Australian Institute for Bioengineering and Nanotechnology

The University Of Queensland
AUSTRALIA

CREATE CHANGE

Urgent solutions are needed for the way our global community deals with serious health issues, generates and uses energy, and interacts with our environment.

At the AIBN we are working on the answers.

Learn more about our work in:

- Precision nanomedicine.
- Nanoengineered materials.
- Advanced biomanufacturing.

Solving serious problems in health, energy and the bioeconomy

From breakthroughs in personalised medicine; to the creation of clean energy systems made from nanoengineered materials; and the use of biological materials to reduce reliance on fossil fuels - the Australian Institute for Bioengineering and Nanotechnology (AIBN) is making an impact.

Founded in 2004, the AIBN, proudly based within The University of Queensland (UQ), has a unique outward facing operating model that fosters strong industry partnerships to enable translation and prepares the next generation of entrepreneurial scholars.

The AIBN is the leading bioengineering and nanotechnology research institute in Australia with a team of more than 500 researchers from around the globe who translate the most cutting-edge science from lab bench to the production line.

Our power lies in the diversity of our team, our members come from 30 different countries, more than 50 per cent are women and we have 160 PhD students and 120 postdoctoral researchers.

We exist to solve some of the world's most serious problems and some of the projects our research teams are working on, hand in glove with industry, include:

- A research hub dedicated to working with big industry players to reprogram cells to get our society to net zero.
- The BASE facility, which is the country's largest manufacturer of mRNA vaccines and therapies.
- A second-generation COVID-19 vaccine that has progressed to human trials and a vaccine for respiratory syncytial virus that has progressed to clinical trials.
- Nanotechnologies to create new ways of discovering and treating cancer and some of the world's rarest diseases.
- The creation of new smart materials to repel bacteria.
- World-leading quantum dot technology for solar energy storage, as well as new materials to create more economical and better batteries.

Working within the AIBN's labs and leading these projects, we have some of the world's most recognised academic experts, along with nine of the country's most cutting-edge research infrastructure facilities. All of which position the AIBN perfectly to enable the future.

When it comes to precision medicine, advanced biomanufacturing and nanoengineered materials, if you dream it, we can do it.

Professor Alan Rowan
Director
Australian Institute for Bioengineering and Nanotechnology
The University of Queensland

