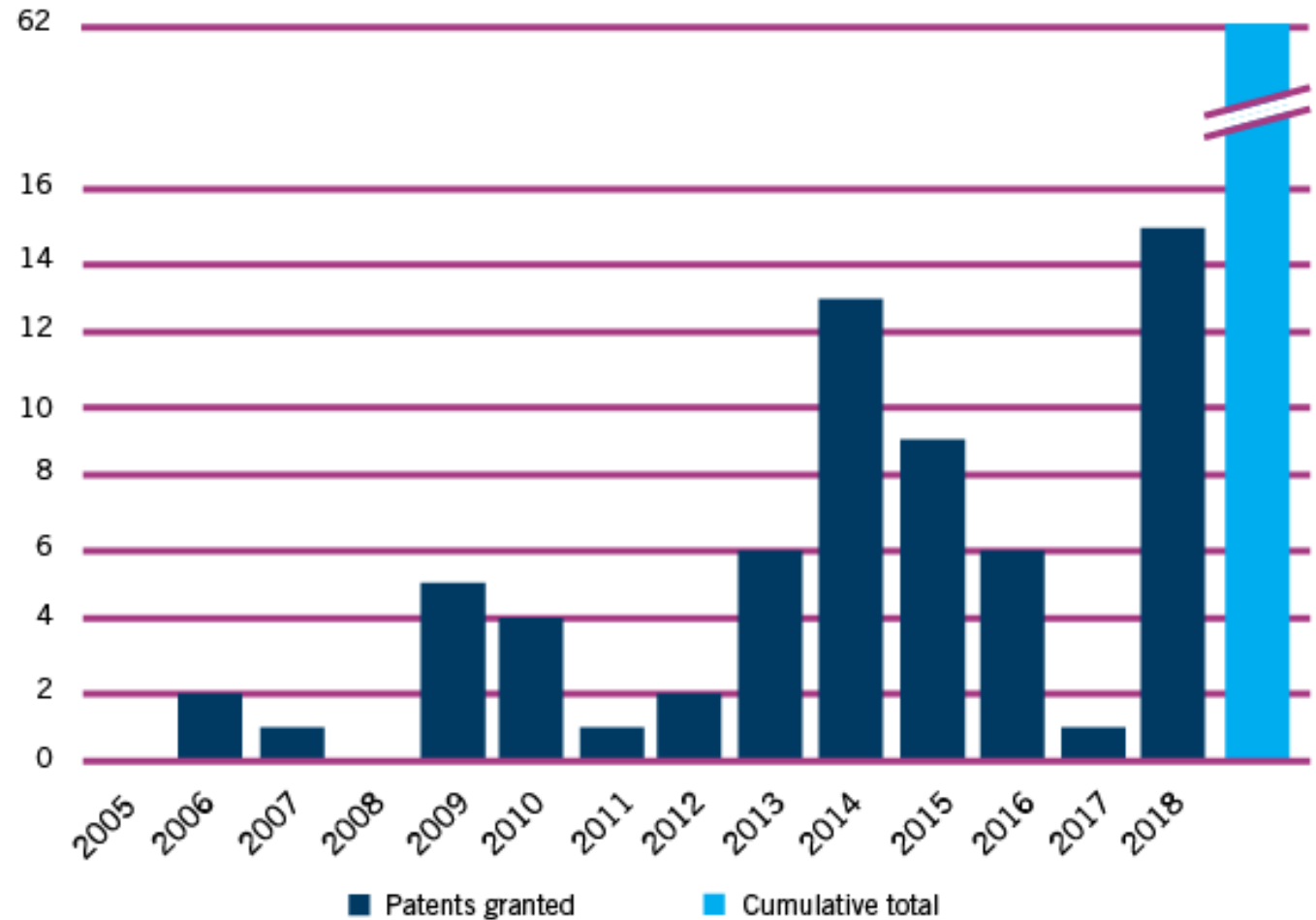
Sources: <sup>1</sup>[Research and Markets](#), Sep. 2017. <sup>2</sup>[Allied Market Research](#), Jun. 2018. <sup>3</sup>Yole Développement. <sup>4</sup>[LEDInside](#), Jul. 2018. <sup>5</sup>Yole Développement, Feb. 2017. <sup>6</sup>[Letters, 113\(4\), 041605](#).

	2018	2017	Movement
Total Revenue	\$871,000	\$685,000	Up 27%
EpiBlu foundry Revenue	\$714,000	\$550,000	Up 30%
Interest	\$157,000	\$135,000	Up 17%
Net Assets	\$25,389,000	\$18,702,000	Up 36%
Capital Raise	\$11,228,000	-	-
Monthly Burn Rate	\$534,000/month	\$466,000/month	Up 14%
R&D Tax Rebate	\$1,987,000	\$2,040,000	Down 3%
Cash Position (as at end of FY)	\$15,354,000	\$8,511,000	Up 80%
Cash Position (as at September)	\$13,008,000*	\$9,094,000**	Up 43%

Currency is Australian dollars. \*Before R&D tax rebate receipt. \*\*After R&D tax rebate receipt.



- Our Intellectual Property portfolio is a critical foundation for our future commercial success and underpins our licensing-based business model
- During the year significant investment was made to further expand and strengthen our portfolio
- In 2018 **15 patents** granted bringing our internationally granted patent portfolio to a total of **62 patents** in key semiconductor jurisdictions
- With a further **16** applications
- Across **7** patent families



