

The University of Sydney Nano Institute

Annual Report 2019



THE UNIVERSITY OF
SYDNEY
—
Nano Institute

THE UNIVERSITY OF SYDNEY NANO INSTITUTE

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The University of Sydney



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We acknowledge the tradition of custodianship and law of the Country on which the University of Sydney campuses stand. We pay our respects to those who have cared and continue to care for Country.

Left to right: Cleanroom, Sydney Nanoscience Hub (SNH) Research Wing, SNH Lab, SNH building

“It was inspiring to see so many Grand Challenge projects aimed at solving social, economic and scientific challenges that have a real impact on people’s lives and the world we live in.”

FROM THE DEPUTY VICE-CHANCELLOR (RESEARCH)



Our research at the University of Sydney is driven by the passion of our researchers for excellence and impact. From combating the world's deadliest diseases, to inventing tiny devices that make a super-sized difference to computing, we are harnessing the extraordinary depth and breadth of our research in pursuit of some of the biggest questions and challenges the world faces today.

That is why we have made significant investments in multidisciplinary research and education initiatives – including the University of Sydney Nano Institute, where we have created unrivalled infrastructure for nanoscale science and technology.

The Sydney Nanoscience Hub is one of the most advanced research and teaching facilities of its kind in the world, underscoring the University's commitment to science and innovation.

Sydney Nano is one of 10 multidisciplinary institutes at the University, which bring together researchers across diverse disciplines to create new ideas and directions, while delivering research excellence and education opportunities.

Research-intensive universities like ours need to be innovative in breaking down disciplinary barriers and work closely with community and industry partners in order to bring diverse forms of knowledge and understanding to bear on complex questions in new ways.

That is why I am particularly proud of Sydney Nano's achievements in 2019. It was inspiring to see so many Grand Challenge projects aimed at solving social, economic and scientific challenges that have a real impact on people's lives and the world we live in.

We are excited by these developments and look forward to the launch of new schemes such as the Frontier, Catalyst and Kickstarter projects as the institute looks toward 2020 and beyond.

Professor Duncan Ivison
Deputy Vice-Chancellor (Research)

“Our mission is to transform our economy, society and everyday life through multidisciplinary research in nanoscale science and technology.”

Professor Ben Eggleton
Director, Sydney Nano



DIRECTOR'S NOTE

As I reach the milestone of 18 months as Director of Sydney Nano, it feels like a natural resting point to reflect on the journey we have all been taking together.

2019 was an incredibly busy year for all of us as we implemented our new strategy, and I am extremely pleased to see that we have made real progress in our strategic fields. I want us all to recognise the great work being done by our Deputy Directors, Dr Omid Kavehei, Professor Manjula Sharma, Associate Professor Wojciech Chrzanowski, and Professor James Rabeau, all of whom have led the portfolios and have been wonderful colleagues. The year also saw excellent results in the research program, which is great to see as it is core to our strategy.

The Grand Challenge projects are doing fantastically, and we look forward to seeing them build more momentum and success in 2020. I am a firm believer in the cross-pollination of ideas and success, accordingly we have a goal to increase multidisciplinary collaboration across the University of Sydney community. In pursuit of this we have expanded our academic framework by the launch of three new research schemes which aim to build research capacity and complement our current six Grand Challenge projects – these are known as Kickstarter, Catalyst and Frontier.

I am also very pleased that we have seen a strong focus on the theme of nanohealth which currently represents more than 50 percent of our portfolio; this seems natural given that health and medicine represents about half of the University's research. In 2020, we are going to be placing serious focus on this growing field by working with the Faculty of Medicine and Health on a more strategic positioning for nano-health across the University's health and medicine ecosystem. We will also launch a new round of Grand Challenge projects in 2021 and are hoping to receive many more submissions of exciting projects from across the University.

This year promises to be an exciting year. As I have said previously, we are where we are because of the highly talented and superbly motivated group of people that make up the Sydney Nano community. I am really looking forward to the next phase of Sydney Nano. I hope that you find this annual report to be interesting.

Professor Ben Eggleton
Director, Sydney Nano

ABOUT THE INSTITUTE

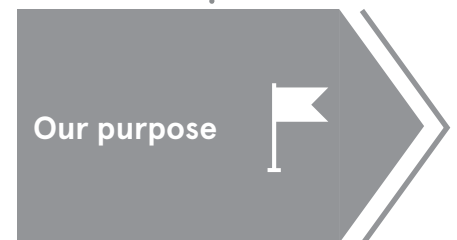
At Sydney Nano, we like to say that the next giant leap is seriously small. Revolutionary changes in science and technology have opened access to the nanoscale and together we are tackling some of the most challenging problems faced by humanity. With combined expertise from across the University's disciplines and access to purpose-built facilities, our research is taking nanoscience to new levels.