* QS World University Rankings for 2024
**Shanghai Rankings for 2023

Located at The University of Queensland

UQ ranks in the world's top 100 universities*

#9 in the world for biotechnology**

UQ is the biggest supplier of mRNA in Australia

150+ active UQ licence agreements

125+ companies created from UQ IP portfolio

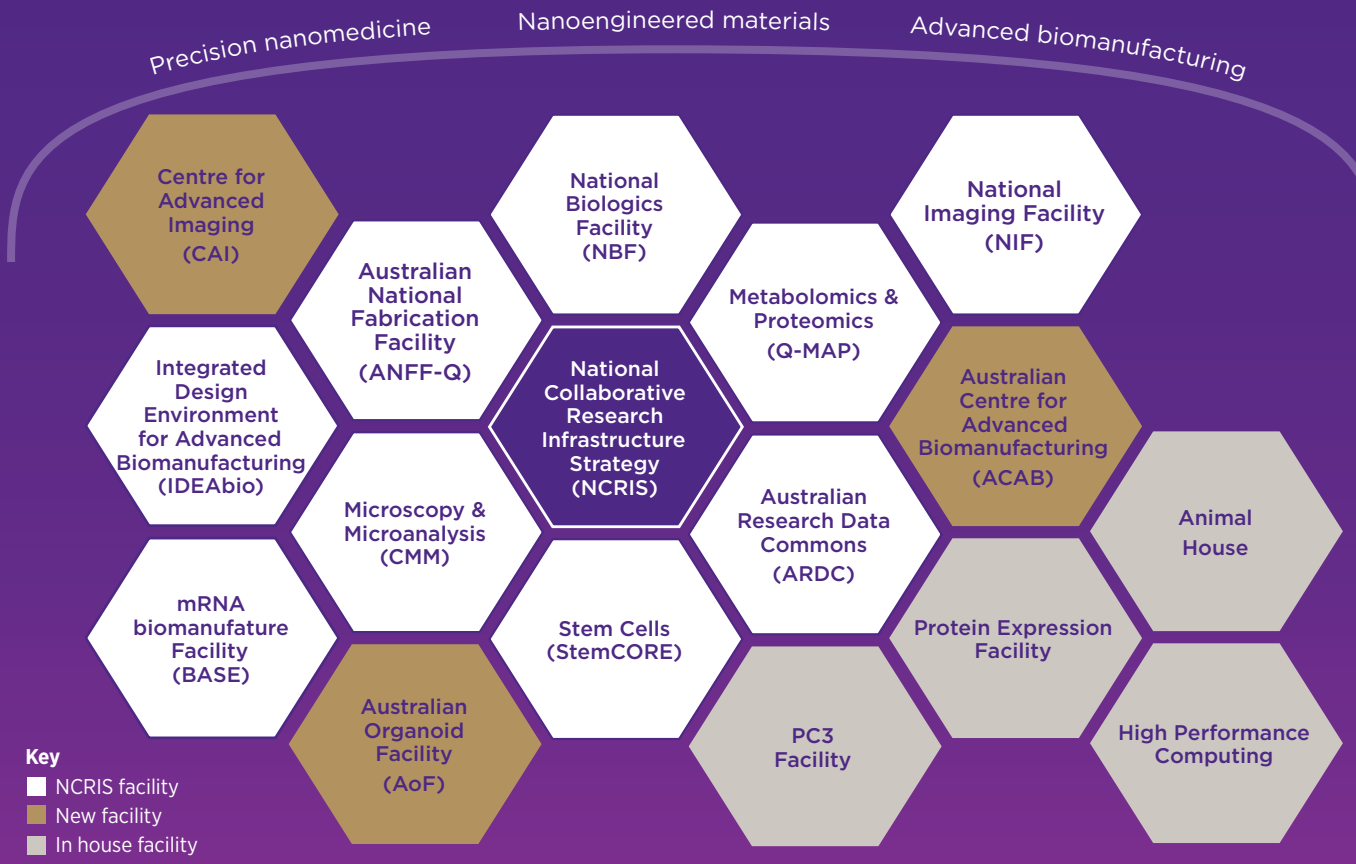
Facilities

Access an impressive array of cutting-edge facilities all under one roof

The AIBN is home to the highest concentration of National Collaborative Research Infrastructure Strategy (NCRIS) facilities of any research institute in Australia.

There is a critical symbiotic relationship between our researchers, industry partners and these facilities that informs world-changing research outcomes and solutions.

Working in the frontiers of biological, chemical, and physical sciences, these facilities give us access to the tools and equipment needed to take our research from the laboratory bench to pilot and production, or clinical translation.



