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# BluGlass advances single-frequency GaN DFB performance

## Highlights

- BluGlass advances its blue single-frequency DFB performance
  - 50% improvement in Side-mode-suppression ration (SMSR)
  - Lowered threshold and voltages improving output power
- BluGlass' proprietary RPCVD technology utilised to extend single-frequency DFB to 480nm

## Opportunity Overview

The emergence of quantum information science has driven a need for compact, single-wavelength (single-frequency) laser light sources. Research in quantum computing and quantum applications is underpinned by stimulated light interaction with unique materials, which require specific wavelengths to target individual atomic interactions.

According to a recent Mackenzie report, "Quantum computing (QC), one of the most revolutionary technologies of our time, is still a decade away from widespread commercial application. However, less well known, but of critical industrial and scientific importance, are two related technologies that are set to become available much earlier: quantum sensing (QS) and quantum communication (QComm)."

Precedence Research predicts the global quantum applications market will reach US $125 billion by 2030 at a CAGR of ~37% from 2022 to 2030.

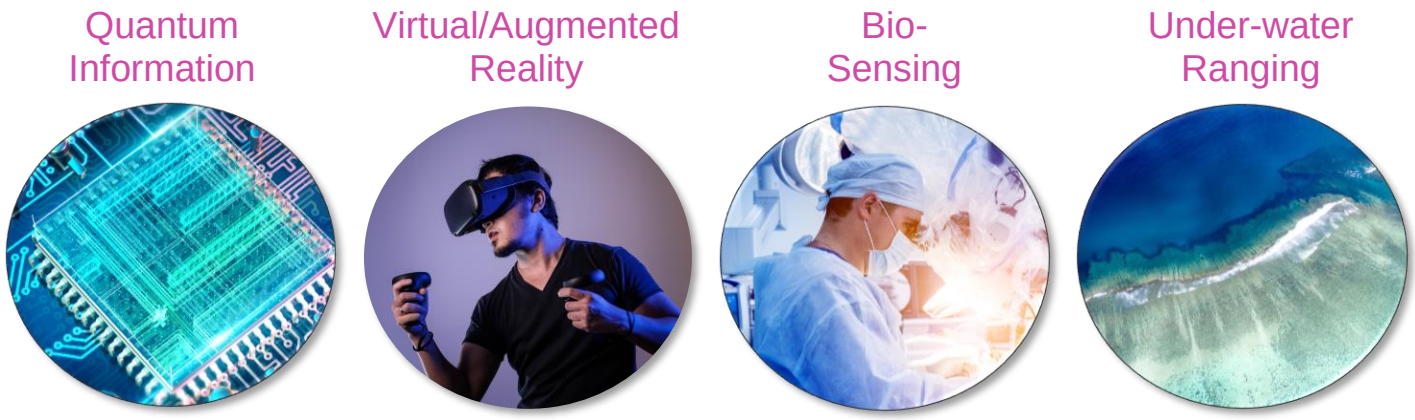
Historically quantum demonstrations have been relegated to benchtop equipment with large external cavity lasers and tunable dye lasers. BluGlass's recent advances in GaN-based distributed feedback (DFB) laser diodes offer an alternative to prohibitively large and expensive systems. GaN devices are well-known for emitting high-quality, high-efficiency UV to green laser light and BluGlass's visible DFB lasers have demonstrated near single wavelengths with extremally narrow full width at half-maximum (FWHM) wavelength distribution and high side mode suppression ratio (SMSR), which is the suppression of undesirable wavelengths. These DFBs are compact and fabricated at the wafer scale, enabling integration onto portable platforms, enabling volume production to address the quantum markets and applications.

These emerging quantum markets present an enormous opportunity for visible laser diode manufacturers, such as BluGlass, as many of the enabling atomic transitions occur at visible wavelengths and are being increasingly sought after by customers in highly promising applications, such as advanced robotics, bio-medical applications; for example brain-driven prosthetic automation, atomic clocks for quantum navigation for both military and commercial applications.

In addition to Quantum applications, single-wavelength visible laser sources, due to their unique performance properties, will enable advancements in underwater ranging and underwater communication and underpin next-generation display and wearable technologies, including augmented and virtual reality applications.

This enormous opportunity, combined with strong customer interest, has driven research efforts at BluGlass on the development of gallium nitride (GaN)-based distributed feedback (DFB) laser diodes. DFB lasers are an ideal candidate to enable the strict frequency, beam fidelity, narrow linewidth requirements, and the high power and efficiency these next-generation technologies require.

## Applications




## BluGlass' DFB Laser Development

BluGlass has demonstrated significant progress in strict frequency control, beam fidelity, and narrow linewidth with its recent GaN DFB laser developments, which have benefited from its proprietary Remote Plasma Chemical Vapour Deposition (RPCVD) technology. This development work by the company has led to increased laser performance, including suppression of undesired side modes, lower operating voltage, and higher efficiency. The beam linewidth is proven stable over a large range of drive currents and has wavelength-tuning capability.