# MANAGING DIRECTOR'S REPORT



Giles Bourne

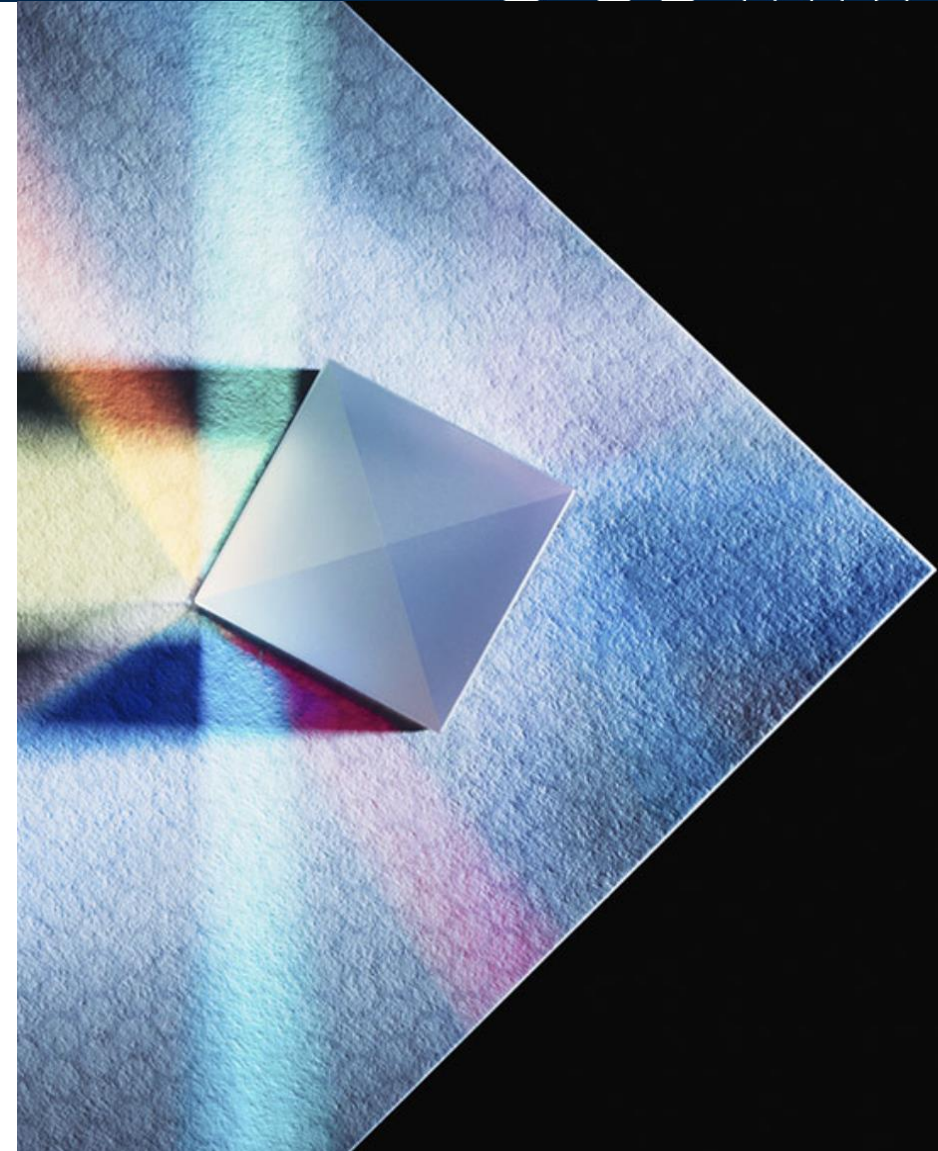


# SIGNIFICANT COLLABORATIONS & PARTNERSHIPS



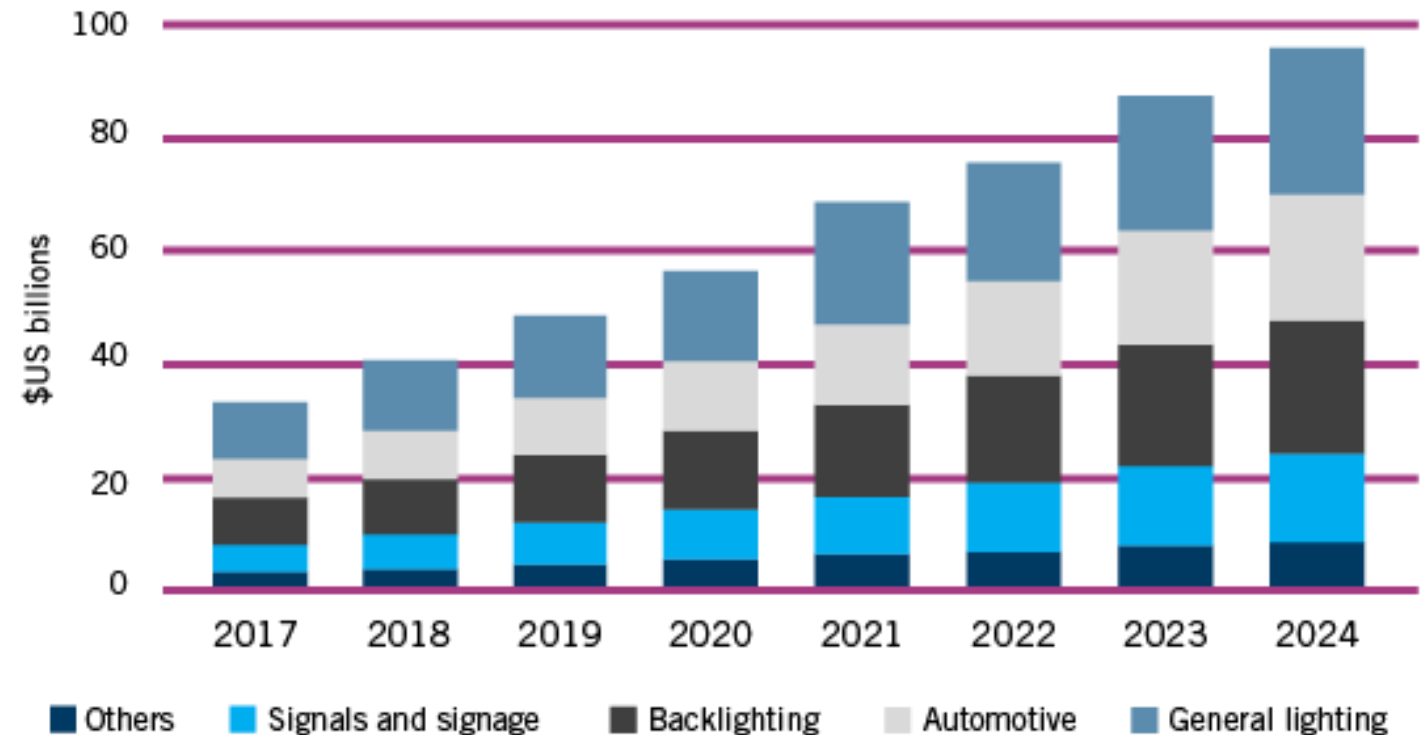
## BluGlass has commenced commercial negotiations with Lumileds

- We will provide the market with further details on the outcome of this negotiation
- BluGlass is pleased with the results of the project to date which has shown clear promise that our proprietary technology could substantially improve LED efficiency for high powered LED applications
- A key consideration for BluGlass in these negotiations is assessing the potential value of extending the company's exclusive collaboration with Lumileds compared with the potential value of engaging with others in the LED industry

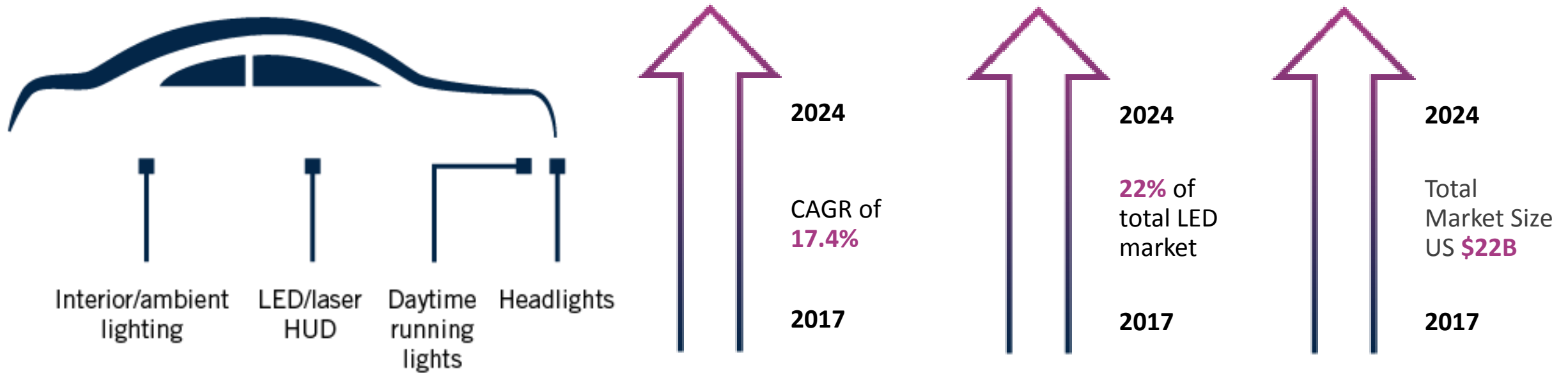


- The Global LED market is expected to grow from **US \$33.1B** in 2017 to US **\$96.71B** in 2024
- With a CAGR of **15.9%**
- BluGlass is interested in the high-brightness segment of the LED market
- The biggest gains will be in automotive, displays and general lighting

Global LED Market by Application, 2018-2024



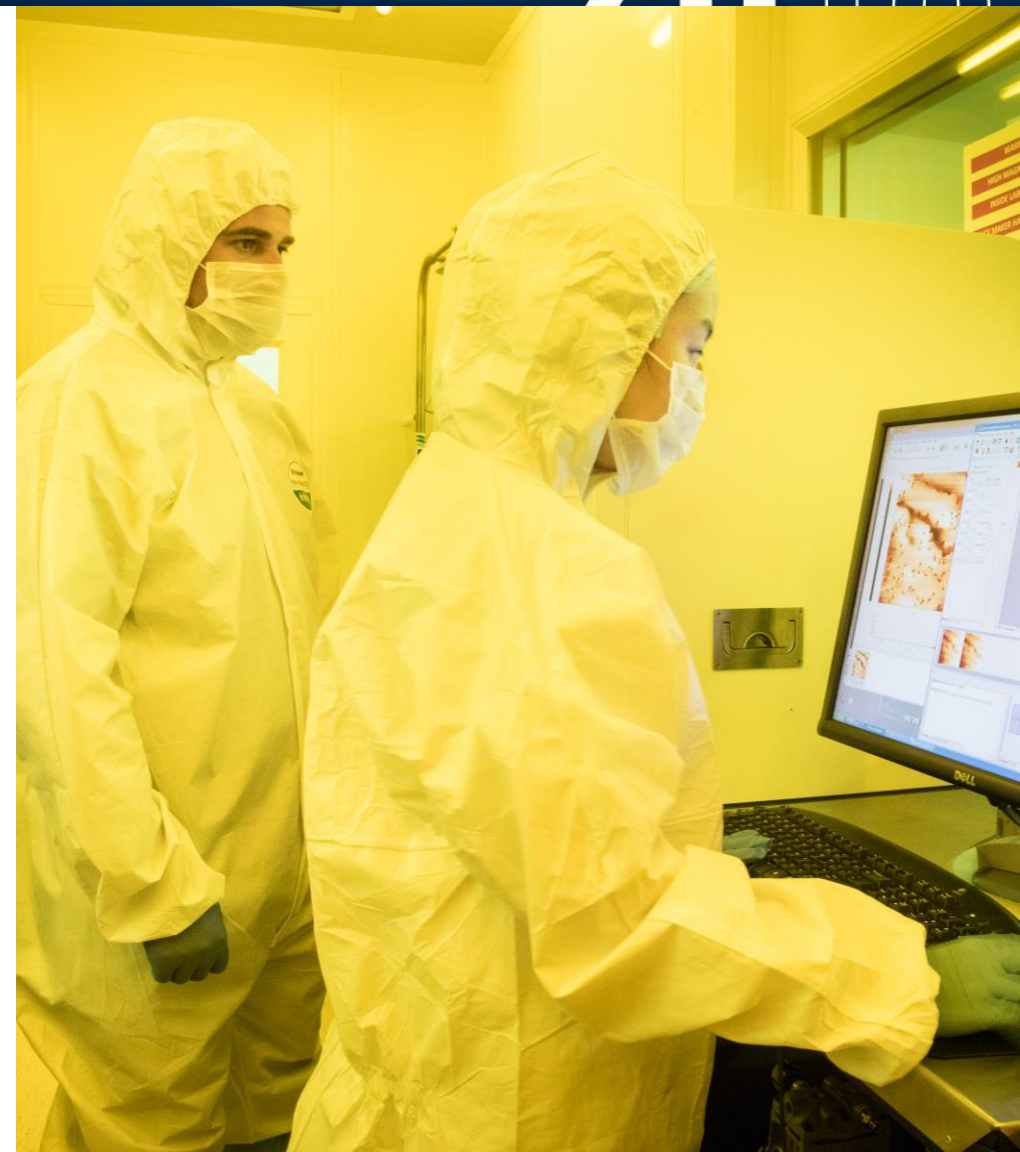
Sources: Applied Market Research, Global LED Market Report 2018