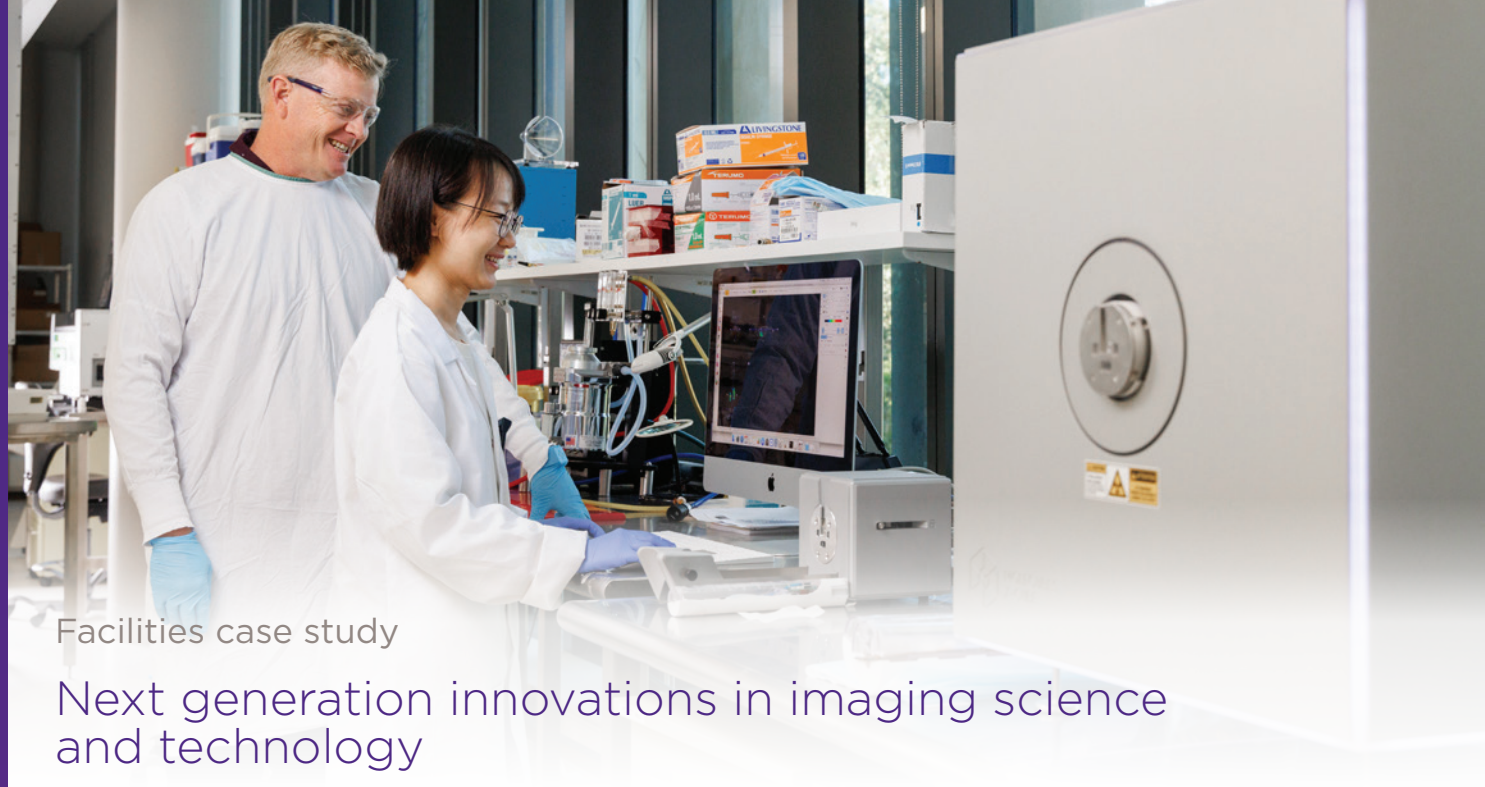
World class facilities and researchers

9 NCRIS co-located facilities at AIBN

450+ research staff and students

5 ARC Laureate Fellows

27% of AIBN publications are in the top 10% of journals



Facilities case study

Next generation innovations in imaging science and technology

The Centre for Advanced Imaging (CAI) within AIBN, is at the forefront of imaging science and is the only centre of its kind in Australia.

Bringing together a critical mass of researchers and state-of-the-art preclinical and clinical research infrastructure and instruments, CAI enables world class research through collaborations with industry and academia while fostering a rich, collaborative environment for our own experts to innovate across spectroscopic and imaging technologies.

The CAI's work is fundamental to a broad range of research fields, from major diseases affecting various organ systems, such as neurodegenerative disorders, cancer, and cardiovascular disease, through to imaging economically significant agricultural animals and plant material, minerals and construction materials.

Through techniques such as Magnetic Resonance Imaging (MRI), Positron Emission Tomography (PET), Nuclear Magnetic Resonance (NMR) and Electron Paramagnetic Resonance (EPR) spectroscopy, as well as the state-of-the-art isotope production and radiochemistry capability within the centre, our researchers gain unique insights into the structure and function of biomolecules through to whole organisms.

CAI's impact on translational research is maximised through collaboration with clinical research sites and other local, national, and international research institutes. This gives CAI a comprehensive 'end-to-end' biomedical imaging capability which allows integrated progression from the laboratory bench, all the way through to a clinical setting.

Precision nanomedicine

Creating a pipeline from diagnosis to drug design, testing, to patient

AIBN is revolutionising the way the world understands, diagnoses and treats disease by designing nanotechnologies to pioneer personalised medical breakthroughs.

Precision nanomedicine moves away from a one size fits all approach to focus on how diseases develop differently and respond to treatment depending on genes, lifestyle or environment.