BluGlass, together with its collaboration partner the University of Santa Barbara California (UCSB), has made significant improvements to its GaN Distributed Feedback Laser (DFB) performance using RPCVD for longer-wavelength devices. The Company improved DFB side-mode suppression ratio, a critical requirement to enable single-frequency lasing performance, by more than 50% since Photonics West, delivering advanced single-frequency performance at 450nm and demonstrating longer-wavelength DFB lasers up to 478nm.

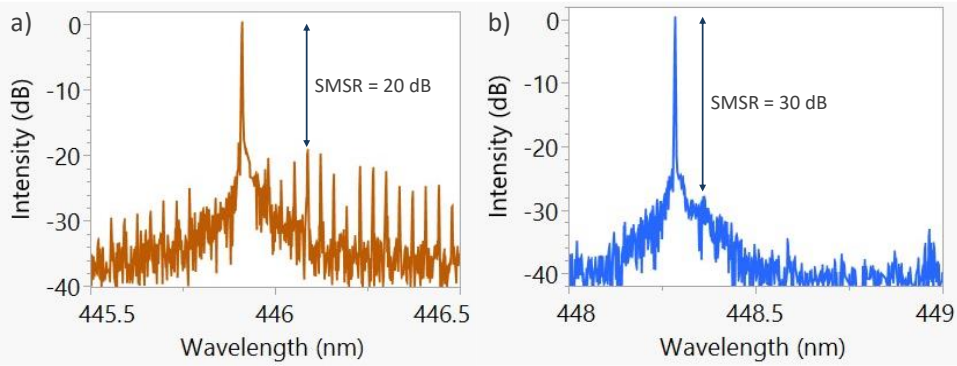



Figure 1. Emission spectra from DFB laser chips on submount under continuous-wave operation in a) previously published work and b) with improved chip design.

BluGlass' latest development iterations demonstrate lower threshold and voltage performance achieving higher powers across similar current densities.

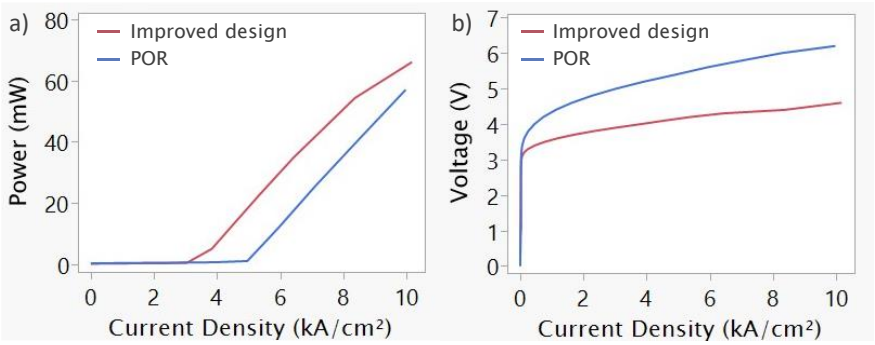



Figure 2. Comparison of previously published output power and voltage results with BLG's improved grating design. Chips are on a submount heat sink and electrically injected under continuous wave operation. The new grating and epitaxial design improved threshold and decreased operating voltage resulting in higher efficiency and reduced heat generated as waste.

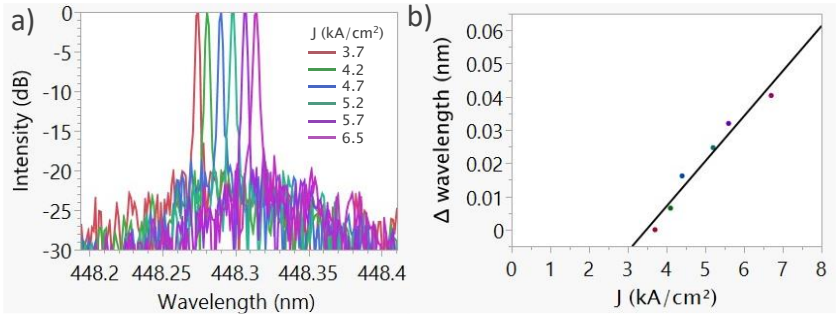



Figure 3. The improved grating maintains stable emission wavelength with increased operating current. The emission spectra tested over a range of current densities are shown in a), and notably maintain narrow linewidth of less than 3 pm. The emission peaks are plotted in b) showing the range of wavelength tuning capable of a single chip.

Fundamental improvements to the epitaxial material overgrown by remote plasma chemical vapor deposition (RPCVD) have expanded single-frequency emission towards longer wavelengths. These results show the potential for RPCVD to outperform traditional growth methods in fabricating long-wavelength GaN laser diodes.

