# THE AUSTRALIAN NATIONAL FABRICATION FACILITY

ANFF

## ENABLED BY ANFF 2021


ENABLED BY

NCRIS
National Research Infrastructure for Australia
An Australian Government Initiative

ANFF.ORG.AU

# ANFF IN 2020/21

2020/2021 has been a demanding year with the COVID-19 pandemic and associated lockdowns – it has impacted severely on the availability of ANFF's facilities and prevented interstate users from travelling to make use of specific fabrication competencies.

Yet, despite all of this, researchers have continued to make progress on a number of exciting projects, as outlined in this Casebook. It is a great tribute to the Node Directors, Facility Managers and the technical specialists that keep ANFF capabilities at the cutting edge, and able to support innovative research.

In September of this year we were shocked to learn of the unexpected death of ANFF's Chief Executive Officer, Dr Ian Griffiths. Ian contributed so much to ANFF's ability to take interesting ANFF-supported science up the technology readiness level to the pre-commercialisation stage. We will miss Ian's enthusiasm and knowledge, particularly as ANFF negotiates its future in a year where the Expert Working Group develops a new Roadmap to guide the National Collaborative Research Infrastructure Strategy through the next stage of its development.

However, whatever next year holds, ANFF will continue to maintain the state-of-art standing of its research infrastructure offerings; to assist in capturing the benefits of publicly funded research that uses ANFF facilities where appropriate; and to help Australia develop sovereign capacity in a wide range of new technology areas.

The present Casebook provides a snapshot of some of the exciting new research developments supported by ANFF, and, despite the manifest hurdles that have come our way, illustrates the resilience of the ANFF community to produce outstanding science and technology for Australia. Thanks are due to all those who have made this possible.

**Emeritus Professor Chris Fell** AO FTSE HonFIEA ust CPEng
ANFF Chairman

Another year under the shadow of COVID-19 has passed and ANFF continues to prove how vital its services are to the Australian R&D community. At the same time, priorities at state and national level have emphasised the need to accelerate technologies out of the lab and into the real world, a pursuit that is reliant on open access to research infrastructure.

This year we have seen some fluctuations in numbers of users and hours but overall, we have shown a consistency that demonstrates the importance of the world of research infrastructure to our academic and industry client bases. Our support of more than 100 companies and more than 2,500 users underlines the impact that coordinated and strategic investments can make to our nation.

The structures that our greatly missed former CEO has put in place for ANFF will serve as a platform. They will enable ANFF to continue its excellence in providing fabrication solutions and provide more assistance to translate exciting projects.

The future looks bright. With a great many of the investments from the Research Investment Implementation Plan coming online in the coming months and the release of the National Research Infrastructure Roadmap, ANFF is well placed to be integral to the successful translation of research that will help Australia's economic recovery, just like the stories highlighted in this year's Casebook.

**Dr Jane Fitzpatrick**
ANFF CEO

NCRIS National Research Infrastructure for Australia
An Australian Government Initiative

ANFF

**Australian National Fabrication Facility Ltd**
151 Wellington Road
Clayton VIC 3168
T: +61 3 9902 9619
E: info@anff.org.au
**www.anff.org.au**

# IN MEMORIAM

**In September, our dynamic CEO Dr Ian Griffiths suddenly passed away. He was a brilliant, dedicated and passionate man, and will be fondly remembered by all of those that had the pleasure of knowing him.**

Always light-hearted but fiercely driven in his work, Ian has left a significant impact on ANFF's network and the Australian R&D community as a whole.

Ian's career focused on making it easier to extract real-world impact from exciting research with a particular eye for medical technologies. The paths he has carved will benefit people for years to come, making an enormous difference to all of those involved in research development and the uncountable number of people whose lives are made better by the technologies he helped deliver.

His special blend of eternal optimism and acute realism provided him with an uncanny ability to spot potential and to understand what was needed to capture it. While being personally engaging, Ian could also instantly distil the most in-depth technical concepts or complicated legal practices into common-sense statements that accelerated discussions and projects immensely.

The Chairman of ANFF, Emeritus Professor Chris Fell, said: "The ANFF community is in deep shock over Ian's passing. We owe him so much. He brought his wisdom on the path to commercialisation of university R&D to ANFF and set about identifying with researchers whose projects have marketable potential, indicating the steps required to lift their Technology Readiness Levels to an extent where they would be attractive to institutions and angel investors. ANFF has been much enriched by his leadership and his loss is a deep blow to our community."

ANFF Chief Operating Officer, Dr Jane Fitzpatrick, said: "Working with Ian has been a wonderful experience. His passion and insights into our organisation and what we are capable of have been truly inspiring. Personally, I have enjoyed having him in my life for the past couple of years and ANFF will feel less rich without him."

Ian was a proud champion of luring research out into the real world, and helping people to realise the fullest potential of their projects. ANFF's part in the successes celebrated in this Casebook wouldn't have been possible without his drive and direction, and his influence will be evident in our triumphs for years to come.

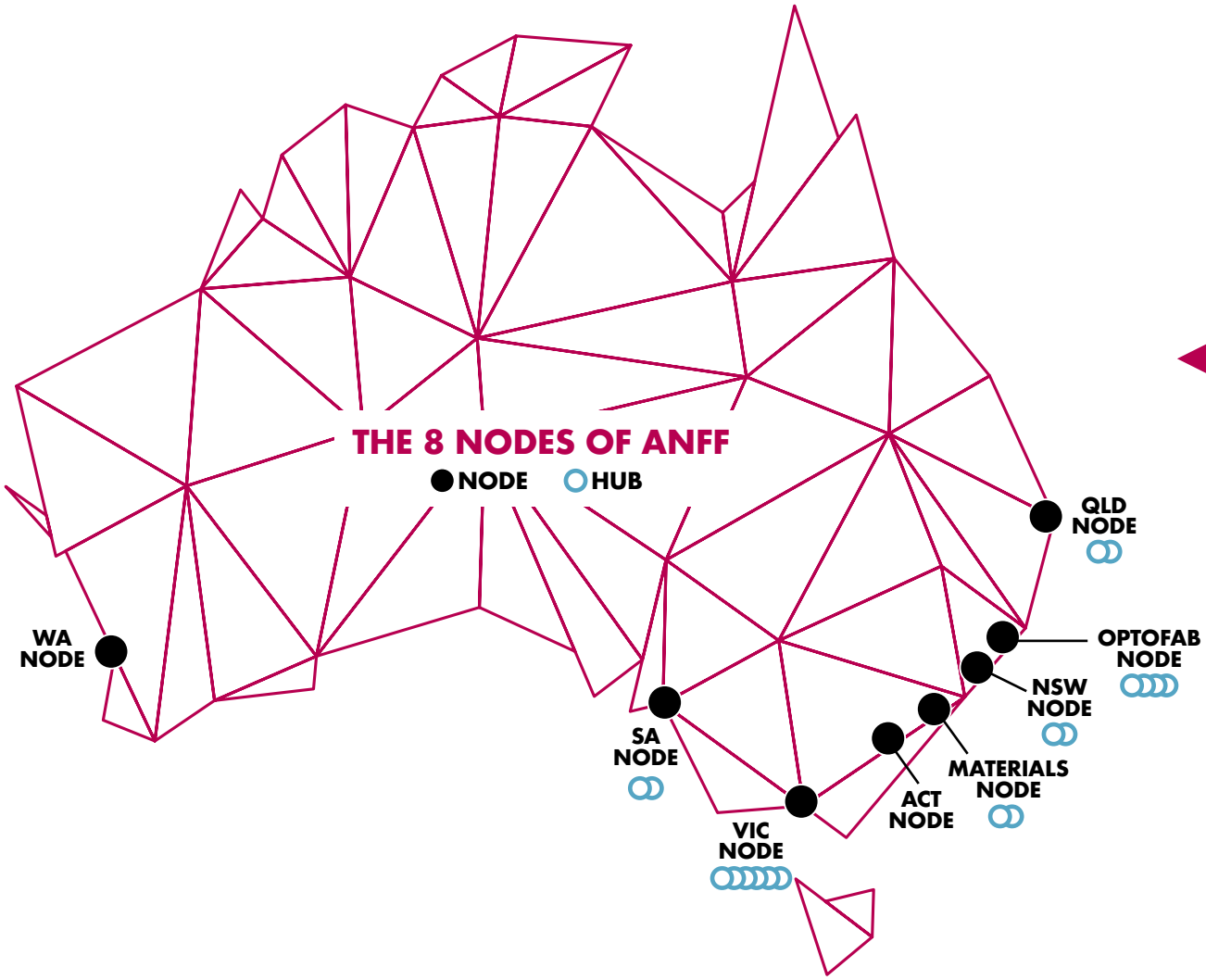
# CONTENTS

# SNAPSHOT OF ANFF

The Australian National Fabrication Facility (ANFF) was established under the Australian Government's National Collaborative Research Infrastructure Strategy (NCRIS).

ANFF's mission is to provide micro and nano fabrication facilities for Australia's researchers, SMEs and start-up companies.

More than 500 tools are located across 21 institutions around Australia in a national network of 8 Nodes. Each Node offers complementary specialised manufacturing facilities supported by trained staff.