We examine individual molecules, manufacture proteins and use the study of bioinformatics to develop treatments getting them from the lab bench to the clinic more quickly than ever.

Our game changing solutions in precision nanomedicine include:

- Organoids and stem cells to treat rare diseases.
- Vaccines for infectious diseases.
- Needle-free vaccinations.
- Personalised diagnostics and therapeutics for more targeted and effective treatments for serious illnesses.
- VR imaging tools.
- Nanoparticles and radiopharmaceuticals for targeted drug delivery.

Organoids

Tiny organs shaping modern medicine

From neurodegenerative disorders like Alzheimer's and Parkinson's to cancers, infectious diseases, and rare genetic conditions, AIBN researchers are using organoids to transform our approach to addressing the world's most serious health problems.

Rare diseases like epilepsy, leukodystrophies, Hereditary Spastic Paraplegia, Zika associated microcephaly, and Ataxia Telangiectasia could be a thing of the past, thanks to our world renowned organoid scientists. Using these 'live models' to diagnose and find treatments for these conditions, is putting the AIBN at the frontier of biomedical research and personalised medicine.

Using cutting-edge technology, AIBN researchers design and grow organoids both for their own work and for labs across the country, coaxing pluripotent stem cells or tissue samples into 3D structures that mimic the function and complex architecture of real brains, livers, kidneys, spinal cords, and intestines.

Crucially, organoids could one day decrease the reliance for animal models in understanding and treating diseases, as they can be designed to replicate what is happening inside an individual patient, offering researchers a unique opportunity to study personalised responses to new treatments.

This could shave years off the drug development process and - ultimately - the time between diagnosing a problem and delivering the solution.

Molecular sensor

Developing our patented 'molecule chips'

AIBN researchers are revolutionising the way we understand, diagnose and treat disease by creating nanotechnologies that can detect and manufacture molecules on a single wafer thin chip.

The 'Immuno-storm chip' is one of these devices. It can detect single molecular entities called cytokines from a drop of blood to identify patients with illnesses who are at risk of a potentially lethal cytokine storm. This is a reaction that can lead to serious long-term damage of organs and is prevalent in diseases such as cancer and acute and long COVID-19.

Early detection of a cytokine storm, which can also be caused by emerging therapeutic technologies such as immunotherapies, could provide critical information that guides treatment decisions and personalised therapies.

Access to medicines and vaccines during peak demand is a global problem. Our researchers have created a 'molecule chip' to accelerate and control chemical reactions, paving the way for on demand, miniaturised, remote manufacturing for medicines, vaccines and energy storage materials.

We are also focused on preventing the transmission of viruses through nanosensors that can be cheaply grown on the surface of yeast cells using food processing equipment. This yeast sensor dust technology could drive real-time virus tracking in public spaces, and animal to human transmission - giving our health systems a head start on new and emerging viral threats.

Uncontrolled bleeding

Snake venom to save lives

AIBN researchers are using venom from two of the world's deadliest snakes to save lives by stopping uncontrolled bleeding.

They have developed a hydrogel using replicated proteins from the saw-scaled viper and Australian eastern brown snake to stop uncontrolled bleeding and have designed an easy to use applicator to apply the product to injuries.

Within years, the product could be sold in pharmacies, added to first aid kits, and used by paramedics or military personnel in combat zones, to stop bleeding while a patient is taken to hospital.

As many as 40 per cent of trauma related deaths are the result of uncontrolled bleeding, with the figure much higher when it comes to military personnel with serious bleeding in a combat zone.

Reducing blood loss through improved early point of care will save lives and avoid later complications including multiple organ failures that occurs with increasing blood loss.

This work has been made possible thanks to funding from the US Department of Defence, Metro North Health and funding from CUREator to create the application device.

This gel has the potential to expand into the lucrative hospital, prehospital, and battlefield haemostatic agents market, currently valued at $US4.3 billion.

Nanoengineered materials

Smart materials for next generation energy storage and technology

Working at the nexus of physics, chemistry and engineering, the AIBN is creating smart materials for the next generation of energy storage and production.

Through our unique interface of bioengineering and nanotechnology we develop specific solutions to improve existing energy generation technologies, at scale, and develop entirely new ones.