As a multidisciplinary institute, we foster and enable research and education across all faculties, in a way that would not be possible through traditional university structures.

Our mission is to transform our economy, society and everyday life through multidisciplinary research in nanoscale science and technology, and this is something we have developed further in 2019. Our research is impacting a variety of areas including manufacturing, energy and the environment; medicine and health; and communications, computing and security.

Through our education and training programs, we are inspiring the next generation of scientists and engineers. Together we are tackling some of the most challenging problems facing humanity: inventing new technologies for renewable energy; designing new medicines; creating nanorobots for surgery; and taking inspiration from nature to develop completely new materials engineered at the nanoscale.

The impact of this technology will be felt far beyond science, medicine and engineering. That is why we are reaching across our academic community into the arts and social sciences, business, law, and architecture and design.



We work horizontally across the University and in close partnership with all faculties and schools to achieve transformational and translational outcomes in six strategic fields. Each of these fields are linked to our academic framework and will support the Grand Challenge projects.

These are:

- Research excellence
- Infrastructure and enabling capabilities
- Member engagement
- Outreach, training and education
- Academic partnerships
- Industry, innovation and commercialisation

Our vision is to be globally trusted and recognised experts in nanoscience and technology.

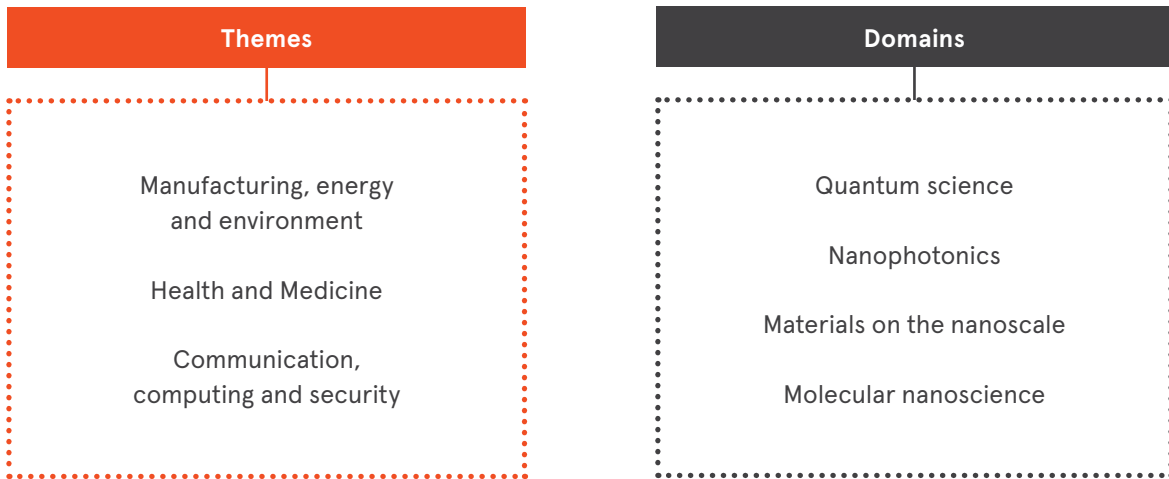
Our mission is to transform our economy, society and everyday life through multidisciplinary research in nanoscale science and technology.

Our purpose is to enable, facilitate and promote transformational activities and translational outcomes in nanoscience and technology that would otherwise not be possible through existing faculty and university structures.