# ANFF IN NUMBERS

**Financial year 2021 saw the ANFF network achieving the following fantastic outcomes despite COVID restrictions affecting normal operations.**


## 21+ years

185,952 hours of tool usage recorded, a rise of 4% on last year

## 2,865

clients helped – average time on tool per client was 65 hours


## 58,396

supplies manufactured, a rise of 124% on last year

## 2

new ANFF flagship capabilities unveiled, representing an investment of ~$1.5m

## 714

publications that acknowledged ANFF in the calendar year 2020

## ~2,500

instances of process training

## 130

experts on hand to assist clients

# ANFF CAPABILITIES

**ANFF provides access to micro and nanofabrication equipment and expertise. These capabilities are used to do anything from making new metamaterials to CNC milling of blood-carrying microchannels.**

ANFF's extensive equipment portfolio is put on offer to help Australia's researchers and engineers to stay at the forefront of global R&D and scientific trends.

Markets are driving technologies to be smaller, more powerful, and more efficient. There's distinct need for medical technologies that can be easily taken to the point of care, or that can provide lifesaving diagnoses in rapid time – this has resulted in the development of diagnostic tools that are more sensitive, more affordable, smaller, and less powerhungry. A want for easier, and more complete information gathering has led to highly efficient and robust sensors that can be incorporated into wearable technologies or mounted onto drones.

Improving electronics and computing componentry has made smart devices both powerful and portable, allowing for information to be processed in far more accessible ways and in a fraction of the time compared to previous generations of the same technologies. Green energy production has reached never-before seen efficiencies through use of novel materials and coatings, providing cleaner means to power the modern world.

We're also in the process of superseding the electrical revolution. We're starting to harness quantum effects to create sensors and computers that provide unparalled promise, while photonics and plasmonics are providing light-speed information transfer not just for long range communications, but within computer chips.

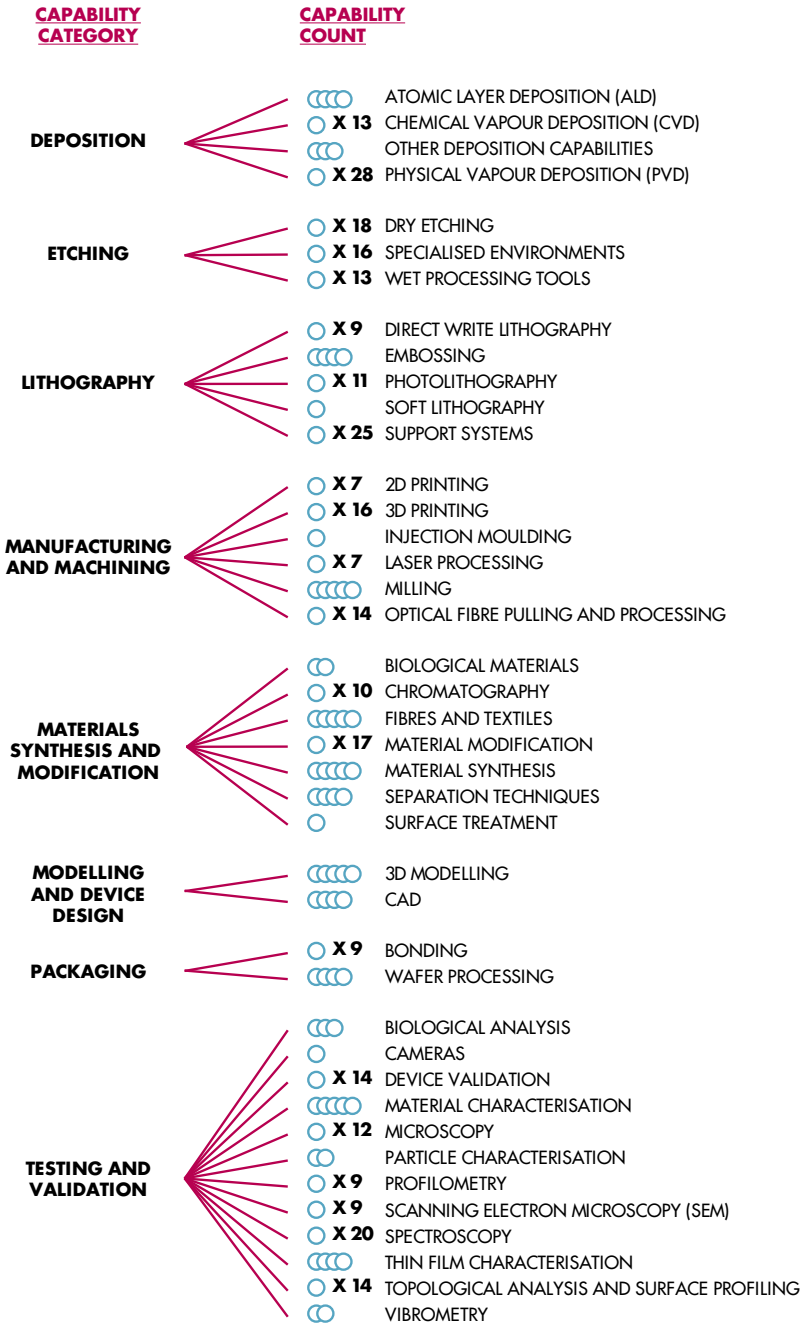
To continue pushing boundaries in these fields and many more, innovators have to be able to fabricate structures at the micro or nanoscale, 10,000 times smaller than a human hair.

Through access to ANFF's world-class micro and nanofabrication equipment, businesses and universities are able to perform at the cutting edge.

ANFF provides novel capabilities, varied process expertise, and knowledge of end application areas together in order to assist its clients to achieve their project aims in a reasonable timeframe, and at a reasonable cost.

In essence however, ANFF's entire half-a-billion dollar portfolio can be boiled down to 3 key processes – creating patterns and drawing out designs; laying down desirable material or creating new materials; and selectively removing unwanted material.

The network provides access to 500 specialised tools to do these three things in a variety of ways in order to cater for any project.




▲ ANFF'S EXTENSIVE EQUIPMENT LIST IS PROVIDED WITH EXPERT SUPPORT THAT ENABLES CLIENTS TO REACH THEIR DESIRED OUTCOME.

# TECHNOLOGY READINESS LEVEL

**Australia is a hotbed for world-class research and as the country looks to establish new industries and expand existing ones in the wake of the COVID pandemic, more pressure is being placed on the R&D ecosystem to capture promising projects and carry them through to completion.**

It takes talent, drive, resources, and money to even start investigating whether research is worth translating. Regardless of whether the project is being run by a multinational organisation developing its hundredth product, or by a single academic with a neat idea and a whole lot of pep, translation is hard.

It's a constant race against time – funds are expended and dwindle, endurance and ideas become exhausted. It's also a process that requires a lot of iterating and flexibility – problems may need any number of things to be solved. In nanotechnology this often means varying a process, trying a different piece of equipment, or starting again with new materials. Every iteration requires significant funds, and the luxury of toying with various processes doesn't come cheap either.

However, speed has to be traded off against quality, particularly in the business of technology where cutting corners leads to malfunctions that can stop the progression of a project entirely. Most ANFF clients are working at the cutting edge, where niche process knowledge and indepth understanding of multidisciplinary scientific principles is essential. This accumulation of expertise is another enormous time sink.

With the right help though, translation is possible, and the task has a far higher chance of success when adequate resources are available.

ANFF was established to provide exactly this sort of assistance, creating a carefully curated playground for R&D. The network reduces the risk, outlay, and time required to conduct research of all types, drastically increasing a project's chance of success of being translated into either a scientifically significant outcome or a commercially viable product – in short, ANFF sites across the country reduce barriers to research and development.

The network does this by making it far easier to access the tools and expertise required to build at the micro and nanoscale. It has the expertise to provide training and consultancy, and it has the breadth of capabilities required to offer flexibility.

The results can be seen in any one of ANFF's open access research spaces across the country. There's an abundance of fantastic ideas being researched, of products being prototyped, and of manufacturing methods being refined.

This year's Casebook focuses on research translation, looking at the projects that ANFF is assisting and where they are up to on their journey.

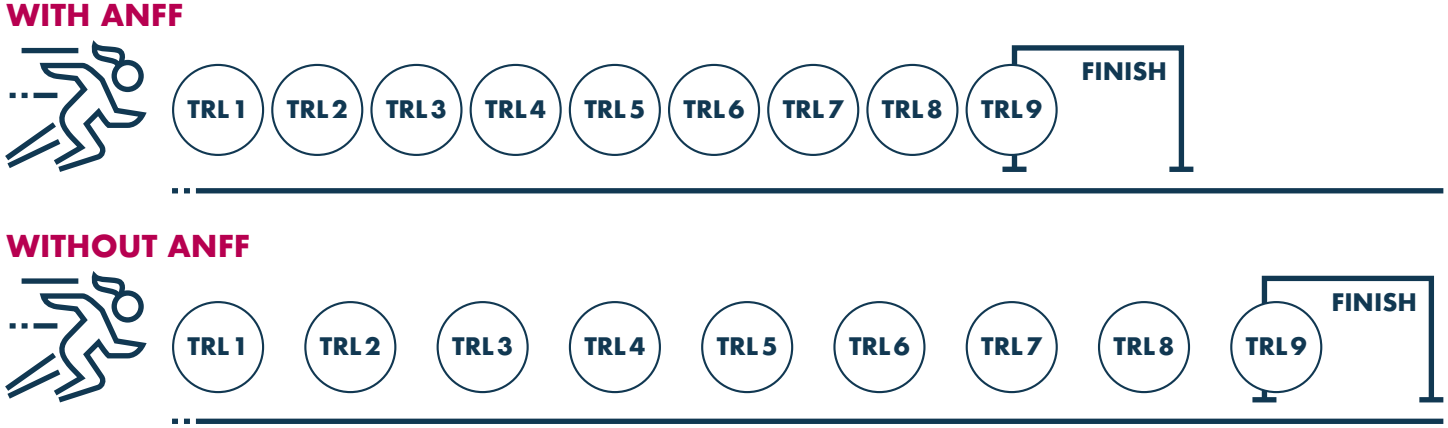
Routes to market are as unique to a product as the technology itself, but it's possible to gauge how developed a project is by using a metric such as the Technology Readiness Level (TRL) scale. This NASA-developed yard stick provides quick understanding of where on the development pipeline a project is.