Sources: Allied Market Research, Global LED Market Report 2018

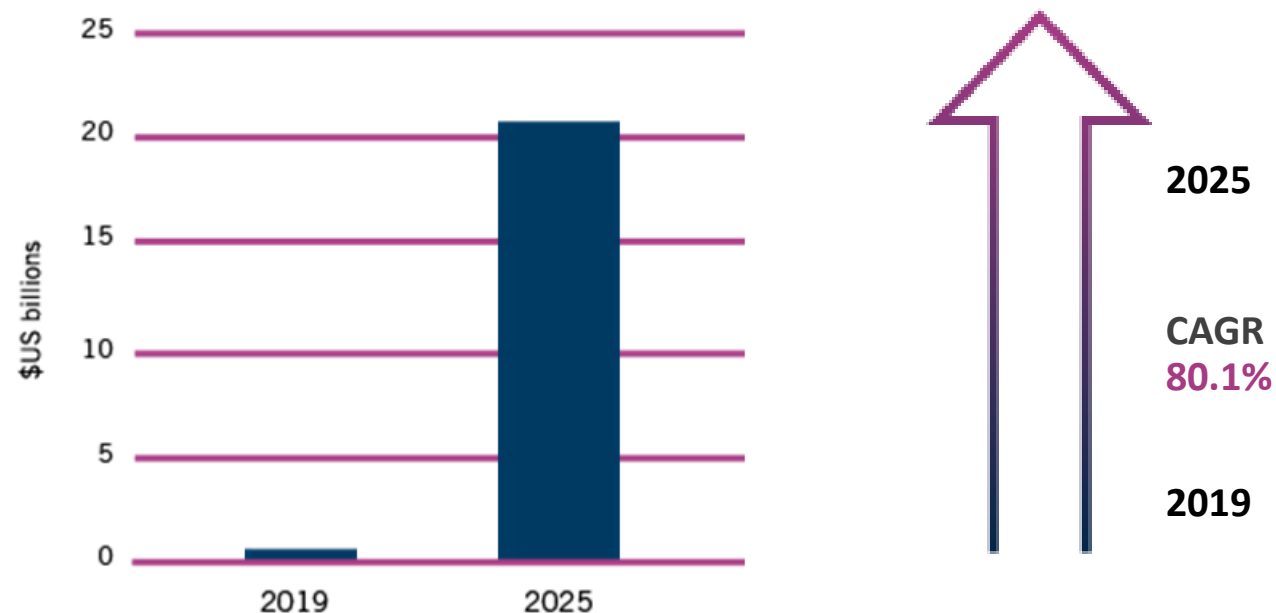


- microLEDs present a compelling opportunity for the competitive advantages of RPCVD
- RPCVD's lower deposition temperature allows for the growth of indium rich InGaN, the key performance material and ingredient required for longer wave-length LEDs including green, yellow and red colours
- BluGlass RPCVD technology has demonstrated a performance improvement in light output in green LEDs
- Industry expects mass manufacturing to commence from 2022 - with no clear technology solution yet established
- BluGlass is working with **multiple microLED customers on novel applications, including an RPCVD collaboration** with a leading European developer



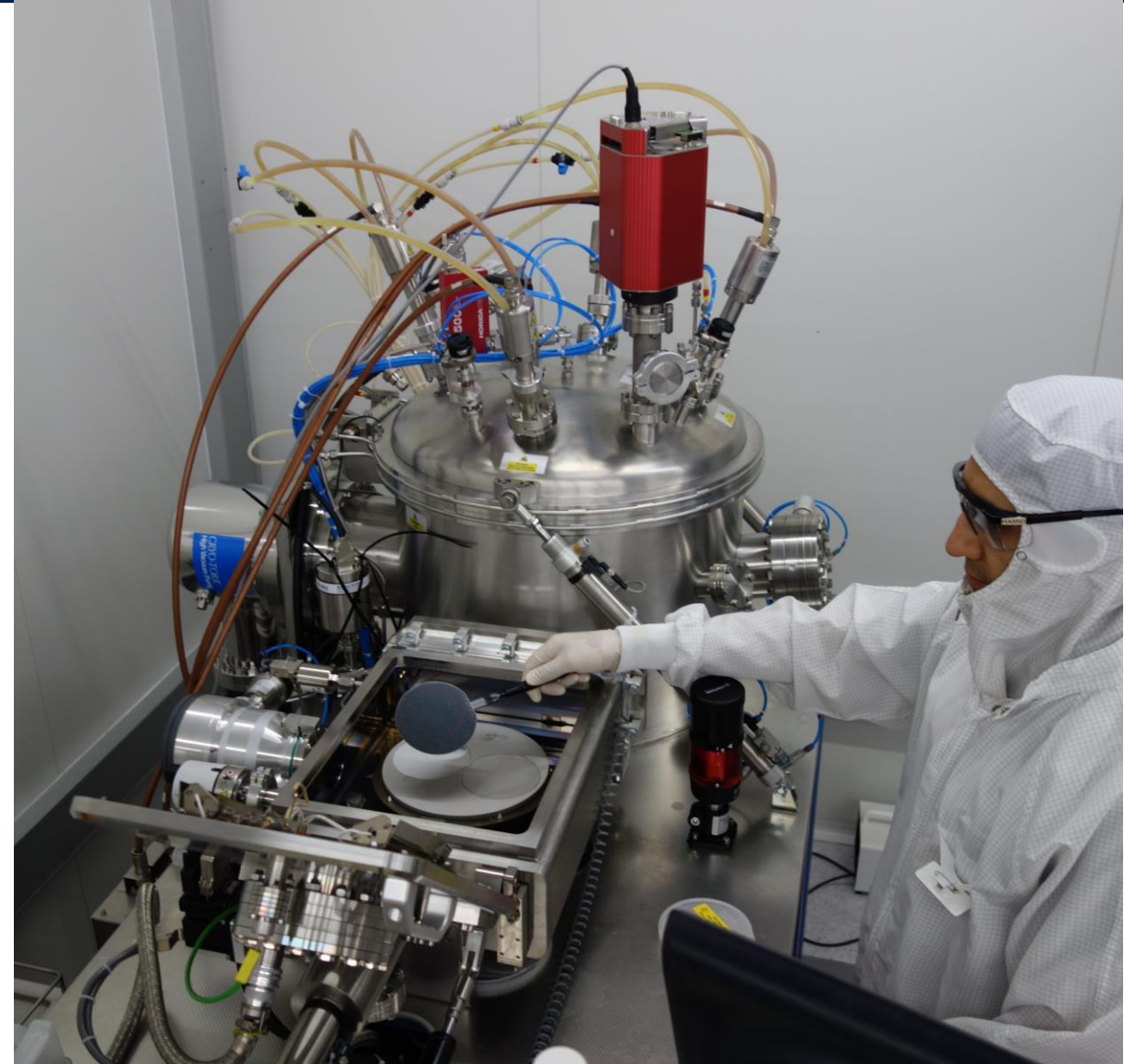
- microLEDs represent a potential game changer on the way for displays
- Predicted to become a **US \$20.5B** market by 2025
- Superior display performance for fraction of the power consumption of LCD and OLED
- Application from smartphones, wearables, AR/VR and potential for transparent displays
- Both emerging and major global players are investing significantly in this market

Global microLED Market, 2019-2025



Source: microLED Market by Application (Display (Smartwatch, NTE Devices (AR, VR), Smartphone, Television, HUD, Digital Signage, Laptop & Monitor) and Lighting (General, Automotive)), Display Panel Size, Vertical, and Geography - Global Forecast to 2025 by Markets and Markets May 2018