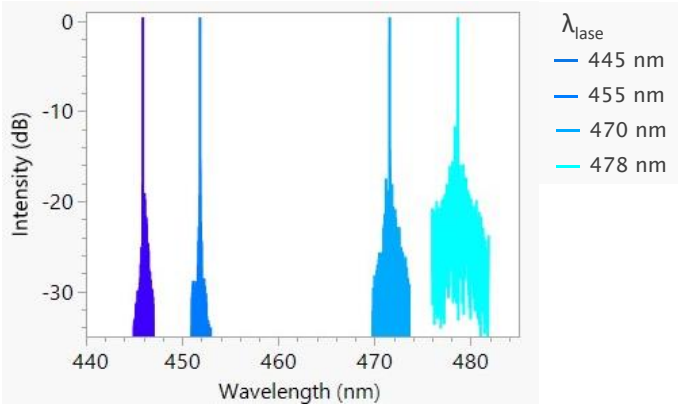



Figure 4. Spectral emission showing the range of wavelengths from DFB lasers grown by RPCVD and fabricated at BluGlass. RPCVD technology allows epitaxial growth of higher-quality material layers at longer wavelengths enabling single-frequency lasers. The latest demonstration reached as long as 478 nm with less than 3 pm linewidth.

During development, BluGlass has demonstrated multi-mode, single-mode, and single-frequency performance from common wafers. Below is a comparison of the results. The Company will continue to compare these results and progress towards green wavelengths.

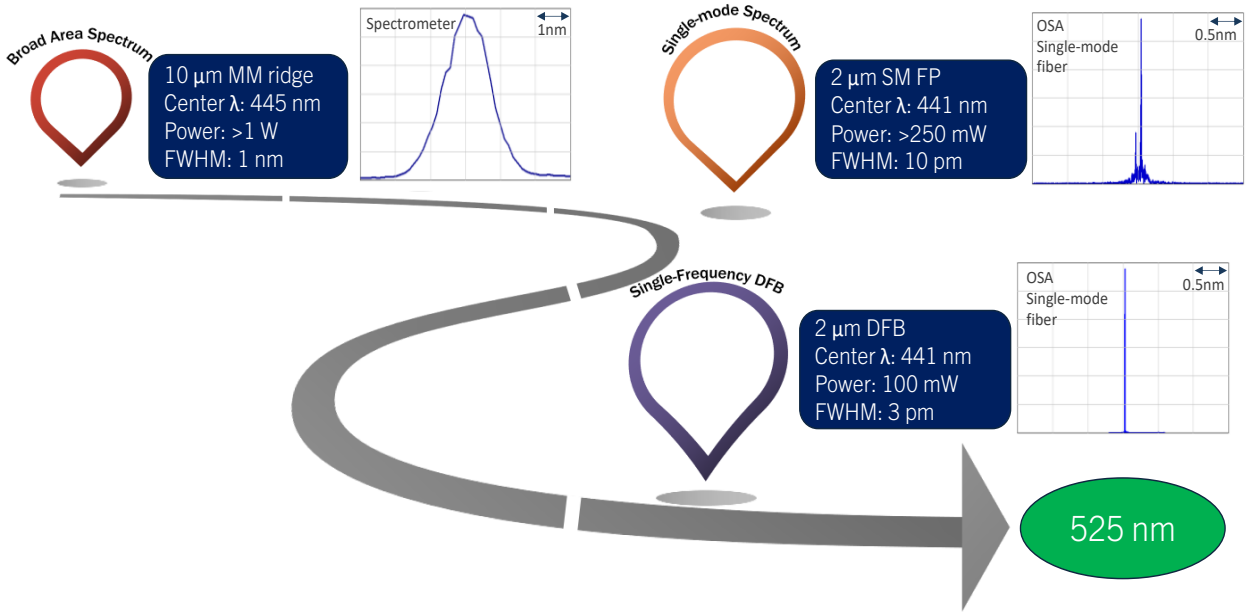



Figure 5. The integrated factory at BluGlass allows design and fabrication of high-power multi-mode, single spatial mode, and single frequency type DFB laser diodes onto a single wafer. While significant progress has been made extending the operating wavelength from blue to cyan, BluGlass aims to develop single frequency true-green sources.

The Company's Single-Frequency DFB laser diodes at visible wavelengths grown with low-temperature remote plasma chemical vapour deposition p-AlGaN paper can be downloaded exclusively from the SPIE Photonics West website here: [Single-Frequency DFB laser Diodes grown with low-temperature remote plasma vapor deposition P-AlGaN]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## About BluGlass

**BluGlass Limited (ASX:BLG)** is a leading supplier of GaN laser diode products to the global photonics industry, focused on the industrial, defence, bio-medical, and scientific markets.

Listed on the ASX, BluGlass is one of just a handful of end-to-end GaN laser manufacturers globally. Its operations in Australia and the USA offer cutting-edge, custom laser diode development and manufacturing, from small-batch custom lasers to medium and high-volume off-the-shelf products.Its proprietary low temperature, low hydrogen, remote plasma chemical vapour deposition (RPCVD) manufacturing technology and novel device architectures are internationally recognised, and provide the potential to create brighter, better performing lasers to power the devices of tomorrow.

BluGlass' technical innovations are protected by 93 internationally granted patents and 17 trademarks in key semiconductor manufacturing jurisdictions.