Starting with early-stage research, the TRL levels work through the various prototyping phases and establishment of manufacturing processes, all the way through to the finish line of being ready for production, usage, or deployment. Each stage marks a milestone, and reaching the next level is a serious progression in a project's development.

Demonstrating that a project has passed through a TRL stage can provide opportunities for funding or investment, allowing the development to continue.

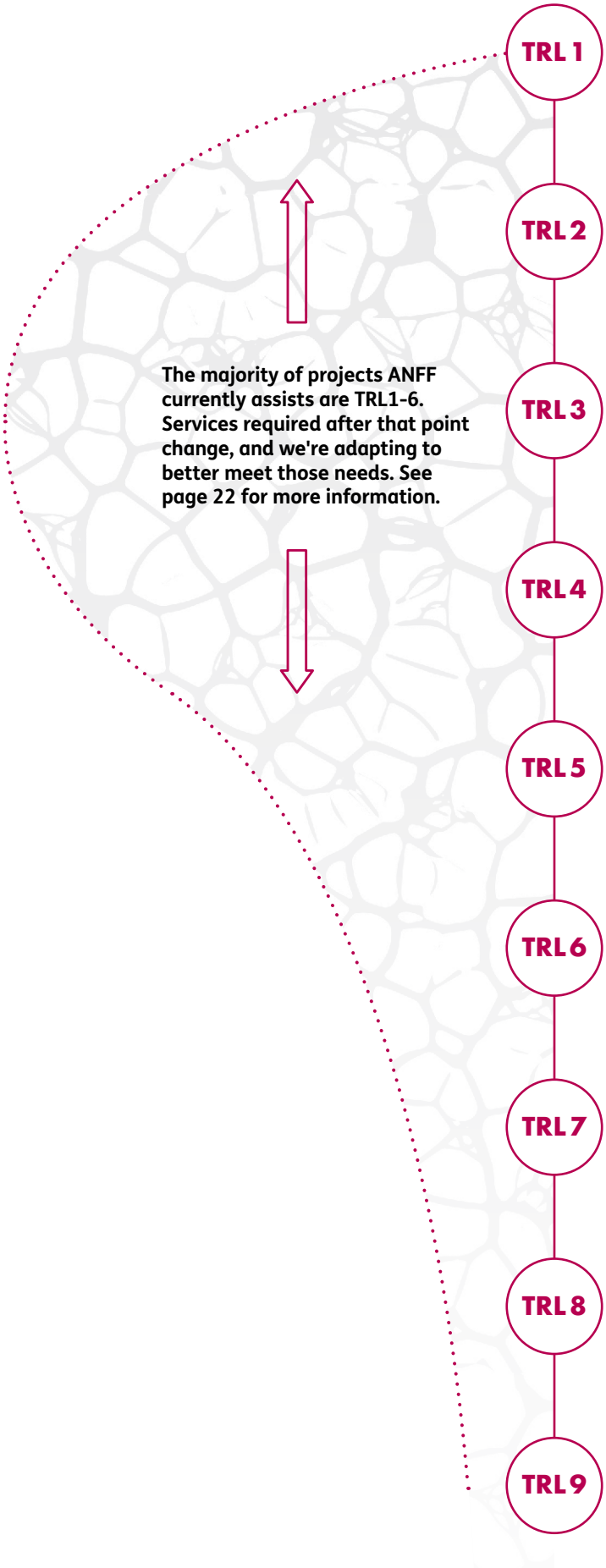
It's ANFF's job to make moving through these levels easier, so it's this metric that we've used to organise the highlights in the following pages.

▼ BY REDUCING TIME AND COST WHILE MAKING EXPERTISE AVAILABLE, ANFF SHORTENS THE TRANSLATION TRACK.



# PROCESS: **TECHNOLOGY READINESS LEVEL**

ANFF capabilities are useful at any stage on the pipeline, though focus may shift from device design and proof of concept, through to prototyping, and on to manufacturing process improvement and analysis/verification.



**The majority of projects ANFF currently assists are TRL1-6. Services required after that point change, and we're adapting to better meet those needs. See page 22 for more information.**

**TRL 1**

**TRL 1 – BASIC RESEARCH:**
Initial scientific research has been conducted. Principles are qualitatively postulated and observed. Focus is on new discovery rather than applications.

**TRL 2**

**TRL 2 – APPLIED RESEARCH:**
Initial practical applications are identified. Potential of material or process to solve a problem, satisfy a need, or find an application is confirmed.

**TRL 3**

**TRL 3 – CRITICAL FUNCTION OR PROOF OF CONCEPT ESTABLISHED:**
Applied research advances and early-stage development begins. Studies and laboratory measurements validate analytical predictions of separate elements of the technology.

**TRL 4**

**TRL 4 – LAB TESTING/VALIDATION OF ALPHA PROTOTYPE COMPONENT/PROCESS:**
Design, development and lab testing of components/ processes. Results provide evidence that performance targets may be attainable based on projected or modelled systems.

**TRL 5**

**TRL 5 – LABORATORY TESTING OF INTEGRATED/SEMI-INTEGRATED SYSTEM:**
System Component and/or process validation is achieved in a relevant environment.

**TRL 6**

**TRL 6 – PROTOTYPE SYSTEM VERIFIED:**
System/process prototype demonstration in an operational environment (beta prototype system level).

**TRL 7**

**TRL 7 – INTEGRATED PILOT SYSTEM DEMONSTRATED:**
System/process prototype demonstration in an operational environment (integrated pilot system level).

**TRL 8**

**TRL 8 – SYSTEM INCORPORATED IN COMMERCIAL DESIGN:**
Actual system/process completed and qualified through test and demonstration (pre-commercial demonstration).

**TRL 9**

**TRL 9 – SYSTEM PROVEN AND READY FOR FULL COMMERCIAL DEPLOYMENT:**
Actual system proven through successful operations in operating environment, and ready for full commercial deployment.

# THE HUMAN SPACE

**With ANFF's help, researchers and engineers are finding ever more advanced and exciting ways to prevent, detect, and treat health conditions and improve quality of life.**

With rapid diagnostics, personalised medicine, wearables, and point of care treatments all exploding with new innovation, the body is one of the most exciting destinations for research that ANFF supports.

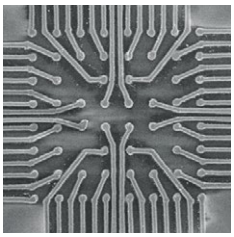
ANFF's cleanrooms buzz with activity as detectors, biosensors, labs on chips, 3D printed organs and far more are being created. However, the field has unique challenges to translation outside of technical difficulty. There's stringent testing, and certain classes of devices require strict protocols to be in place for production.

The familiarity of ANFF's staff with these needs is a resource of its own, and it creates the perfect environment for developing technologies for medical applications when combined with the network's extensive toolkit.

**These examples are of the clients the network has been helping from across the TRL scale**

TRL 1/2

## UNDERSTANDING ALZHEIMER'S THROUGH AI AND NANOTECH

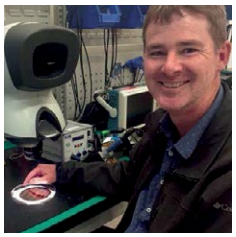


A cross disciplinary team of researchers from the Australian National University, University of Melbourne and University of Wollongong have created "mini brains" to better understand the signalling behaviour of neuron cells in a diseased brain. Stem cells from Alzheimer's patients are used to create brain organoids in the lab and their electrical signals are compared to those from a healthy patients using nanoelectrodes to measure activity, and using artificial intelligence to help interpret the results. Speciality deposition and patterning equipment in ANFF-ACT labs are essential to the project's progression.

**Dr. Vini Gautam:** vini.gautam@unimelb.edu.au

TRL 3

## SIMPLIFYING RAPID DIAGNOSTICS



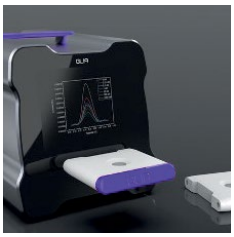
Kimiya is working to make nucleic acid testing affordable, portable, and simple to run by developing a robust, small microfluidic platform with a user-centric operating system.

At the heart of the company's designs is a silicon-based microfluidic device that is being developed with the help of equipment and expertise at ANFF-NSW at UNSW.

**Matt Worsman:** matthew.worsman@kimiya.com.au

TRL 4

## IMPROVING BRAIN INJURY OUTCOMES WITH PORTABLE DIAGNOSTICS



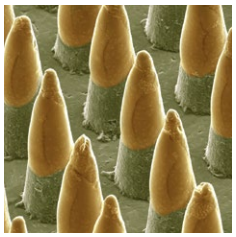
GLIA Diagnostics is developing a biomarker detecting device that can identify and quantify traumatic brain injuries, helping to tackle a leading cause of death and the leading cause of disability in children and adults.