By working at the nanoscale, our research teams are also building environmentally responsive nanoparticles for therapeutics and to treat infectious diseases like COVID-19 or influenza.

Our game changing solutions in nanoengineered materials include:

- Printable solar cells.
- Safer, more energy-efficient and environmentally friendly batteries.
- New materials to absorb harmful chemicals in the environment.
- Platform technologies that can be applied to energy storage across a range of industries.

Designed Nanomaterials

Nanostructured materials for advancing technology

AIBN researchers are working with international colleagues to advance the design and synthesis of nanomaterials critical to the next generation of renewable energy, environmental, and biomedical technologies.

Operating under the Exploratory Research for Advanced Technology (ERATO) program, our scientists collaborate with partners from Nagoya University, Waseda University, the National Institute for Materials Science (NIMS), and the Japan Science and Technology Agency (JST) to craft and produce innovative 'inorganic nanosolids' - unprecedented nanospace materials with distinctive conductive characteristics.

By precisely controlling the assembly, arrangement, and interactions of nanoscale components, the ERATO Materials Space-Tectonics Project aims to unlock a new generation of consumer electronics, photonics, energy conversion and storage devices, sensing technologies, and medical applications.

The highly conductive, second-generation porous materials at the centre of this ERATO reflect the increasing demand for sustainable energy storage and conversion technologies such as fuel cells, water splitting, and secondary battery electrodes – all technologies that rely heavily on catalyst or electrode materials that are currently limited in performance.

The main target of the ERATO is to establish a platform for the synthesis of 'second-generation porous materials' with significant potential for the further development in electrodes, electrocatalysts, and optical and electronic sensors.

Energy storage

Solving the clean energy puzzle

AIBN researchers have created world leading 'quantum dot' technology for electricity conversion to deliver significant upgrades on traditional solar cell technology, changing the game for a range of consumer and energy applications.

Lightweight, cost effective, and able to work on cloudy days or under indoor lighting, our quantum dot application has proven to be 25 per cent more efficient than previous conversion records and is the platform on which we are developing a flexible solar 'skin' printed on flexible sheets.

A breakthrough in materials science, this transparent skin is an extremely promising commercial product that can be applied to windows and other surfaces, offering modern power solutions for phones, electric vehicles, and larger power sources like rooftop solar.

It is one example from a suite of commercially viable technologies our researchers are developing to deliver practical energy solutions and help industry and households cut carbon emissions.

We have also created perovskite nanocrystal technology delivering unbreakable glass for lighting LEDs and phone, television and computer screens and our researchers are supercharging renewable energy applications to boost solar fuel hydrogen production, deliver high efficiency low cost solar cells, and vastly improve the performance and lifespan of high voltage Li-ion batteries.

Chemical capture

Remediating contamination with new materials

AIBN researchers are developing new, cost effective technologies to remediate and protect even the most remote sites and waterways that have been contaminated by the family of 'forever chemicals' known as perfluorinated compounds (PFAS).

Our scientists work hand in hand with industry and government to design functional and reusable materials that vastly improve on conventional methods to capture and destroy these long lasting PFAS, with one product working in under a minute.

This technology makes use of magnets and reusable sorption aids to rapidly concentrate and capture PFAS from contaminated water sources, improving on existing machine based methods that are unsuitable for removing PFAS in isolated or off grid communities.

Other projects are exploring how captured PFAS chemicals might even be repurposed as next generation fluorinated components for energy storage devices, including batteries, and as biopolymers for use as molecular imaging agents.

By bridging the gap between fundamental research and practical applications, our researchers and industry partners are able to break new ground in fluoropolymer chemistry while delivering commercially viable products that will ultimately protect the health of Australia's natural environment and people.

Advanced biomanufacturing

Working towards a sustainable future

At the AIBN, we are world renowned in synthetic biology which is the process of developing new materials, fuels, foods, chemicals and medicines from biological materials, or creating them from waste using biological processes.

By changing production practices from those dependent on fossil fuels to biomanufacturing, we are changing the game for our planet.

We map the processes of biology at the nanoscale, in the gene, genome and protein level of organisms so we can harness cells to create and manufacture new sustainable solutions.

