Australian National Fabrication Facility
ACT Node & WA Node
NEWSLETTER
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MOCVD systems are GO!

Tuesday, 18 November saw the official opening of the two newly installed Metal Organic Chemical Vapour Deposition (MOCVD) systems at the ACT Node by Senator Zed Seselja, Senator for the Australian Capital Territory. The event was attended by about 150 people, including representatives from the Federal Government, Department of Education, US Air Force Office of Scientific Research, US National Institutes of Health and many more. It was fortunate that this event coincided with the ANFF Research Showcase as many of our interstate/international colleagues would otherwise been unlikely to have been able attend this opening.

After welcoming all the guests Prof. Chennupati Jagadish, ACT Node Director, introduced ANU Pro Vice-Chancellor (Innovation), Prof. Michael Cardrew-Hall; ANFF Board Chairman, Prof. Chris Fell and ANFF CEO, Rosie Hicks for opening remarks.

Part of the MOCVD opening crowd with (L-R front row only) Prof. Jagadish, Prof. Tim Senden, ANU Pro Vice-Chancellor Prof. Michael Cardrew-Hall, Senator Zed Seselja, Rosie Hicks and Ditta Zizi listening to ANFF Board Chairman, Prof. Chris Fell delivering some opening remarks.

This was followed by Senator Seselja officially opening the facility saying "the Metal Chemical Vapour Deposition reactors will give Australia the capacity to keep in touch with the latest trends in advanced manufacturing.

"For the everyday Australian, like me, this will mean new areas where Australia can excel, new technologies and new jobs. The benefits are many and will all lead to positioning Australia for the future.

"Research infrastructure, like the reactors, are critical for university and public sector researchers, as well as the broader economy. The Australian Government recognises the importance of creating and maintaining such facilities and over the years has invested more than $113 million in the ANFF.

"The Australian National Fabrication Facility is an outstanding example of how capabilities developed under the National Collaborative Research Infrastructure Strategy can reach across large geographical, institutional and state boundaries, providing integration of research infrastructure at a national scale."

Fig. 1 - The new Aixtron CCS MOCVD system for growing As- and P-based materials

MOCVD, or sometimes known as Metal Organic Vapour Phase Epitaxy (MOVPE), is commonly used for the growth of compound semiconductors. It is currently the dominant epitaxial growth process for III-V semiconductor materials and devices, and the technique of choice for the semiconductor industry. Commonly found devices grown by this technique include LEDs, laser diodes, photodetectors, high frequency and high power transistors, and multi-junction solar cells.

Both the new systems are the Closed Coupled Showerhead (CCS) model from Aixtron (see Fig. 1). In the CCS configuration, precursors and gases are introduced vertically into the process chamber through an array of very small holes in the reactor ceiling, just like a showerhead. The design of the showerhead, and its close proximity to the heated wafers, ensure the gases are distributed uniformly throughout the whole wafer carrier surface. Both systems are capable of growing 3 x 2-inch wafers in each run and equipped with the LayTech Epi-TT, an optical in-situ metrology tool that allows the user to monitor all essential properties of

Fig. 2 - A distributed Bragg reflector showing the uniformity of the layers across a 2-inch wafer.

the growing layers, such as growth rate, film thickness, stoichiometry changes and morphology, and also the precise surface temperature. The benefits of the in-situ process monitoring tool include quick identification of process deviations, optimisation of the film quality, improvement of yield and the fast tracking of new processes.

One system is designed for N-based material systems and has been in operation since late April 2014 and the other is for As- and P-based materials, in operation since the end of September 2014.

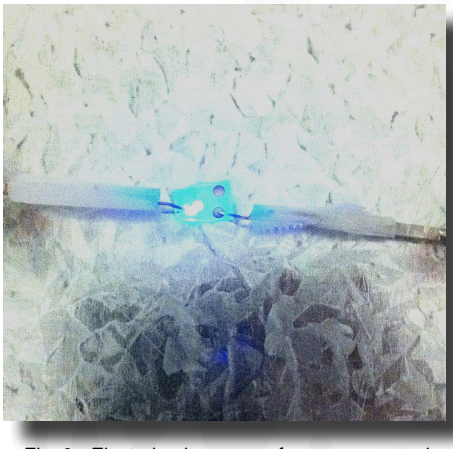


Fig. 3 - Electroluminescence from a processed InGaN-GaN quantum well LED.