With funding from the Australian Defence Force's Innovation HUB and extensive fabrication support from the Melbourne Centre for Nanofabrication, it's hoped that within two years GLIA's mobile Point of Care (POC) device will be helping to make life-saving triage decisions at the moment of brain injury.

**Edmond Sorich:** ed@gliadiagnostics.com

TRL 5

## PAINLESS VACCINATIONS ANYWHERE IN THE WORLD



Vaxxas has been working extensively with ANFF sites across the country to develop a novel way to administer vaccines without having to use a needle. The company's nanopatches contain an array of features that can painlessly deliver vaccine material through the skin, into the body. The technique uses dried vaccines, this means there's no need for refrigeration and enables lifesaving treatments to be taken to some of the hardest to reach parts of the world. This project also relies heavily on ANFF's NCRIS-funded colleagues at Microscopy Australia.

**Sasikaran Kandasamy:** skandasamy@vaxxas.com

TRL 6

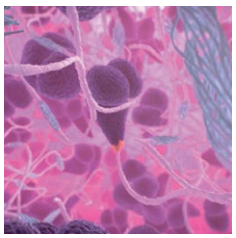
## FACTORY FUNDING FOR LICKABLE DIABETES TEST

In collaboration with GBS Inc., researchers at the University of Newcastle have developed a pain-free diabetes test using glucose biosensors on a lickable tab. The project, which was developed on ANFF Materials' roll-to-roll printing facilities, is on its way to being translated for consumer use with the announcement of $6.3 million grant to establish the first manufacturing facility for the device. Funded by the Medical Products priority of the Australian Government's Modern Manufacturing Initiative, the new biosensor factory will be established in the Hunter region.

**Paul Dastoor:** paul.dastoor@newcastle.edu.au

TRL 7

## INVENTIA LIFE SCIENCE



Inventia Life Science is an Australian start-up that has developed a platform to accelerate medical research by 3D printing accurate biological models on demand, using inks made of cells and supportive gels. This includes the RASTRUM™ 3D cell biology platform, built for applications including 3D cell biology, drug discovery and biomedical research. The company is also utilising their bioprinting knowledge to develop a platform that can be used in surgical theatres to treat burn wounds. Inventia draws on the extensive expertise in bioinks and 3D printing available at ANFF Materials, through its partnership with TRICEP.

**Cameron Ferris:** cameron.ferris@inventia.life

CASE STUDY:

# OPEN ACCESS MADE EASY

**ANFF reduces barriers to development, this is done by providing affordable, easy access to R&D infrastructure in an IP-neutral environment.**

Typically, engagement with one of ANFF's sites involves tool access, process training and consultation, and low volume contract manufacturing. However, flexibility in how those services are accessed is essential to the network's ability to adapt to the needs of individual clients. ANFF's headquarters, the Melbourne Centre for Nanofabrication (MCN), extends this adaptability to extreme levels.

The Centre is ANFF's largest site, it's a joint venture of seven Victorian universities and the CSIRO, and it provides access to more than 100 capabilities in its open access cleanroom and lab spaces.

It has placed adaptability at its core in order to assist its hundreds of clients to reach R&D goals. Three medtech companies in particular have made full use of MCN's willingness to accommodate specialised needs.

EQi Bio is a four-year old Australian medical technology start-up, developing ground-breaking proprietary diagnostic detection approaches. The company has also designed, constructed and is now leveraging an extremely large proprietary molecular library to assist and speed up diagnoses. Their approach is expected to create new markets, while disrupting existing ones.

As momentum behind the company built, the team found it needed constant access to research space. Having investigated options to set up their own labs, they reached an agreement with the MCN to embed their researchers into the Centre full time, until a point where it made sense to establish their own production lines.

The advantage was obvious – instead of waiting to move into a location, procuring equipment, and training staff, they were able to start work immediately, surrounded by tens of millions of dollars-worth of pre-existing infrastructure, expertise, and equipment. With access to capabilities and expertise, development rocketed, and two years after the agreement started EQi Bio's resident headcount at the MCN has expanded from two to ten, and the company has announced that it has successfully filed its first of many global patents this year.

MuPharma, a second Melbourne company, took a different approach while creating its platform for non-invasive, ultrasound mediated, drug delivery devices. The team comprises of Mr Mark and Dr Harry Unger, who conceived of the technology to try to remove the need for needle injection delivery of drugs into the eye when treating conditions such as macular degeneration.

Neither of the Unger's are engineers, and contracted MCN to fabricate early models of their device. Once the concept was proven, they capitalised on the Centre's internship matchmaking program, which sees a suitable early career engineer selected by the MCN to carry out a project for the company while receiving guidance and training from ANFF staff.

With six months of dedicated work conducted by a full-time researcher, rapid progress and further refinements were made. The intern is now a member of staff at the MCN, while the Node's Director is partnering with the company to continue development of muPharma's platform.

MuPharma has now proven its device can safely and non-invasively deliver a significant amount of a large sized biologic drug to the back of the eye in animal models. The team is now working to show its device can administer vaccines into membranes such as the inside of the lip.

Sometimes however it isn't ANFF's brains that are needed, but rather its desire to procure and make exciting nanofabrication capabilities available. Despite having an extensive portfolio, there are always new assets needed in order to cater for client needs.

La Trobe University is currently working with industry partners towards establishing a new spin-out company, AlleSense, in order to commercialise their NanoMslide technology. The NanoMslide is a novel microscope slide created by Professor Brian Abbey and Dr Eugeniu Balaur based at La Trobe. The slides passively improve the contrast of an image when looking at a sample using a conventional microscope – it's already been shown that it could potentially aid in tissue diagnosis in a small study with breast cancer patients, a task undertaken hundreds of times a day across the country.

AlleSense was outgrowing its production practices, demand for their technology reached a point that they simply weren't able to manufacture enough using capabilities on offer in Australia. After scouring the world for a solution that would serve both AlleSense and Australia's nanofabrication community, ANFF-VIC and La Trobe coinvested half-a-million dollars to procure the Eulitha Phabler, a high-resolution, high-throughput patterning tool.

The capability enables the team to produce 1,000s of units each month, allowing the company to establish a foothold in a global market as it continues scaleup. Meanwhile, thanks to ANFF's involvement, the new capability is available for others to access, providing the Australian research sector with a means to follow in AlleSense's footsteps.

The flexibility shown in these examples allows ANFF to support Australia's R&D sector, enabling the network to provide its clients with both solutions and success. Contact ANFF to tell us what you need, and see how we can help.

# PROJECTS TO WATCH:

## AI MEETS SURFACE ANALYSIS

An international collaboration involving La Trobe researchers has applied artificial intelligence to thousands of ToF-SIMS readouts, allowing them to map similar clusters and regions across an image at very high resolution. The approach is appealing to a number of areas, including biosensing applications.

This novel application of ToF-SIMS provides researchers with an in-depth understanding of the properties of surfaces, interfaces, coatings, fabricated structures and devices. By comparing hyperspectral signatures to a known library, compositions can be easily and accurately calculated. In mapping the resulting information across a real image, the team have created a quick and intuitive way to interpret the make-up of materials.

Node: ANFF-VIC

Applications: Materials analysis, biosample analysis, quality control

**Sarah Bamford:** s.bamford@latrobe.edu.au

## 3D BIOPRINTING TRAINING SYSTEM

3D REDI is a 3D bioprinting system designed and built by University of Wollongong researchers for use in research and training.

The platform, combined with practical training modules, equips users with the essential hardware and skills to embark on projects in the rapidly emerging bioprinting industry.

Now available for purchase, the system features a custom bioprinter user interface and toolpath generator, tailored to teach the next generation of experts and engineers how produce functionally graded structures.

Node: ANFF Materials

Applications: Bioprinting, education, medical technologies

Related link: https://www.tricep.com.au/post/meet-3d-redi

**Peter Innis:** innis@uow.edu.au

## AMPLIFY AND IDENTIFY

University of Puerto Rico and the University of South Australia have created an electrochemical sensor that is capable of detecting the Colibactin gene, a harmful genotoxin found in E. coli that has been associated with colorectal cancer.

The biosensor combines the selectivity of a PCR technique coupled with the sensitivity of the electrochemical impedance spectroscopy to identify the gene – the design of the platform shows promise that it can be applied to a variety of organisms and with its biocompatible nature, could be used for in vivo applications.

Node: ANFF-SA

Applications: Diagnostics, medical devices

Full paper: https://doi.org/10.1007/s00216-021-03404-6

**Carlos R. Cabrera:** carlos.cabrera2@upr.edu

## ENABLING RAPID RESPONSE TO OVERACTING IMMUNE SYSTEM

A cytokine-storm chip developed by University of Queensland researchers could diagnose those cancer and COVID-19 patients that are at risk of a potentially lethal overreaction of the body's immune system.

The team have produced a biosensor that monitors a class of proteins called cytokines – overproduction of cytokines can lead to fatal outcomes, causing the body to damage itself in its efforts to eliminate an illness such as cancer or COVID-19. Being able to track cytokine levels and catch these "storms" early could help healthcare workers to closely monitor high-risk patients and begin treatment much earlier.