Our game changing solutions in advanced biomanufacturing include:

- Converting waste, such as plastics, into useful chemicals and products.
- Creating future foods.
- Reprogramming bacteria to 'eat' harmful greenhouse gas waste and produce new chemicals.
- Using cutting-edge gene technology to chart a new path in the field of mRNA vaccines.
- Exploring greener fuels.
- Enabling ecologically sustainable agriculture.

mRNA

Engineering new therapies and treatments

As the biggest supplier of mRNA vaccines and therapies for research in Australia, the AIBN's BASE facility is well positioned to lead the world in mRNA translation for biotechnology firms.

BASE is building quality-assured mRNA vaccines and therapies for academic, clinical and industry use. With a state-of-the-art laboratory backed by The Medical Research Future Fund, BASE researchers are equipped with end-to -end capabilities for mRNA vaccine development, from their initial design through to Phase 1 clinical trials - allowing the next generation of mRNA vaccines and therapies to be built.

While the highly customisable mRNA platform has proven a quick and affordable pipeline for new vaccines and therapies - evidenced by soaring demand for BASE's products since the team was established in 2021 – the platform is also expected to be a decisive factor in future treatments for cancers and infectious and genetic diseases.

This trajectory promises to further cement the BASE facility's footing in the mRNA industry, and ensure the world's biggest biotech companies will continue to turn to our researchers when they're looking to make what could be the next medical advance.

Vaccine production

Taming deadly viruses

AIBN research is driving crucial progress in vaccine science, with our technology key to advancing a reengineered COVID-19 vaccine to clinical trials, and central to manufacturing the antibody materials for the world's first human Hendra virus therapeutic clinical trial.

Combining fundamental research, industry connections, and specialist production facilities, our team has a strong track record of delivering vaccine candidates and therapeutics for potentially devastating diseases, including the Middle East respiratory syndrome (MERS), human metapneumovirus (hMPV), respiratory syncytial virus (RSV), and Lassa fever.

The UQ developed second-generation molecular 'Clamp2' platform has underpinned a new COVID-19 vaccine candidate through to proof-of-concept human trials, while showing aptitude as a key platform technology for planning for future pandemics.

As part of our partnering agreement with The Coalition for Epidemic Preparedness Innovation (CEPI), vaccine candidates produced using 'Clamp2' technology will be made available in an outbreak situation to populations at risk including low-income and middle-income countries, ensuring that the AIBN will be crucial to ensuring Australia has the capability to develop and deliver clinical-grade vaccines whenever, and wherever, they are needed.

Biosustainability

Reshaping our lives

Researchers at the AIBN are using synthetic biology to help the world's biggest industries transition to net zero in a cutting-edge, Australian-first facility called the Biosustainability Hub.

The hub is a one-stop-shop for industry to partner with our research teams to create carbon neutral and economically viable products and materials.

Bringing together established UQ researchers and some of the world's biggest companies, the hub's focus includes greener biofuels, clean energy applications, animal free meat and milk products, more sustainable mining technologies and sustainable materials; all projects which are backed by the most up to date synthetic biology processes in the world, including the conversion of waste products and waste gases using reprogrammed bacteria to 'eat' greenhouse gas waste.

This agenda setting infrastructure houses research expertise and industry relationships that will drive innovation and research translation and ensure Australia's transition to a net zero future is both swift and commercially viable.

By the end of the decade, synthetic biology could be used extensively in manufacturing industries that account for more than a third of global output- a share under $30 trillion in terms of value.

This hub will position Australia to be part of this economic shift.

Partnerships

Commercial partnerships driven by intellect and entrepreneurialism

At the AIBN, our scientific expertise, coupled with our commercial nous, means we understand the barriers to creating a product out of a scientific idea.

Precision nanomedicine, nanoengineered materials and advanced biomanufacturing are our strengths.

We partner with industry, government and academia to develop solutions to some of society's biggest challenges.

Our entrepreneurial mindset, global research reach, industry networks and world class facilities means we can take solutions from the laboratory bench and work them into investment ready products.

aibn.uq.edu.au/
partnerships

100+ AIBN industry partnerships

72% of AIBN publications include an international collaboration

22% of UQ's patent portfolio is generated by the AIBN

40% of AIBN funding comes from industry partnerships

Entrepreneurial student case study

Building the skills to solve some of the world's biggest problems

Capitalise on our track record of partnering with key industry players and connect with a talent pipeline of high performing and job ready scientists through our Entrepreneurial Scholars program.