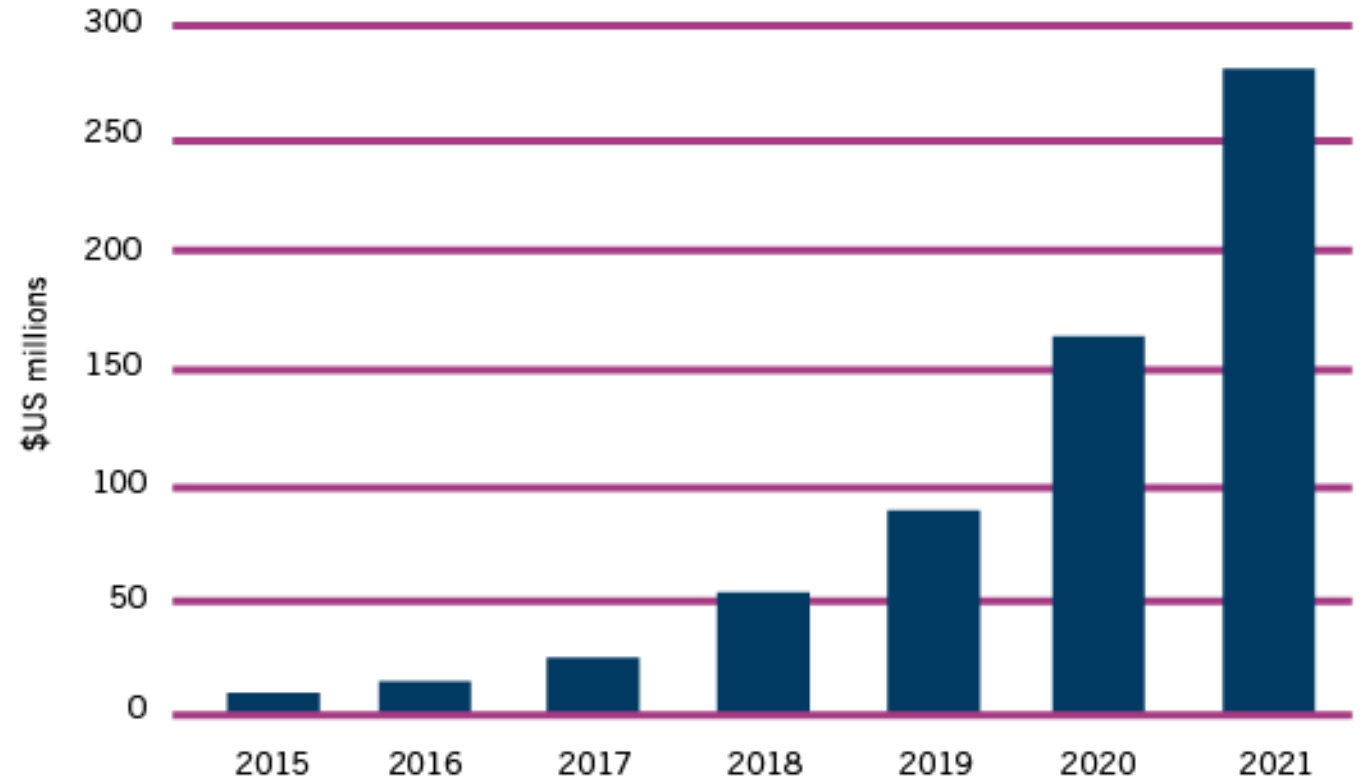
- Partnership with Griffith University and the Innovative Manufacturing Cooperative Research Centre (IMCRC) to develop next-generation GaN transistors
- Objective is to develop commercial-spec devices for product demonstration as a commercial proposition for the transistor market
- Focus is on specialised switches called High Performance Normally-Off GaN High Electron Mobility Transistors (HEMTs) used in high-reliability, low-temperature applications (e.g. electronics equipment, cellular telecommunications, radio & RADAR)
- Exploits inherent advantages of lower temperature RPCVD





- Major applications in power supply (laptop, mobile, USB chargers, large-scale server data centres), electric vehicles & hybrid electric vehicles and inverters
- GaN on Si for power electronics is preferred choice for high frequency applications
- Emerging GaN power segment has strong growth potential with estimated **+80% CAGR** to reach **US \$270M** from \$0.6m in 2017

## GaN Power Electronics Market



Source of GaN power electronics market stats and chart: Yolé Developpement, SiC and GaN devices for the power electronics webcast, Dec 5, 2017. See also market overview at <https://www.google.com/url?q=https://www.youtube.com/watch?v%3DS1FQoK8QHAw&sa=D&ust=1541585860045000&usg=AFQjCNGn9jqM2FPiaAHdG9hv51QVVWXvfA>

BluGlass continues to engage in collaborations, evaluations and prototyping with a number of industry leading partners in specialised, high-value technologies including:

### Global foundry: IQE

- Continuing collaboration on technology for high-quality nitride films deposited by low temperature RPCVD on silicon wafers and specially-engineered substrates using crystalline rare earth oxide (cREO™) on silicon

### MOCVD Equipment Vendor: Veeco Instruments

- Power electronics collaborative evaluation

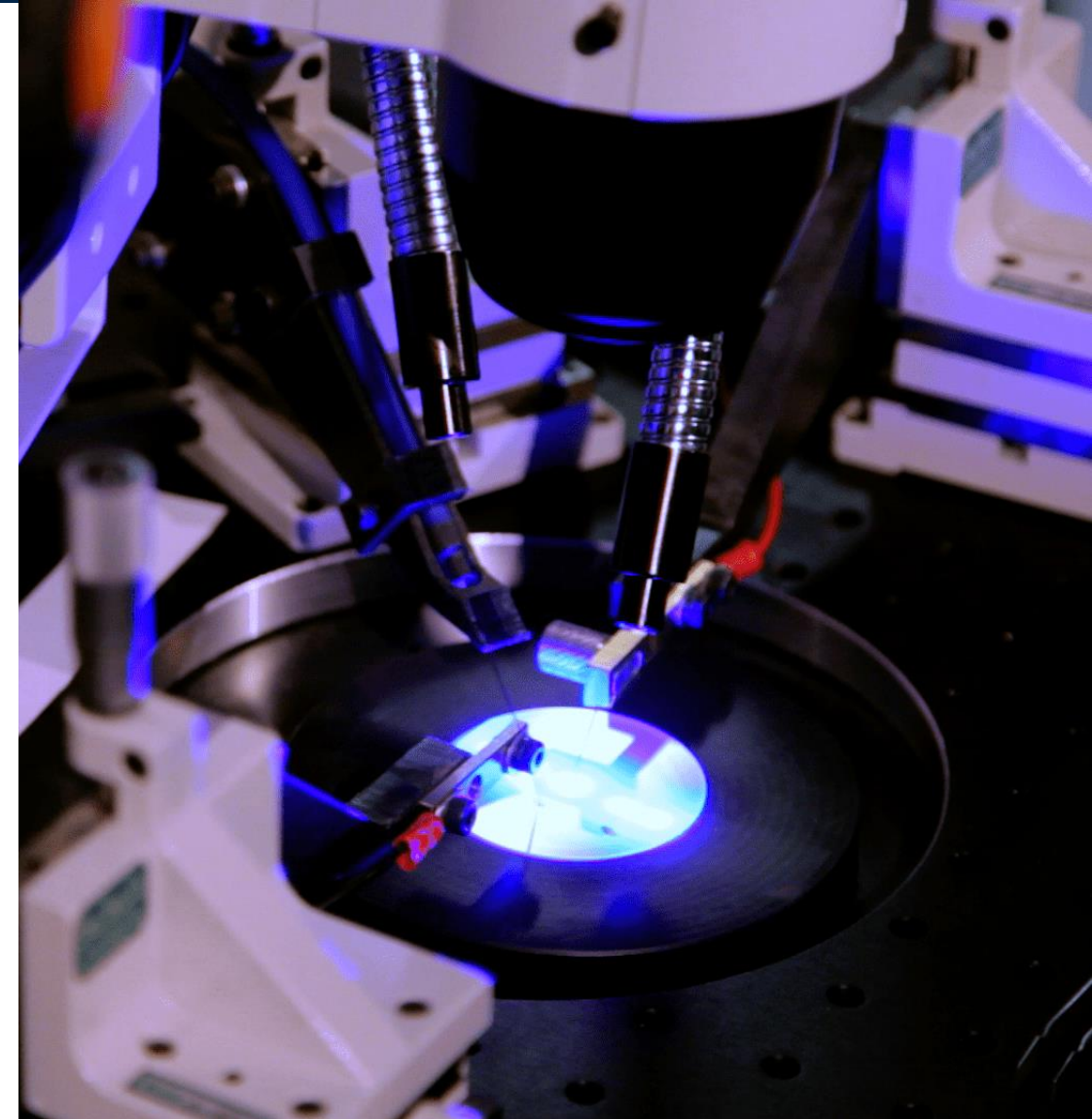
### LED Manufacturer: HC Semitek

- LED applications under evaluation



### Strategic vehicle for RPCVD industry acceptance

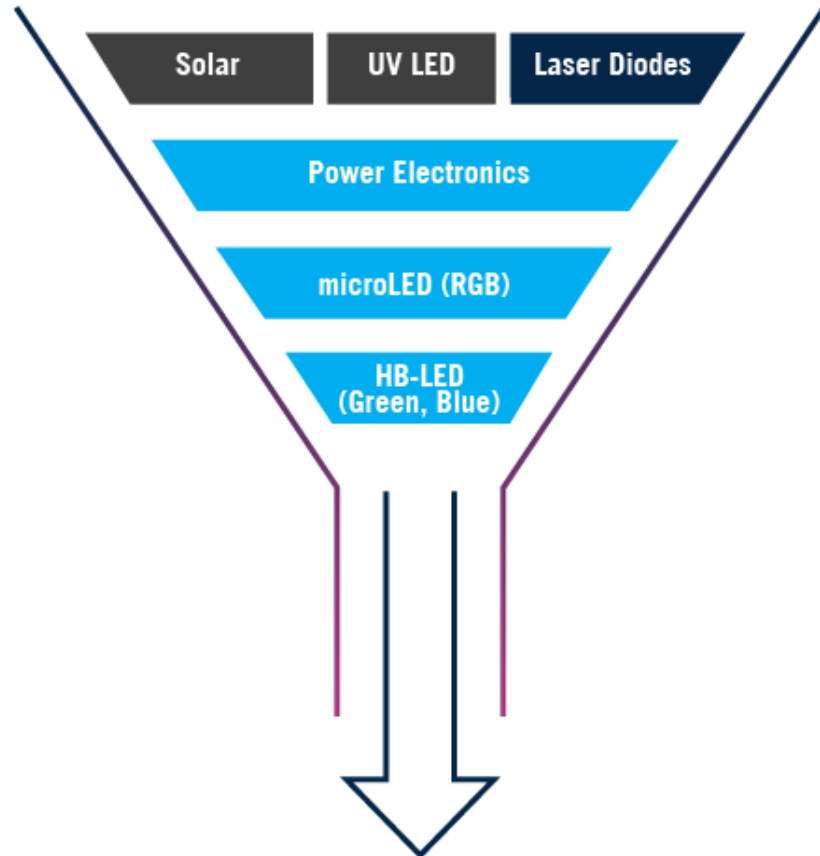
- Specialised GaN foundry and epitaxial wafer growth services
- High value, low volume services
- Custom & contract R&D
- RPCVD and MOCVD services available
- Epitaxial characterisation services