The UQ team's device is a digital nanopillar surface-enhanced Raman platform that is capable of detecting single cytokines in human serum. By simultaneously monitoring four cytokine biomarkers in a small patient cohort, the team has shown that it can track elevated cytokine concentrations and predict which patients are at higher risk of developing severe immune toxicities.

Node: ANFF-Q

Applications: Medical devices, rapid diagnostics, sensing

Full paper: https://doi.org/10.1038/s41467-021-21431-w

**Junrong Li:** junrong.li@uq.net.au

# NEW HORIZONS

**Frontiers are explored in ANFF labs, and some of the most exciting ones are those that humanity has created for itself.**

Fields such as computing, energy creation, and transport, are all entirely invented applications, but they have very real impacts on everyday life.

These artificial worlds are being simultaneously created and understood by intrepid explorers – brave researchers and engineers delve into technological tundras, using the basic building blocks of the universe to induce bizarre effects to improve on technologies that didn't even exist a few decades ago.

Using photonic, plasmonic, electronic, and quantum effects, new devices are being produced that are putting ever more power into pocket sized computers, making modelling of complex problems possible, and providing cleaner methods of energy production. The technologies used as tools in advanced manufacturing practices are racing forward, enabling production of a range of products in more efficient, more productive ways.

Pushing these boundaries however, is only possible with access to the types of tools that let you manipulate materials at the micro and nanoscale.

**Here's a selection of the projects ANFF is assisting that are pushing forward towards these new horizons**

TRL 1

## LIQUID ELECTRODE DESIGN FOR MASS POWER STORAGE

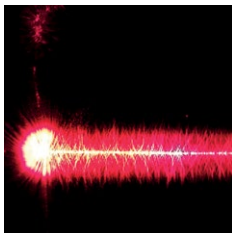
Zinc-ion batteries show promise as a grid-scale energy storage solution but face significant hurdles such as the ability to survive being charged and discharged many times, and the achievable speeds that this cycle can happen.

Adelaide-based researchers worked with ANFF-SA to develop a new method to prepare electrode materials with high crystal water content to greatly improve charge-shielding effects and electrical and ionic conductivities, delivering superior performance from zinc-ion batteries.

**Jun Ma:** Jun.Ma@unisa.edu.au

TRL 2

## MEMS THE WORD



A University of Western Australia team are working with silicon nitride to create affordable light-manipulating devices for on-chip information control within photonic integrated circuits. The team used ANFF-WA expertise in Micro-electromechanical systems (MEMS) and photonics to create their device that is capable of directing information signals within a chip. Their SiNx photonic coupler is both economic to manufacture, and provides fantastically low light loss with large signal bandwidth.

**Shubhashree Swain:** shubhashree.swain@research.uwa.edu.au

TRL 3

## OPTICAL FIBRES DELIVERING A CUTTING EDGE

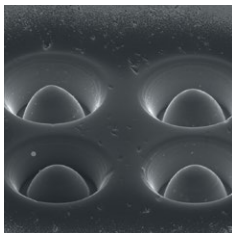
Next-generation glass fibres are being developed to deliver high-power mid-infrared laser beams – such as those produced by $CO^2$ lasers – with improved efficiency and precision. The advance will benefit applications ranging from medical procedures through to advanced manufacturing.

The fibres are the result of a collaboration between USA-based company IRflex and ANFF's Optofab team at the University of Adelaide. Using the Node's fabrication capabilities and field-leading photonics expertise, the project has delivered titanium dies that allow the company to produce proprietary glass preforms. They are now working toward mass production.

**Luis Lima-Marques:** luis.lima-marques@adelaide.edu.au

TRL 4

## DIAMOND-BASED QUANTUM COMPUTING



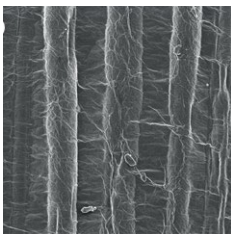
Canberra-based start-up Quantum Brilliance has worked with ANFF-ACT to create micro-optic structures that improve the collection of signals given out by Nitrogen-vacancy (NV) centres in diamond with an ultimate goal to deliver quantum computers that work at room temperature.

The team harnessed ANFF-ACT's FIB milling capabilities to produce microscopic half-spheres and parabolic mirrors on diamond that can capture and focus light signals from NV centers. Further work helped the company refine a manufacturing process that opens the door to successful scale up.

**Vivek Raj Shrestha:** vivek.s@quantum-brilliance.com

TRL 5

## DRIVING WOVEN ELECTRONICS FORWARD

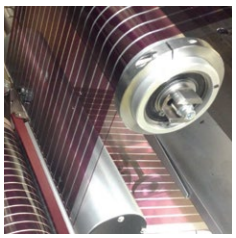


In partnership with Ford Motor Company, Deakin University engineers have demonstrated the potential of using textile wool waste to make bio-based electric hybrid fabrics. With a simple and easily applied approach, the team developed fibre and textile fabrics with high electrical conductivity suitable for e-textiles used in different application areas including the automotive industry and consumer electronics. The technique reuses waste textile to support cleaner production, and could lower consumption of the petroleum-based fibres currently being used.

**Maryam Naebe:** maryam.naebe@deakin.edu.au

TRL 7

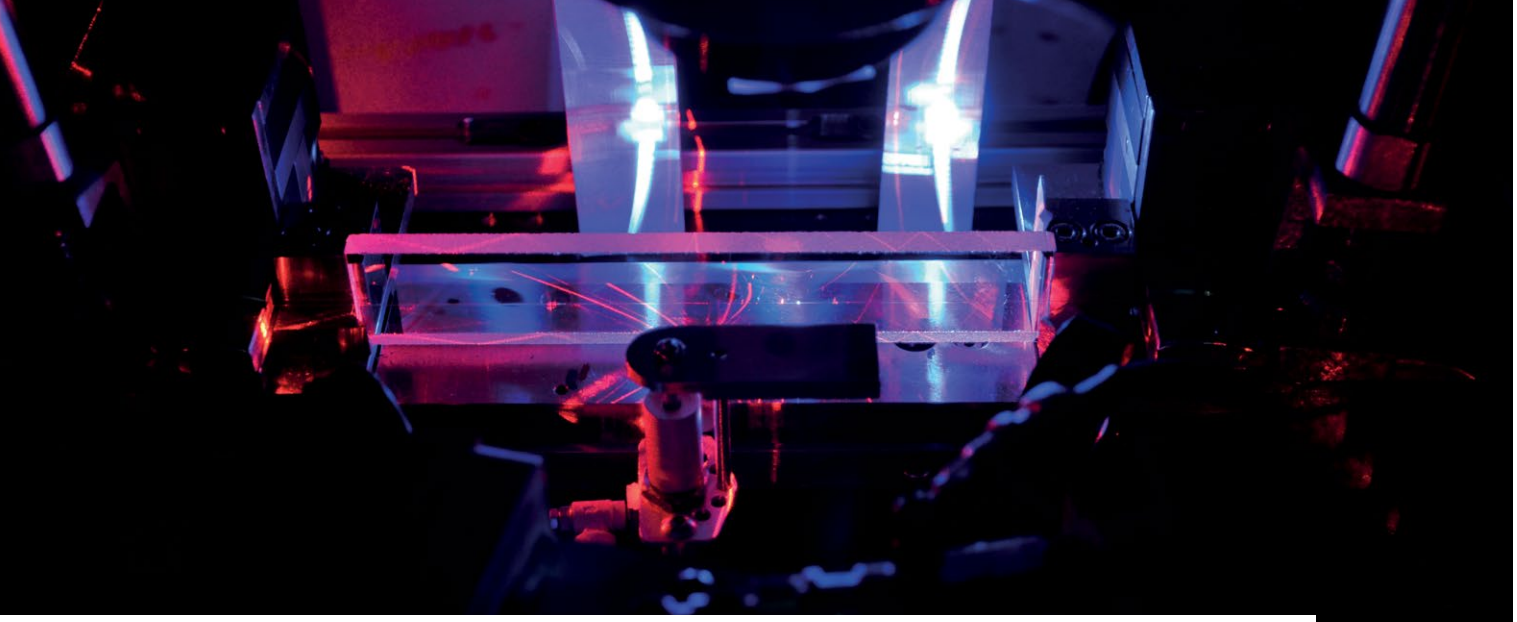
## BULK PRINTING POWER



ANFF Materials at the University of Newcastle is supporting the development of a printed solar cell technology that could revolutionise energy capture. Hundreds of metres of the team's solar sheets can be printed per day using a photovoltaic ink, polymer substrate, and roll-to-roll printing techniques found in the printing industry.

The incredibly affordable technology can be installed on nearly any surface using adhesive tape, and it's been successfully demonstrated on the roofs of buildings, and along walkways in parks. The researchers are now scaling up production to kilometres per day, to further reduce the cost.

**Ben Vaughan:** ben.vaughan@newcastle.edu.au



CASE STUDY:

# GUIDED BY THE LIGHT

**2021 saw ANFF bring a privately owned advanced fibre optic processing suite out into the open.**

In making these tools available to the public, the network has improved Australia's sovereign capability and created enormous opportunity for researchers to use new technologies to tackle a range of problems.

The capability makes fibre Bragg gratings (FBG) in optical fibres, creating a highly adaptable class of optical components that can be incorporated into systems, sensors, and signal processing modules. They're widely used in communication technologies as light filters within the submarine cables that account for 99% of internet data traffic crossing oceans.