AIBN PhD scholar Nashaat Gadelhak is working with clean technology manufacturer Graphene Manufacturing Group (GMG) to ensure his science has real world applications.

As a member of our Entrepreneurial PhD Scholarship cohort, Nashaat is helping to design and produce graphene aluminium-ion battery prototypes - the next generation battery technology.

"Partnering with GMG is helping me to break down the barriers between my research and producing rechargeable battery products that will improve our energy ecosystem," Nashaat says.

"I am able to draw on the expertise of my mentors at the AIBN, while also accessing manufacturing technology and industry insights you can't get by sitting in a lab."

Nashaat says the opportunity to complete his doctorate alongside AIBN's leading scientists and GMG's industry experts has opened his mind to the rigors of translational science, providing him valuable contacts and enhancing his future job prospects.

Ultimately, the program has shown him first hand what it takes to be an industry ready scientist who can take their ideas from the lab bench to industry and ultimately commercialisation.

"Sometimes in research you find yourself removed from the realities of producing a solution that can be made available to consumers and scaled for even wider use," Nashaat says.

"Becoming an Entrepreneurial PhD Scholar has not only opened new avenues for my research, it has helped me understand the process of commercialisation while giving me the skills to help solve these real problems."

Commercialisation case study

Spin out company translating Indigenous knowledge

Spinifex from the Queensland outback has been used to develop innovative injectable medical gels to treat arthritis and osteoarthritis, help deliver drugs more efficiently to the body, and for use in cosmetic procedures.

Following an agreement between Indigenous group Bulugudu Ltd and UniQuest, a spin out company called Trioda Wilingi Pty Ltd was created to develop the gels from cellulose nanofibres extracted from spinifex.

Spinifex survives in temperatures up to 60°C, puts down roots up to 30 metres below ground to find water and produces a resin which can be melted and solidified to form a polymer that is a foundational ingredient in creating these gels.

Trioda Wilingi Pty Ltd is the result of a long term partnership between the AIBN and Bulugudu Ltd (formerly known as Dugalungi Aboriginal Corporation DAC), based in Camooweal about 200km west of Mt Isa; as well as investment from Uniseed.

Trioda Wilingi is a success story about what happens when scientists and Indigenous communities work cooperatively to translate traditional Indigenous knowledge into modern products. The word 'Trioda' comes from the scientific name for the Triodia species of spinifex grasses. 'Wilingi' is a Indjalandji word which means special grass.

This is a tangible demonstration of how spinifex, a plant that has been a building block for some Aboriginal societies in the desert, will continue to play a role in advancing local communities through business and employment opportunities.

Under the deal a percentage of all royalties will go into an Indigenous education fund at UQ, to enhance training and education opportunities for Indigenous Australians.

Commercialisation case study

Virus fighting surface coating on aircraft and in space

AIBN researchers, in partnership with Boeing (BR&T- Australia) have developed an antiviral surface coating to protect against COVID-19 and other existing and emerging viral and bacterial transmissions on aircrafts and for space travel.

This environmentally friendly, cheap antiviral surface coating is currently being manufactured to industrial scales.

The coating started as a concept in 2016 to protect passengers and crew in aircraft from pandemic threats and shows the power and impact of commercial partnerships between industry and research.

The product was created using polymers which inactivate viruses transmitted through coughing, sneezing or saliva.

This versatile chemistry can be readily redesigned to target emerging viruses and aid in controlling future pandemics.

After this project began and before the COVID-19 pandemic, researchers and Boeing recognised the potential threat of microbial contamination on space missions - to astronauts, equipment and interplanetary contamination, so the product was tested on the International Space Station (ISS) in 2022 and again in November 2023.

The ISS experiment tested objects from the aircraft including fabric and seatbelts, as well as areas on the floor and other surfaces, with only one set receiving the antimicrobial surface coating.

Throughout the life of this project, Boeing has supported the costs of 5 patent families, manufacturing, regulatory approvals and commercialisation of the product to market.

THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

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Collaborate with us to help change the future

E partner@aibn.uq.edu.au

T +61 7 3346 3877

W aibn.uq.edu.au