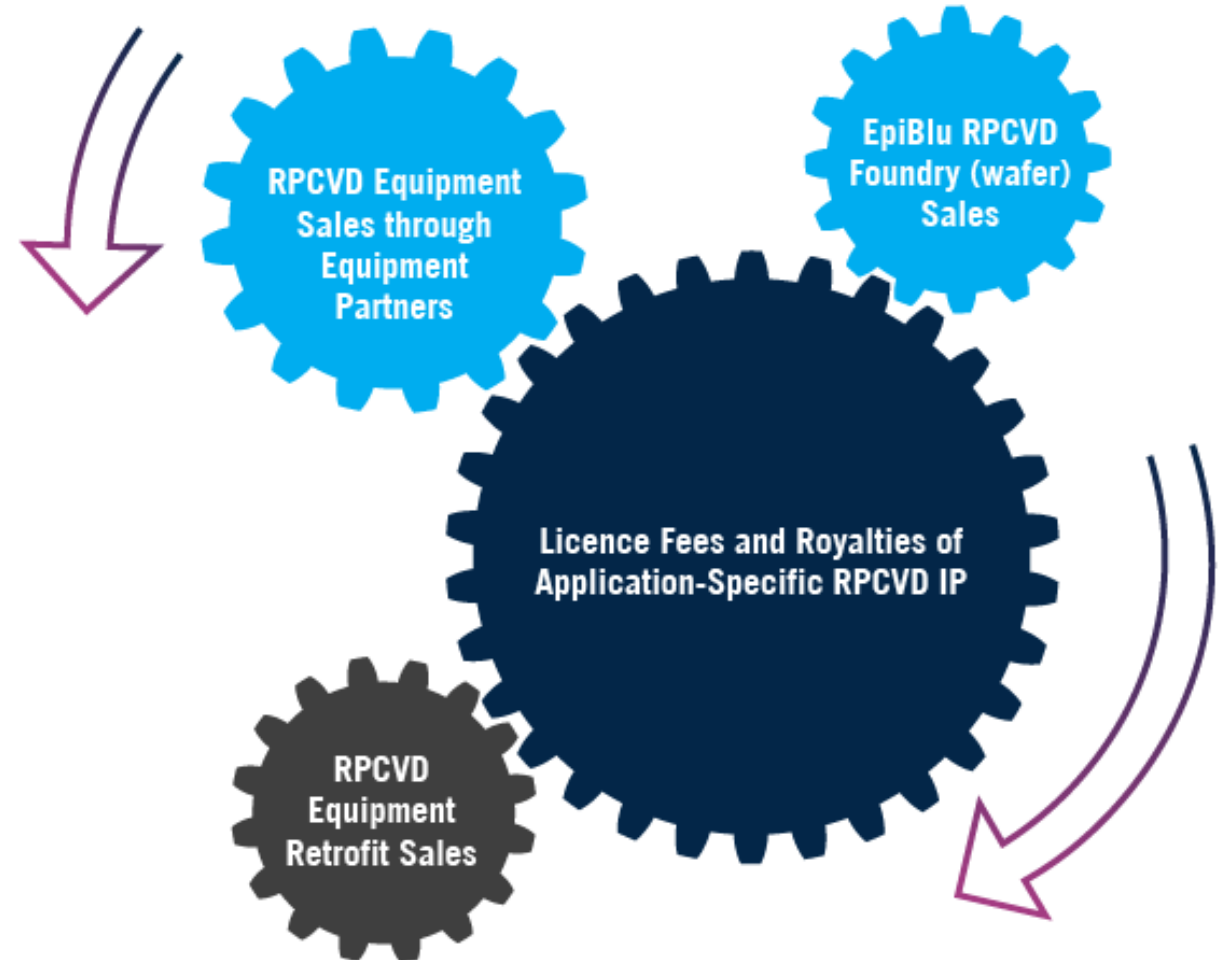
# PATH TO MARKET

## Applied Development of RPCVD



Pipeline of RPCVD IP

BluGlass will generate RPCVD revenues through a combination of the following:





# MAJOR MILESTONES FY2018



# SUMMARY MILESTONES IN FY2018

# 2018

Entered into a unique partnership with Griffith University and the Innovative Manufacturing Cooperative Research Centre (IMCRC) to develop next generation of power electronics.

RPCVD technology achieved major technology development milestone, with upgraded BLG-300 demonstrating good thickness and performance uniformity over 2-inch, 4-inch and 6-inch wafers.

Entered into a Collaboration Agreement with a microLED company to develop novel RGB microLED applications.

BluGlass and Lumileds agreed to extend Phase II of the collaboration. The extension is designed to accelerate the development of new applications of LEDs using RPCVD.

Appointed industry expert, Dr. Mike Krames as an Advisor to provide guidance on the technical development and commercialisation plans of RPCVD.

Completed Board renewal with the appointment of professional director, Stephe Wilks to the BluGlass Board of Directors.

August 2017

September 2017

November 2017

March 2018

April 2018

May 2018

June-July 2018

Delivered a major hardware upgrade project to address the uniformity and scalability challenges of the RPCVD technology.

Successfully delivered new modular RPCVD platform, the BLG-300.

Presented best RPCVD performance data to date at international nitride conference, presenting a greater than 30% performance improvement in RPCVD based green LEDs\*.

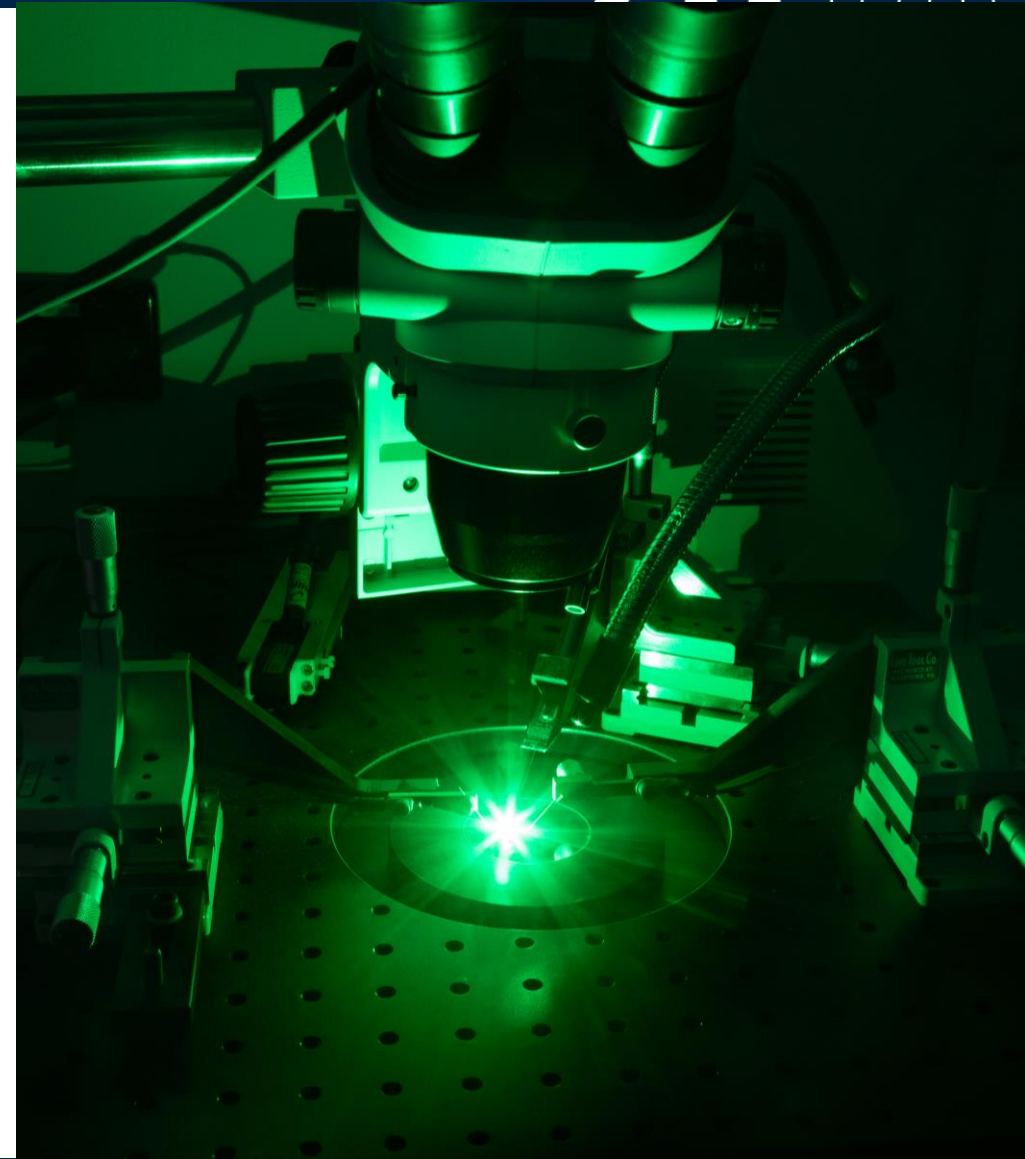
Launched our custom epitaxy brand, EpiBlu

Appointed Brad Siskavich a full-time, global Vice President of Business Development to lead the expansion of the BluGlass custom services business, EpiBlu.