While the Advanced Fibre Bragg facility is a new inclusion to the ANFF-NSW node and located at the University of Sydney, it was previously owned by a company and used as part of a factory line for producing novel fibres.

However, when the international company closed its Australian operations, the opportunity arose for ANFF to make the unique system open to all.

The facility, now available through ANFF-NSW, employs an interferometer to selectively modify the inner material of an optical fibre and create FBG gratings within it. It's a far-field writing technique that provides world-leading resolution and unique flexibility when making gratings in optical fibres, and that allows for the creation of designs that are impossible with traditional approaches. It's extremely well suited to manufacturing for prototyping or research purposes, but products off the line can also easily be made ready for real-world deployment.

The team that surrounds the suite have been tweaking and improving the technology for more than 15 years – the knowledge of what the process is capable of is internationally unrivalled. The combination of the tools and the expertise had such value that ANFF made the decision to make it available to those who need it.

Not even having completed its first year of operation under ANFF, the equipment is already helping to take Australian R&D to new levels.

Prof. Joss Bland-Hawthorn from the University of Sydney is using it to create components that filter out atmospheric noise when using ground-based telescopes. When installed, the components will allow astronomers to look deeper into space, and into the origins of the universe, than ever before.

Joss said: "We're back to the R&D days, where we really can explore almost any ideas that people have. It used to be like that, back in about 2005, but the previous provider ended up taking a big contract approach. The setting in ANFF really encourages R&D, and there's many more ideas that we'll be able to get to."

Dr Scott Foster and a team at the Defence and Science Technology Group (DSTG) are using FBGs to develop unparalleled sonar systems. He explained that: "It's extremely important that ANFF has helped to bring this capability to the Australian community. I'm really excited, it's been at least 10 years since we've had this kind of access to the facility, and had the opportunity to work genuinely collaboratively."

Meanwhile, Dr John Bartholomew and his group at the University of Sydney are utilising FBGs made using ANFF's facility to tackle problems for what is perhaps the most futuristic of research areas – quantum technologies.

John and his team are testing new FBG designs to build adapters to allow quantum sensing and computer technologies to communicate over optical fibre networks.

To reduce noise and maintain system integrity, many quantum technologies are cooled to just a few thousandths of a degree above absolute zero. John and his collaborators are developing transducers that convert quantum information to optical signals that can then be communicated at room temperature, an approach that could allow for modular systems to be employed, drastically reducing the effort required to keep technologies cool.

ANFF-NSW's FBG facility stands as proof of the importance of Australia's NRI networks. By making just one exciting toolset open access and accompanying it with exceptional expertise, the R&D community is able to better understand outer space, the deep sea, and the quantum world – and that's in just the first few months.

# PROJECTS TO WATCH:

## RECORD BREAKING SOLAR TECH

Next-generation thin film solar cells are being developed at UNSW that are proving best in their class, having broken a number of efficiency world records. The team's inorganic wide-bandgap films are designed to be employed in future ultra-high efficiency tandem solar cells, and helping pave the way for greener energy futures.

The films are made from materials such as CuZnSnS4 and CuInGaS2 – the researchers have already set a world record efficiency for the former, while their second design is showing it's capable of nearing the same levels.

Node: ANFF-NSW

Applications: Energy

Full paper: https://doi.org/10.1002/aenm.201701940

**Xiaojing Hao:** xj.hao@unsw.edu.au

## SCALABLE PRODUCTION OF NOVEL MATERIALS

A team from ANU have demonstrated a scalable way to manufacture InGaAs/InP multiple-quantum-well nanowires. This novel material is used for creating nanowire LEDs, lasers and photodectors that are essential to advanced optoelectronic devices and integrated photonic systems.

The process is based on Metal Organic Chemical Vapor Deposition (MOCVD) that produces a highly uniform nanowire array under continuous flow condition – as well as being highly efficient, the approach ensures scalability for industry uptake.

The work has led to the demonstration of ultralow threshold room temperature optically pumped nanowire lasing and broadband infrared photodetector with high responsivity and fast response time, which is promising for future nanoscale optoelectronic applications.

Node: ANFF-ACT

Applications: Photonics, manufacturing, novel materials

Full paper: https://onlinelibrary.wiley.com/doi/full/10.1002/adfm.202103057

**Lan Fu:** lan.fu@anu.edu.au

## CUTTING LOSSES

Scientists from the University of Queensland have provided new understanding of losses in quantum devices by exploring new methods of surface treatment and material fabrication of superconducting devices. Losses in this context are thought to be caused by microwaves giving energy to material defects, they can trigger the breakdown of the delicately maintained quantum states that make quantum technologies so promising.

The team explored a number of specific fabrication methods to produce test devices in order to identify what the causes of loss are. In helping with understanding this complex problem, the team uncovered ways to control and reduce these losses, which is critical to the practical implementation of quantum computing.

Node: ANFF-Q

Applications: Quantum technologies, superconducting materials, electronics

Full paper: https://aip.scitation.org/doi/10.1063/5.0061078

**Peter Jacobson:** p.jacobson@uq.edu.au

## MAKING ON-CHIP LASERS MORE EFFICIENT

ANU scientists have overcome a number of obstacles to the widespread adoption of silicon photonic chips by creating a new method for manufacturing on-chip integrated high efficiency lasers.

Their work demonstrates a bottom up fabrication process for building micro-ring lasers. The method creates atomically smooth mirrored rings that allow these on-chip lasers to operate with very little light loss, providing incredible efficiencies that could meet the needs of integrated photonic devices and operate as highly sensitive optical biosensors.

Node: ANFF-ACT

Applications: Photonics, computing, communications, biosensing

Full paper: https://doi.org/10.1021/acs.nanolett.1c01411

**Hoe Tan:** hoe.tan@anu.edu.au

# NEW SOLUTIONS TO AGE OLD QUESTIONS

**There are seemingly perpetual questions researchers face about the world around us, ones that have been asked since the earliest days of the human era.**

What crops should be grown, and what are they used for? How do we ensure safe and abundant supply of water? How do we protect ourselves? Where can we live safely, and what's the best way to build shelter? How can we guarantee that the environment is both productive and sustainable for us to exist in? What can we learn from the world around us, and what learnings wait for us in outer space?

Recent advances are allowing these questions to be answered better than ever before. Technologies allow farmers to monitor their fields remotely, and harvest crops that will be used far from the dinner table; water can be filtered and monitored more effectively; buildings can be constructed using novel or traditional materials in safer, more efficient ways; while secrets from the deepest depths of the universe are being revealed through new means of exploration from earth and space.

**These solutions are being found through fabrication of micro and nanotechnologies**

TRL 1/2

## NOVEL COATINGS IMPROVING SHELF LIFE

A team from the University of South Australia has worked with ANFF-SA to demonstrate functionalised coatings that can prevent microbial growth within the food and biomaterial industries. The researchers embedded natural antimicrobials within a novel multilayer, providing them with increased protection.

The prevention of microbial growth within these applications can significantly improve the shelf-life of a product, while reducing the chance of contaminants that cause foodborne illnesses.

**Marta Krasowska:** marta.krasowska@unisa.edu.au

TRL 2

## GENETIC SWITCHING UNLOCKED BY NANOPARTICLES

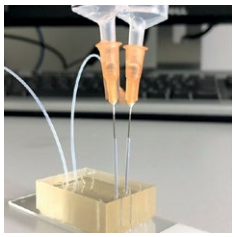
University of Queensland scientists are capitalising on cellular processes to reversibly turn traits on or off within a plant cell. Their work with ANFF-Q involves introducing double stranded RNA (dsRNA) into a pollen grain where it interferes with gene expression – it then degrades without any long-term influence on the cell. The dsRNA is fragile, so the UQ team created nanoparticle carriers to transport it through the plant cell wall, drastically improving effectiveness.

The approach can be used to modify plants without permanently affecting the genome. Traits could potentially be induced just for a season, providing huge robustness benefits to crops.

**Gordon Xu:** gordonxu@uq.edu.au

TRL 3

## CELL SELECTION ON A CHIP



A UNSW team has worked with ANFF-SA to prototype an affordable microfluidic device capable of selectively separating and enriching certain populations of bacteria.

Specifically, the device isolates sodium-powered motile bacteria from non-motile populations, and has broad environmental applications where it can screen bacterial ecosystems in liquids, multiplying their populations for easy detection. The platform could also be employed to quickly test the motility of sperm, and to collect the most active for fertility applications.

**Matthew Baker:** matthew.baker@unsw.edu.au

TRL 4

## USING WASTE TO KEEP WARM

Flinders University scientists have developed a new composite made of waste cooking oil, sulphur and wool offcuts to produce a sustainable housing insulation material. The product is now being commercialised by Clean Earth Technologies. Capitalising on wool's natural low flammability, the new composite is yet another application for a polymer that was initially developed to retrieve oil after a large-scale spill.

The team includes Prof. Justin Chalker, the New Innovators winner in the 2020 Prime Minister's Prizes for Science, and his colleagues at Deakin and Liverpool Universities. The group worked with ANFF-SA throughout the project.

**Justin Chalker:** justin.chalker@flinders.edu.au

TRL 5

## SUPER SENSORS FLYING HIGH

A team from the University of Western Australia has demonstrated a sensor that can selectively identify target materials at range without the need for artificial illumination.