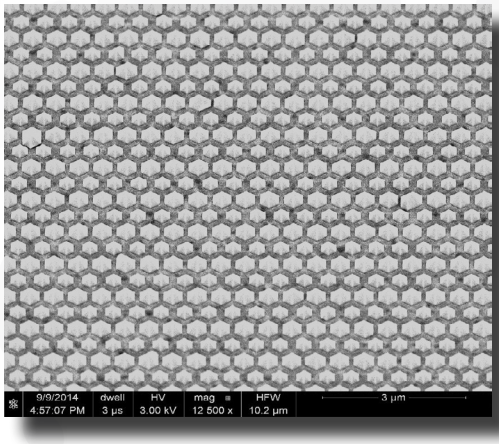


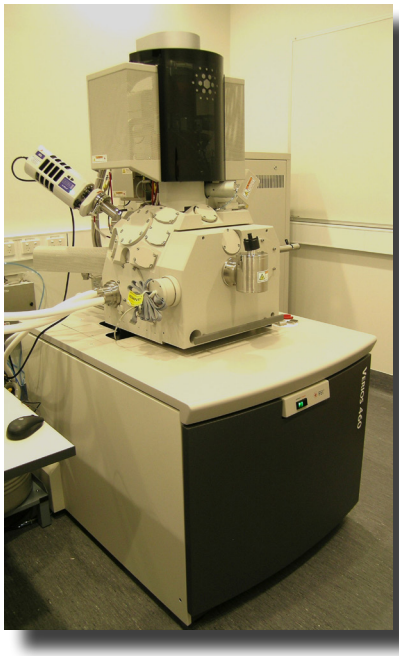
Fig. 4 - Electron micrograph image of a GaN pyramidal array grown in the new N-based MOCVD.

The N-based system is capable of reaching a (surface) temperature of up to 1200°C for the growth of materials such as GaN, InGaN and AlGaN. The As/P system has precursors for the growth of materials such as GaAs, AlGaAs, InP, InGaAs, InGaAsP, GaSb, GaAsSb. Both systems meet the material specifications such as background doping, doping concentration, mobility, thickness and composition uniformities. The thickness and composition uniformities are spectacular, with a value of $\leq$ 1% across a 2-inch wafer. An example of this is shown in Fig. 2 (front page) where a red distributed Bragg reflector was grown using GaAs and AlAs multilayers.

As further testament to the quality of material being grown, we designed and grew a blue quantum well LED structure. The wafer was then processed at ANFF ACT Node and blue emission was achieved as shown in Fig. 3 (above). Detailed characterisation of the devices is now underway. Novel structures such as nano-pyramid arrays are now being explored for light trapping/extraction to improve the quantum efficiency of optoelectronic devices. An example of such a structure is shown in the SEM image of Fig. 4 (above).

MOCVD details courtesy of Prof. Hoe Tan, Department of Electronic Materials Engineering, ANU

State-of-the-Art FESEM for the ACT Node

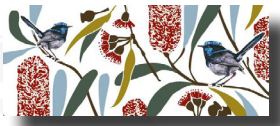


The new FEI Verios field emission scanning electron microscopy (FESEM) instrument was installed and commissioned at the ANFF ACT Node last month (remember the 'mystery' tool from last newsletter?) and our new Microanalysis Research Officer employed specifically for this new tool will commence in early 2015.

The FEI Verios has a field emission gun and a mono-chromator suitable for ultra-high resolution imaging. In addition to the Everhart-Thornley and in-lens detector, the new FESEM boasts several new electron detectors such as retractable directional backscattering detector(R-DBS), a mirror detector and an in-column detector suitable for imaging at low energy.

This instrument is equipped with an Oxford electron dispersive X-ray (EDX) spectrometer with an 80mm^2 silicon drift detector currently installed. In early 2015, a Gatan MonoCL4 Elite cathodoluminescence (CL) system will be installed on this instrument enabling CL mapping and spectroscopic studies at room temperature and low temperatures. See our website news page for more details and images.

Story & image courtesy of Dr Jenny Wong-Leung, EME, ANU



Another busy quarter leading up to the Christmas/New Year break with the official launch of our two new MOCVD systems (see main story), and the installation and commissioning of our new FESEM (remember "What's in the Boxes" from our last issue) representing a total investment of over $5.5 million in new tools and capabilities!

On top of this the ANFF held its annual Research Showcase in Canberra at the Shine Dome - home of the Australian Academy of Science - with this year's theme being 'ANFF - a Platform for Innovation'. I'm sure there will be more on this from ANFFL in their next newsletter. Following hard on the showcase's heels will be COMMAD in Perth, 14-17 December. Our colleagues from ANFF WA Node will be heavily involved with this event and we will probably see a lot of our users/subscribers at this event as well.

Also we launched our 'new & improved' web site early in November - mainly in response to recent survey feedback, the requirement to include new logos and the design & management taking advantage of new HTML protocols.

The home page has links to our most popular pages and there is a horizontal menu for the 'administrative' areas of the website and a vertical menu at the left dealing with the 'operational' areas. This includes direct access to our main 'flagship & small processing tools' Booking Schedule – a feature asked for in our recent User Survey.

After testing on a wide variety of platforms and browsers (both desktop and mobile) I can say it is much more user friendly, particularly on the mobile platforms. But that is my opinion - please let us know what you think if you get the chance.

Lastly, and most importantly, we would like to take this opportunity to thank all our users, colleagues and customers for your support through the year and wish you all the best for Christmas and look forward to being of service again in the New Year.

Cheers. (JK)

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