Raised \$11.2 million expansion capital from an Institutional Placement and SPP. Funds are being used to undertake major upgrade of facility and acquire new commercial scale deposition platforms for commercial demonstrations.

\*30% performance improvement in RPCVD p-GaN based green LEDs compared to BluGlass' MOCVD green LEDs measured at the wafer level using indium dot contacts

- BluGlass has commenced commercial negotiations with Lumileds and will provide the market with further details on the outcome
- Deliver the facility upgrade and install two new RPCVD deposition systems
- Scale the RPCVD technology to commercial manufacturing requirements
- Continue to advance our microLED applications with our collaboration partners
- Grow our strategic service business, EpiBlu
- Enter into new collaboration and evaluation agreements with high value partners to further capitalise on the advantages of RPCVD





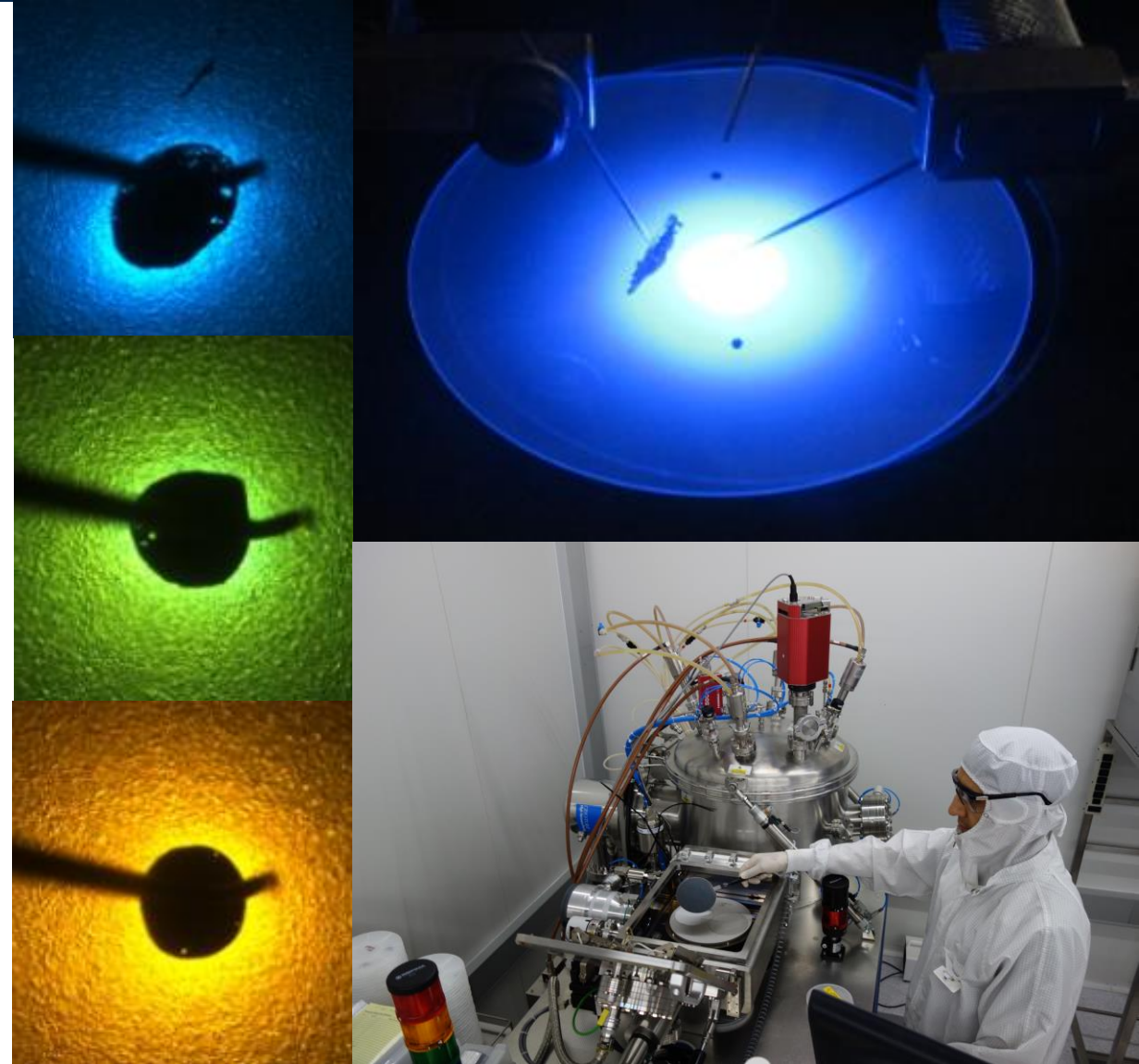
# CHIEF OPERATIONS & TECHNOLOGY OFFICER



Dr. Ian Mann

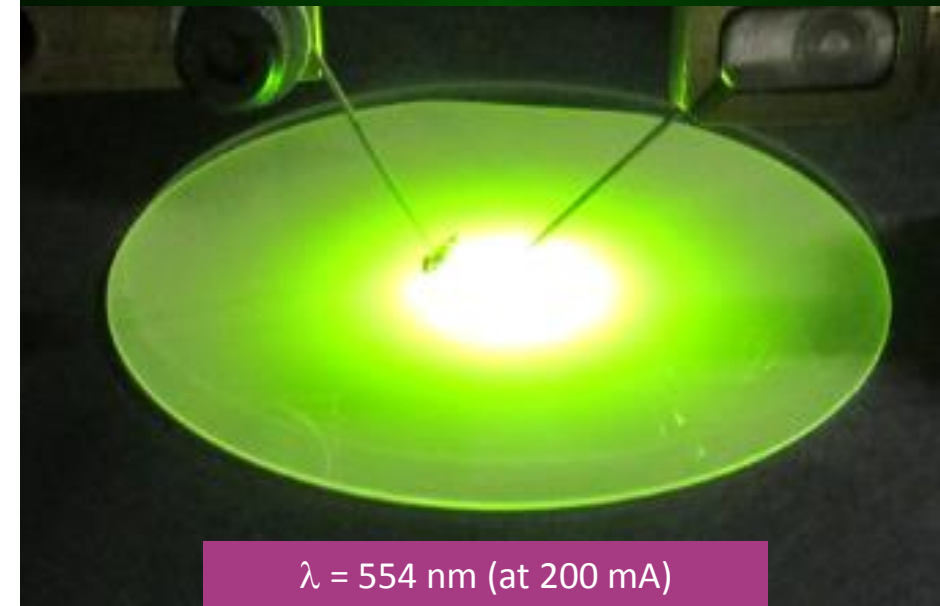
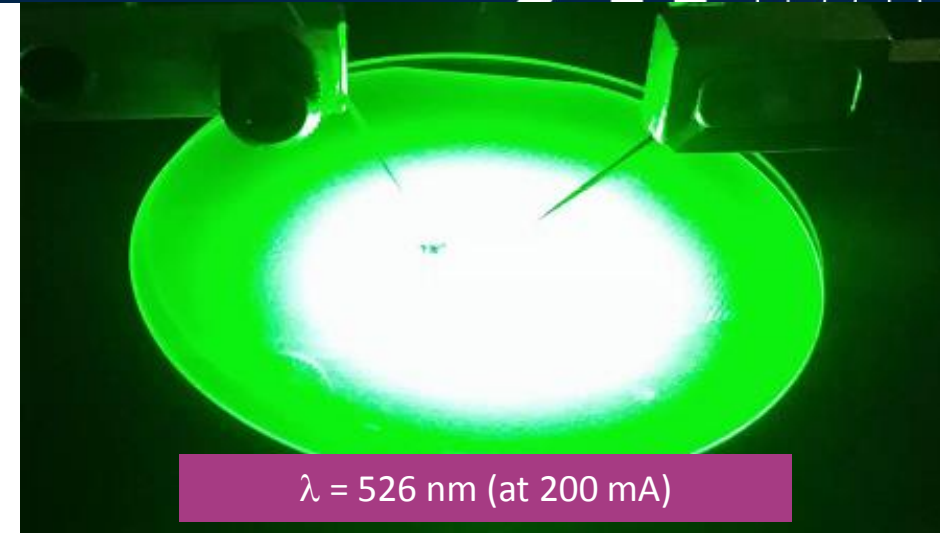