Not having to incorporate additional lighting allows for massive miniaturisation of the overall system. This makes the devices, a class of narrow-band Fabry-Pérot interferometers (FPIs), attractive for deployment in platforms requiring low size, weight and power. They're perfect for use on drones, and mobile phones for in-the-field applications found in agriculture and defence, as well as in the medical arena.

**Gurpreet Gill:** gurpreet.gill@research.uwa.edu.au

TRL 6

## IMPROVISED EXPLOSIVE DEVICES (IED) X-RAY CAMERA

Micro-X, an SA-based manufacturer of portable x-ray technologies, is creating an x-ray camera for stand-off imaging of IEDs, drugs, and other organic material.

The company's camera employs an x-ray emitter developed with extensive support from across the ANFF network. The novel system doesn't need an imaging panel to be deployed behind the object, and provides a resolution of less than 0.5mm. These X-ray images can be viewed remotely to reduce 'time over target' and guide safe disruption. The system has been designed to deploy on robotic platforms or manually should it be inaccessible.

**Micro-X:** admin@micro-x.com

CASE STUDY:

# RISING TIDES

**Most projects conducted with ANFF are at the cutting edge, and often the network is helping entrepreneurs that are so far ahead of the game that the market hasn't caught up.**

One such client is Dr Pia Winberg, a Marine Ecologist and Entrepreneur who founded Venus Shell Systems (VSS). The primary product of VSS is raw seaweed material, it's a rapidly growing agricultural sector that is not only fantastically productive, but provides significant environmental benefits – seaweed grows rapidly, locks in carbon dioxide, and when managed well can even establish or replenish habitats for marine wildlife.

Seaweed's use in food is growing, it's increasingly employed as a nutritious additive, but it can also be broken down and used as a building material. While seaweed farming is a centuries old practice, the use of derived bioproducts away from the dinner table is new, and the list of potential applications is growing so fast that the market is having to race to keep up and capitalise.

This has led Pia to begin investigating uses of her products herself, in doing so she's creating a slew of developments that could each grow into entirely new product lines, companies, or even industries.

Identifying and demonstrating these novel uses of seaweed is where ANFF has been assisting Pia for many years, helping to create new materials derived from bioproducts that can be applied to make clothes, furniture, and biodegradable replacements for a range of plastics. However, perhaps most exciting is the development of medical substances, and this is where ANFF Materials' expertise in bioprinting has been of particular use to Pia.

Working closely with ANFF experts at the University of Wollongong (UOW) and collaborating with researchers from the co-located ARC Centre of Excellence for Electromaterials Science (ACES), Pia and the team have been creating new classes of bioinks for a variety of uses. These inks can be 3D printed and used for cell transplantation, cartilage regeneration and to encourage wound healing.

Use in applications like this adds significant value to the products that VSS offers – the difference between raw material to these refined bioinks could take the price per kilo from single dollars to thousands.

At the same time, the products themselves are part of the current wave of medical developments that sees ever more personalised treatments provided to patients, and of new compounds being used to drastically improve outcomes.

With potential uses piling up and waiting to be seized upon, Pia took her "make your own market" approach to a whole new level. Again working closely with ANFF Materials and bringing in a list of 68 industry, government and research partners including Flinders University, Pia has helped to drive the creation of a new CRC to help cement this budding bioproduct boom into Australia's economy.

The Marine Bioproducts CRC (MB-CRC) will provide a range of opportunities to develop marine bioindustries that are sustainably integrated with the coastal and marine environment. As well as investigating marine resource sustainability and processing techniques, investigators will establish new products that can be made from seaweed. It will see the team continue their work with ACES researchers to identify new molecules from seaweed for use in clinical applications. TRICEP – UOW's Translational Research Initiative for Cellular Engineering and Printing – and the ANFF Materials Node will provide expertise in accelerating commercialisation opportunities in 3D bioprinting of seaweed bioproducts.

ANFF's entire equipment portfolio has been collected over time to support great minds and entrepreneurs like Pia. In enabling her to pursue her research goals and develop new products, the network has also assisted her to play an enormous part in establishing a new industry in Australia, one that is becoming a serious contributor to the economy. The network is actively seeking out other brilliant individuals that it can help to do the same.


DR PIA WINBERG WORKS WITH ANFF'S MATERIALS NODE TO MAKE HER OWN MARKETS.

# PROJECTS TO WATCH:

## ADVANCED AND AFFORDABLE INFRARED IMAGING

Through extensive use of ANFF-WA, the University of Western Australia's Microelectronics Research Group (MRG) has developed a strong history in developing high performance infrared detectors and imaging focal plane arrays for civilian and military uses.

Their most recent advances demonstrate a method for growing high-quality CdTe buffers on large-area alternative substrates using a superlattice-based buffer approach. The results promise next-generation, large array IR detectors and imaging FPAs that are produced at a lower cost, increasing the technology's uptake in imaging, meteorology and space situational awareness applications.

Node: ANFF-WA

Applications: Remote sensing, infrared imaging, LIDAR

Related link: www.mrg.uwa.edu.au

**Wenwu Pan:** wenwu.pan@uwa.edu.au

## OPENING APPLICATIONS OF CARBON FIBRE

The cost of carbon fibre, and in particular the essential ingredients to manufacture it, is a major constraint of this wonder materials widespread application in many commercial, industrial, and defence applications. To reduce costs, a team from Deakin University's Institute for Frontier Materials (IFM) is looking to substitute a conventional precursor chemical, polyacrylonitrile (PAN), and are investigating a number of sustainable or low-cost alternatives including brown coal, lignin, and asphaltene.

The researchers have now demonstrated that fibres developed with these alternative precursors have a great potential for development of low-cost carbon fibres. Their hope is that this research paves the way for green composite manufacturing technology and its broader application.

Node: ANFF-VIC

Applications: Lightweight materials, aerospace, automotive, defence, environment

Full paper: https://doi.org/10.1016/j.pmatsci.2019.100575

**A/Prof Minoo Naebe:** minoo.naebe@deakin.edu.au

## COMBINING ANTIFOULING APPROACHES

Patterned surfaces are widely employed to control certain biomaterials and to reduce fouling in environmental applications. These uses often require sub-micron patterns to match specific sub-cellular structures, for example to control the presentation of certain proteins or to discourage bacterial growth. Plasma polymer coatings are also used extensively in the biotechnology sector for biomaterials, cell culture and tissue engineering, but their patterning has not been extensively investigated at the sub-micron level.

Scientists from the Swinburne University of Technology have now changed this, using Electron beam lithography they have successfully fabricated and characterised sub-100 nm plasma polymer patterns, establishing a clear route for large scale production of plasma polymerized nanopatterning.

Node: ANFF-VIC

Applications: Biotechnology, microfluidics, surface treatment

Full paper: https://onlinelibrary.wiley.com/doi/abs/10.1002/macp.202100026

**Karyn Jarvis:** kljarvis@swin.edu.au

## IMPROVING UNDERSTANDING OF MICROPLASTICS

Present in air and water, microplastics and nanoplastics are unwanted, highly durable, and a persistent polluter of the environment. They accumulate in living organisms and have an extraordinary capacity for absorbing other environmental pollutants. Seeking to better understand this emerging contamination, researchers from the University of Newcastle and Flinders University have developed an effective method to detect and characterise microplastics and nanoplastics as they are created.

Studying dust samples produced by paint polishing, the team demonstrated a set of advanced Raman mapping image algorithms that allowed them to identify and visualise microplastics and nanoplastics down to 100 nm. The work paves the way for better management of these pollutants, and for preventative methods to be employed at source.

Node: ANFF-SA

Applications: Environment, manufacturing

Full paper: https://doi.org/10.1016/j.watres.2020.115658

**Cheng Fang:** cheng.fang@newcastle.edu.au

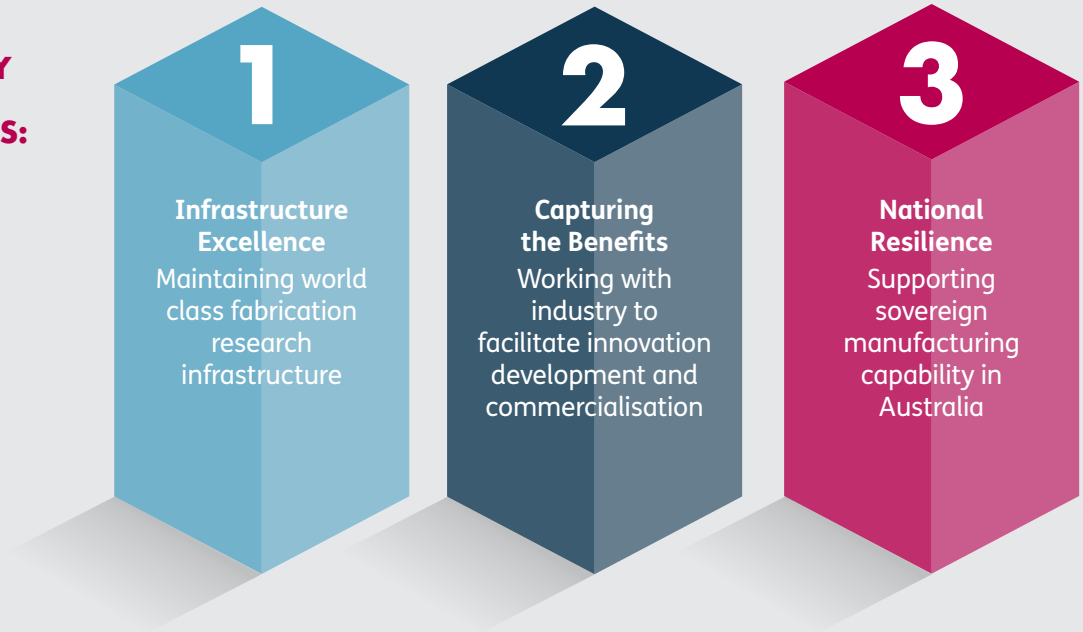
# AN EVOLVING ANFF

## Providing new services to meet client needs

**This year ANFF expanded its focus, making moves to extend out-of-lab support and ensuring businesses can access essential assistance through a customer-centred approach.**

**The activities are central to the networks' new organisational strategy which rolled out in late 2020. The new approach has been employed to help reinvigorate key industry sectors that can be supported by ANFF's cutting-edge micro and nanofabrication capabilities, and to enable Australia's post-COVID-19 recovery while aligning with Government priorities.**

### THE STRATEGY CENTRES ON THREE PILLARS:




### IMPACT AGAINST STRATEGY

The strategy is already being put into action, with outcomes being delivered under the guidance of the central pillars.

Ground has been broken on a new platform that will support and accelerate the commercialisation of novel intellectual property enabled by ANFF assets and expertise.

This new service will provide extensive assistance to qualifying projects in essential out-of-lab activities like developing capacity, capability, and investor interest. As with all ANFF activities, this is done without taking an equity stake in any enabled projects. With pilot projects underway and some already complete, this new service drastically improves the completeness of the networks' support package for promising projects, improving progress up the TRL scale discussed in this Casebook still further.

ANFF is also addressing a need for improved interactions between businesses and organisations that enable commercialisation and translation practices. July 2021 saw the network welcomed new team members to drive projects that streamline the process for industry to work with ANFF and similar groups, and to build strategic relationships that benefit the network's client base. A team of industry liaison officers will be created shortly to maximise the impact of ANFF's support to industry.

This will be done by:

- Creating a recognised entry point for businesses to gain access to ANFF's full suite of services;
- Becoming a repository of information regarding ANFF's abilities, the offering of NCRIS and other infrastructure providers, and of available funding or grant opportunities;
- Identifying strategic projects that, in collaboration with ANFF's service offerings, improves sovereign capability in target industry sectors; and
- Effectively identifying novel intellectual property and technology companies that can be referred to ANFF's new commercial development platform.

With these foundations laid, 2022 is going to be an exciting year for ANFF as these pursuits explode with activity.

**IF YOU'D LIKE TO FIND OUT MORE ABOUT HOW ANFF CAN HELP, CONTACT: info@anff.org.au**

# ACCESSING ANFF

## PRINCIPLES

- The Australian National Fabrication Facility (ANFF) provides access to nano and microfabrication facilities to all Australian researchers;
- ANFF seeks to encourage collaboration in research;
- The ANFF Access and Pricing Policy is intended to ensure that there are as few barriers as possible to accessing major infrastructure for those undertaking meritorious research;
- The Policy has been developed to ensure open and transparent access to the facility for all Australian researchers;
- The procedure for all users accessing a Node will be as equitable as possible.

## PRICING STRUCTURE

ANFF recognises three classes of user:

1. **PhD students;**
2. **Publicly funded researchers, including University researchers; and**
3. **Industry users.**

Pricing for public sector researchers is based on marginal costs only. A full listing of costs for each Node, including consumables, is given in the Access and Pricing Policy (**www.anff.org.au/access/access-pathways**).

## ACCESS STEPS

ANFF's goal is to have a new user being able to use a tool within 2 weeks of contacting the network.


## ACKNOWLEDGEMENTS

Users are asked to acknowledge the network in research papers as follows: "This work used the [NODE] node of the NCRIS-enabled Australian National Fabrication Facility (ANFF)".

The ANFF logo (available from the website) should be included on the acknowledgements slide of a presentation.

## ANFF HQ CONTACTS

**Contact info@anff.org.au for general enquiries, or get in touch:**

Dr Jane Fitzpatrick
CEO
E: jane.fitzpatrick@anff.org.au

David Martin
Chief Strategic Partnerships Officer
E: david.martin@anff.org.au

Matthew Wright
Office Manager
E: matthew.wright@anff.org.au

Tom Eddershaw
Marketing and Communications
E: tom.eddershaw@anff.org.au

Janet Sanchez
Executive Assistant
E: janet.sanchez@anff.org.au

## NODE CONTACTS

**ACT Node**
Facility Manager: Dr Kaushal Vora
E: kaushal.vora@anu.edu.au
www.anff-act.anu.edu.au

**Materials Node**
Facility Manager: Prof. Peter Innis
E: innis@uow.edu.au
www.anffmaterials.org

**NSW Node**
Facility Manager: Matthew Boreland
E: m.boreland@unsw.edu.au
www.anff-nsw.org

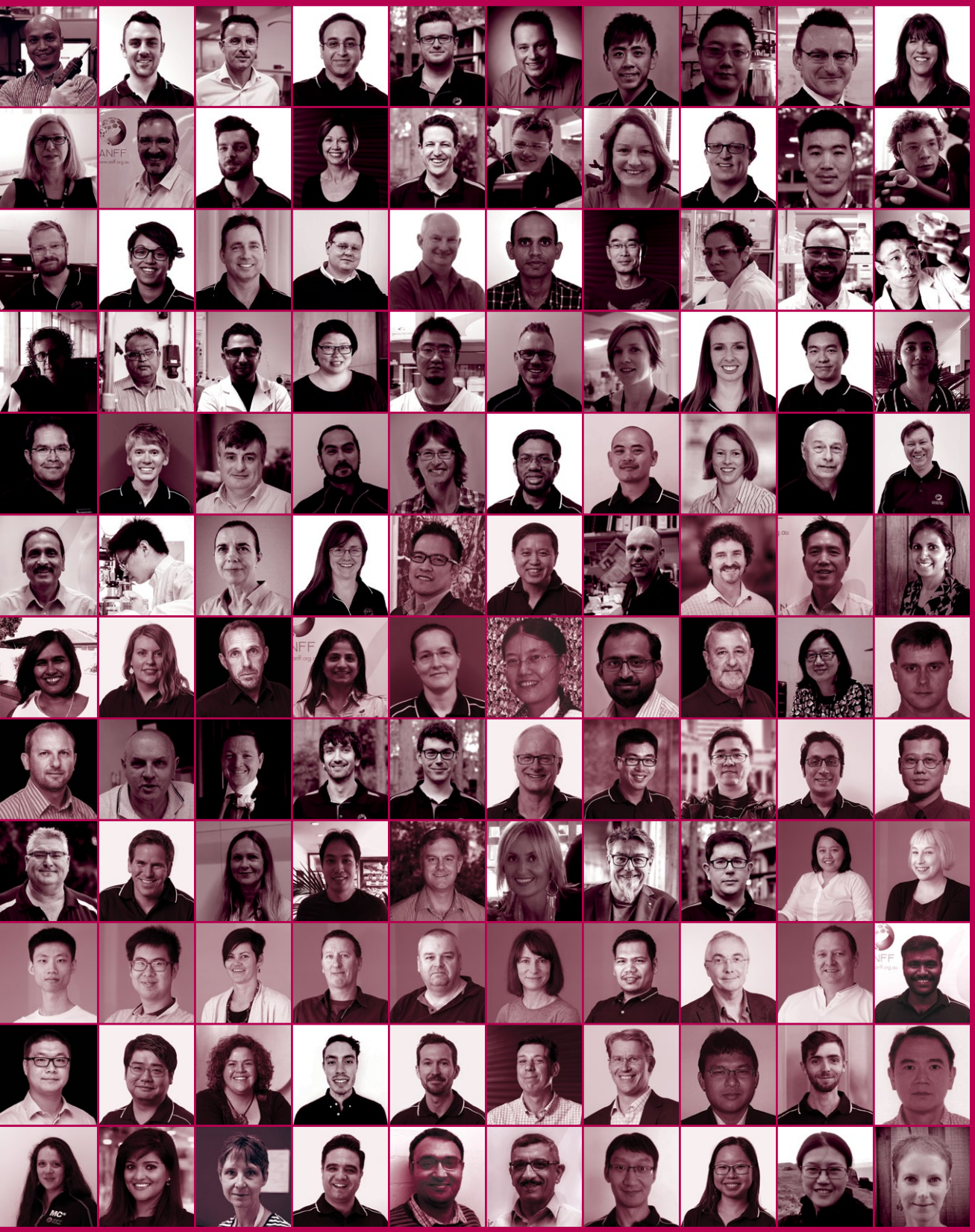
**OptoFab**
Facility Manager: Dr Benjamin Johnston
E: benjamin.johnston@mq.edu.au
www.optofab.org.au

**Queensland Node**
Facility Manager: Anthony Christian
E: a.christian@uq.edu.au
www.anff-q.org.au

**SA Node**
Facility Manager: Simon Doe
E: simon.doe@unisa.edu.au
www.anff-sa.com

**Victorian Node**
General Manager: Dr Sean Langelier
E: sean.langelier@nanomelbourne.com
www.nanomelbourne.com

**Western Australia Node**
Facility Manager: Prof. Mariusz Martyniuk
E: mariusz.martyniuk@uwa.edu.au
www.anff-act.anu.edu.au
www.mrg.uwa.edu.au



ANFF.ORG.AU

INFO@ANFF.ORG.AU