- Strong technical progress on Lumileds milestones enabled commercial discussions to commence
- RPCVD scaling to production platform to commence in 2019 - large deposition system purchased and en route to Silverwater for RPCVD retrofit
- Continued technical progress on RPCVD RGB microLEDs
- Initial demonstrations of RPCVD in Power Electronics under way with Innovative Manufacturing CRC Grant with Griffith University
- IQE, HC Semitek and Veeco collaborations ongoing
- Growing pipeline for custom epitaxy business, EpiBlu



## RPCVD p-GaN overgrowth demonstration on longer wavelength green and green/yellow LEDs

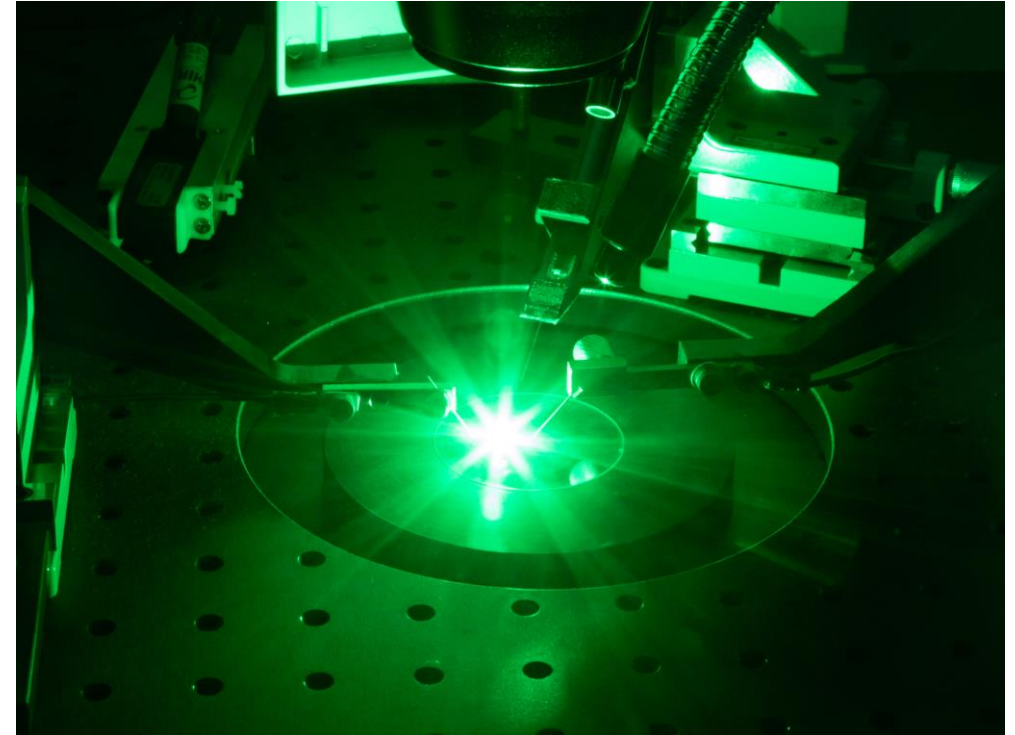
- BluGlass continues to improve performance of its longer wavelength LEDs – Critical for RGB microLED demonstrations for customers
- In MOCVD, the higher temperature growth of p-GaN on top of the key performance and light emitting layer (the InGaN MQW) can cause damage to this temperature sensitive layer
- At high temperatures indium (In) diffuses out of the MQW layers and therefore lowers light output. This gets worse as the wavelength gets longer (e.g. green and yellow that require greater concentrations of indium in the InGaN MQW)
- MOCVD cannot effectively grow high performance p-GaN at lower temperature
- Low temperature RPCVD p-GaN has **significant potential to improve device performance in long wavelength LEDs** – by overgrowing RPCVD p-GaN on indium-rich InGaN MQWs





In 2018, BluGlass has manufactured fully packaged LEDs using RPCVD p-GaN

- Initial results of these RPCVD containing LEDs are being shared with select customers





## LED STRUCTURE GROWN USING MOCVD

## p-GaN & MQW GROWN USING RPCVD

p-GaN grown at **INTERMEDIATE to HIGH** temperature



Multi-Quantum-Well (MQW) InGaN layer, the **ACTIVE REGION** of an LED – grown at low temperature



n-GaN grown at high temperature

GaN grown at high temperature

Sapphire Substrate

p-GaN grown at **LOW** temperature



Multi-Quantum-Well (MQW) InGaN layer, the **ACTIVE REGION** of an LED – grown at low temperature



n-GaN grown at high temperature

GaN grown at high temperature

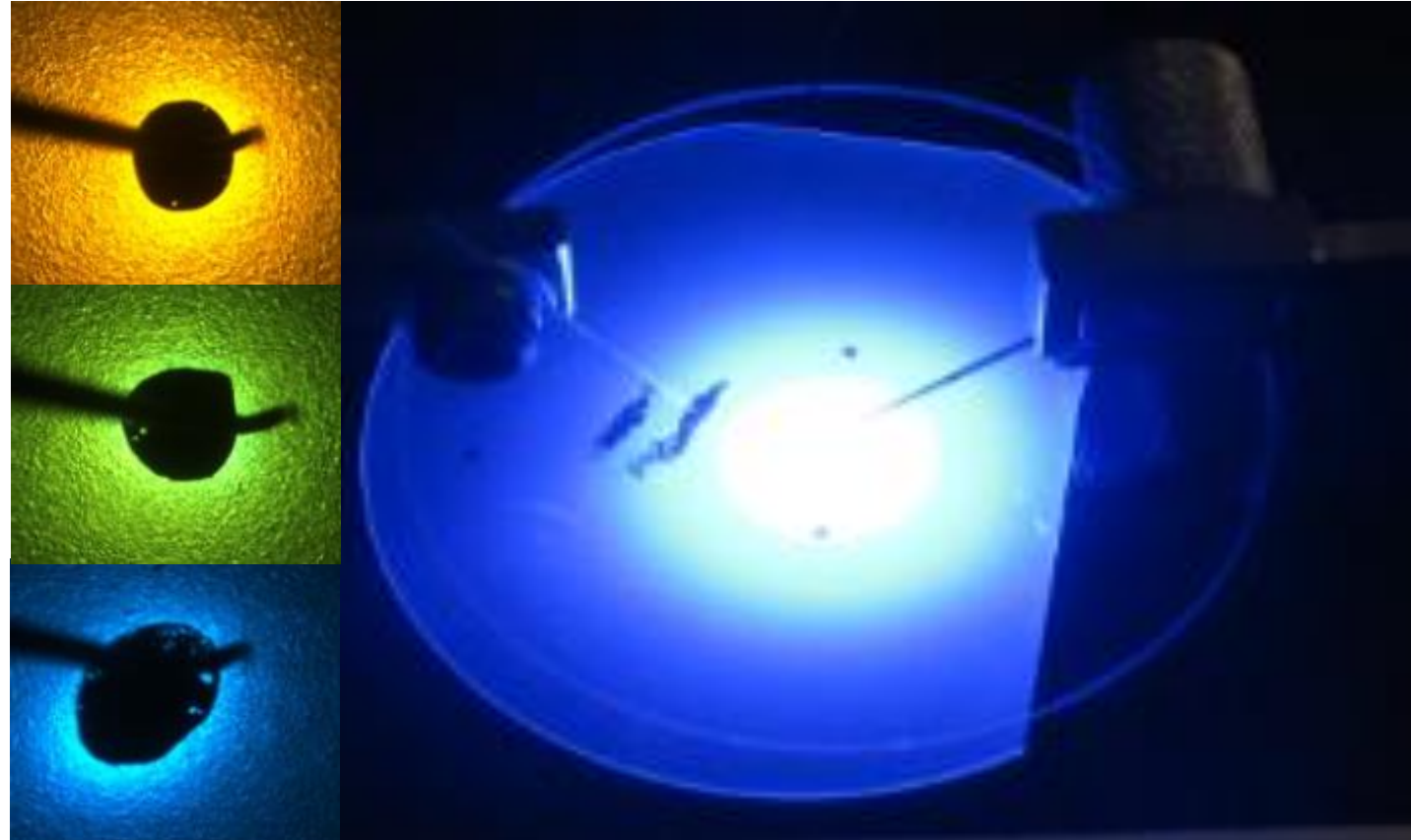
Sapphire Substrate

RPCVD

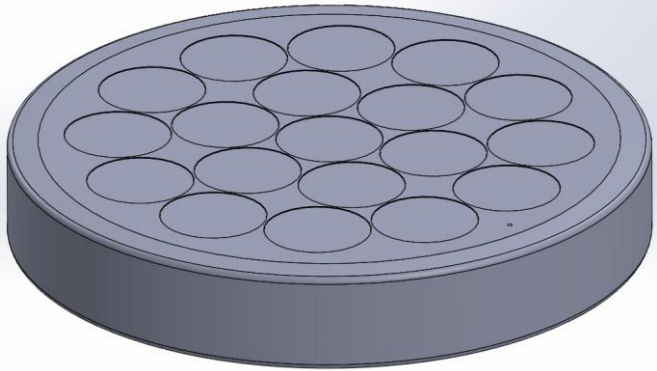
MOCVD

## RPCVD MQW + p-GaN BASED BLUE LED

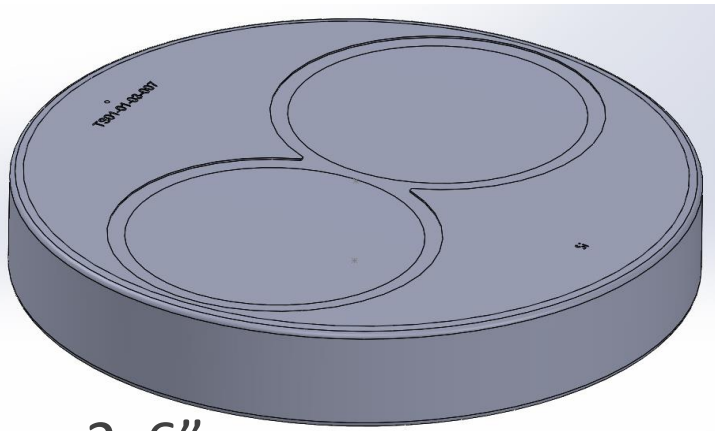
- To attract further industry interest BluGlass continues to enhance the capability of RPCVD
- Low temperature RPCVD is favourable for Indium-rich InGaN MQWs useful for longer wavelength LEDs
- microLED players have shown interest in **RPCVD capability for blue, green, yellow and red LEDs** for display and other applications
- BluGlass has improved performance of RPCVD MQW based blue LED



## BLG-300 RPCVD Wafer Configurations

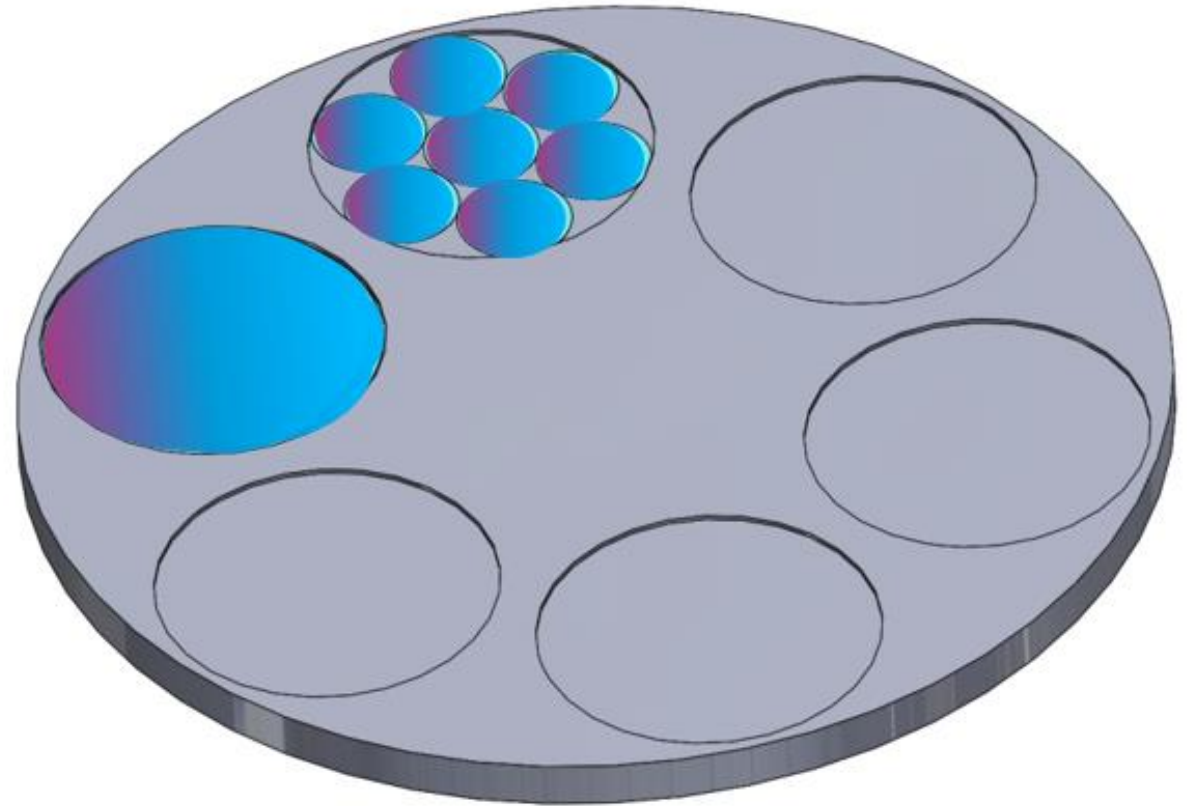


19x2"



2x6"

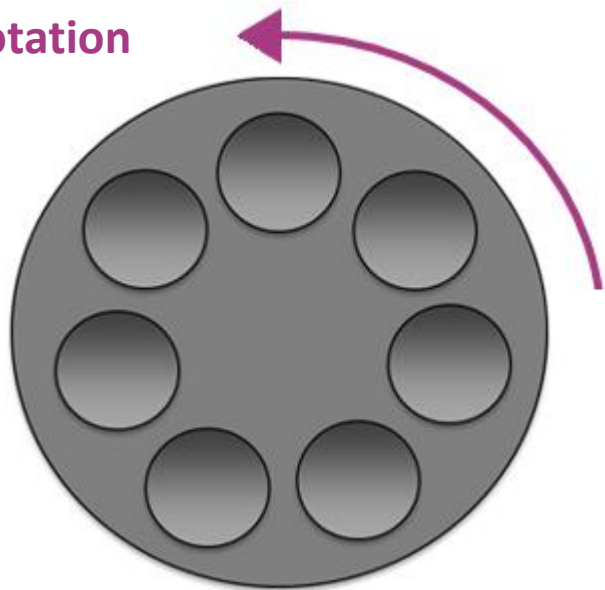
## New RPCVD System Wafer Configurations in 2019



6x6" or 42x2"



## Simple Rotation

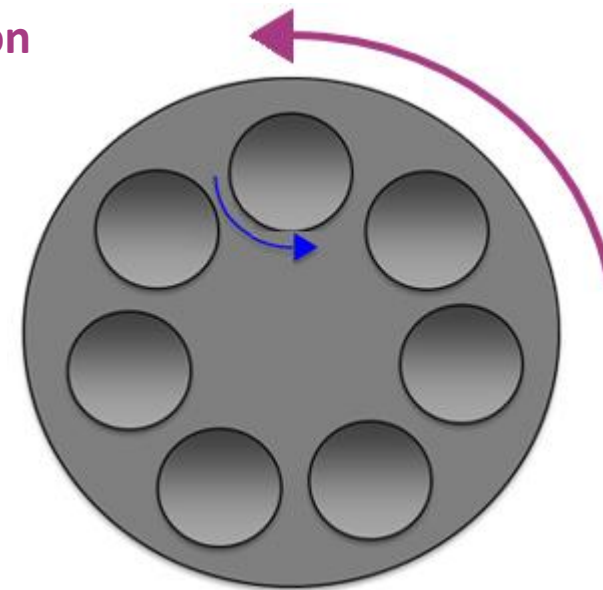


### Single axis of rotation – wafer carrier rotates only

- Non-uniformity in gas distribution can lead to non-uniformity of the profiles across the wafer carrier
- Chamber design must provide extremely uniform distribution of gas species to achieve within-wafer growth uniformity

## Planetary Rotation

New RPCVD  
System in 2019



### Two axes of rotation: wafer carrier and planets rotate

- Wafer carrier & planets (individual wafers or collections of wafers) also rotate
- Planetary rotation can average certain non-uniformities in gas distribution across the wafer
- Improved within-wafer uniformities
- Well-suited to large scale multi-wafer deposition

BluGlass' new facility upgrade will provide two new clean rooms (Bays 1 and 2) with two new RPCVD systems

- **Initial Use:** Scaling for RPCVD commercialisation and increase RPCVD capacity for projects
- **Future Use:** RPCVD Equipment Retrofit sales and RPCVD foundry services





## New Production Bay 1



- New BLG-300™ RPCVD system (19x2")
- Increase RPCVD industry project capacity
- RPCVD foundry services

## New Production Bay 2



- Installation and retrofit of commercial scale Aixtron G4 Planetary Reactor (capable of 6x6" or 42x2")
- Next generation of RPCVD retrofit – larger area and improved uniformity
- Suitable for LED production for select customers



## Existing RPCVD & MOCVD Labs (3 Prototyping Systems)

**USE:** 2 RPCVD system for process development  
1 MOCVD system for custom epi services and RPCVD support



### OUTPUT

- IP generation
- RPCVD demonstrators
- Collaborations
- MOCVD custom epitaxial services

## New Production Bay 1 (1 x RPCVD System)

**USE:** RPCVD industry projects  
Support hardware and process development



### FUTURE OUTPUT

- Sell RPCVD wafers and epitaxial services directly to customers

## New Production Bay 2 (1 x Production Scale RPCVD)

**USE:** RPCVD scaling  
Demonstration of industry projects on production scale



### FUTURE OUTPUT

- Design, build and sell retrofit RPCVD systems directly to customers

# QUESTIONS