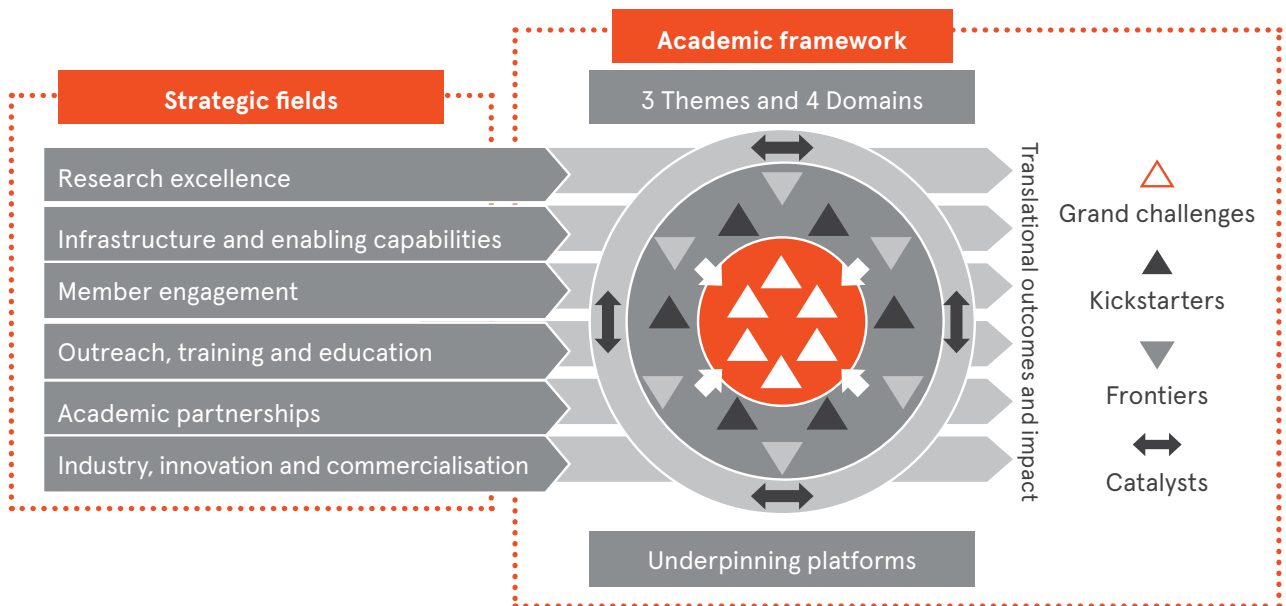
Sydney Nano is not separate to faculties. We facilitate transformational and translational research projects that are populated by academics who belong to faculties.

Strategic Fields and Academic Framework

Our academic framework is based on three themes and four domains, and these are underpinned by infrastructure and capability platforms.



Our research activities are structured in four complementary research schemes. Nodes are selected in each of the schemes to receive funding, strategic, governance and administrative support.





“The next
giant leap is
seriously small.”



OUR PEOPLE

Sydney Nano Executive Committee

The Sydney Nano Executive Committee, chaired by the Director, Professor Ben Eggleton, comprises the Chief Operating Officer and four Deputy Directors who work as a team to affect our academic, strategic and financial goals.



Professor Ben Eggleton
Director



Dr Gunther Schmidt
Chief Operating Officer



**Associate Professor
Wojciech Chrzanowski**
Deputy Director,
Academic Partnerships



Professor Manjula Sharma
Deputy Director, Outreach,
Education and Training



Professor James Rabeau
Deputy Director,
Industry, Innovation, Commercialisation
and Enabling Capabilities



Dr Omid Kavehei
Deputy Director,
Member Engagement

Early Career Research Ambassadors

The Early Career Research (ECR) Ambassadors are an integral part of the team. They represent Sydney Nano and support member engagement initiatives and activities at a faculty level, and via national and international networks including academic and social events.

In 2019, eight ECR Ambassadors were appointed across seven faculties/schools. They were nominated to support the Deputy Director (Member Engagement) Dr Omid Kavehei in his portfolio.



Dr Alessandro Tuniz
Faculty of Science
(Physics) and
Sydney Fellow



Dr Mohammad Mirkhalaf
Faculty of Engineering
(Biomedical Engineering)



Dr Jiao Jiao Li
Faculty of Medicine
and Health (Northern
Clinical School)



Dr Tong Li
Faculty of Medicine and
Health (Health Sciences)



Dr Karla Straker
School of Architecture,
Design and Planning
(Design)



Dr Ben Carey
Sydney Conservatorium of
Music (Composition)



Dr Maria Rumjansetva
Sydney Business School
(Strategy, Innovation and
Entrepreneurship)



Dr Diana Chester
Faculty of Arts and
Social Sciences (Media
and Communication)

Sydney Nano Student Ambassadors

Four Sydney Nano Student Ambassadors were also appointed in 2019. They were mentored by Deputy Director (Outreach, Education and Training) Professor Manjula Sharma and had the opportunity to learn and develop their skills in science and technology communication while also gaining first-hand experience in outreach activities with high schools and the general public. This included giving visibility to the study of nanoscience in innovative and creative ways.



Mr Christopher Vega
Chemistry



Ms Jiarun (Veronica) Lin
Chemistry



Mr Pradeep Murthy
Chemical and
Biomolecular Engineering



Mr Pooria Lesani
Aerospace, Mechanical
and Mechatronic
Engineering

Sydney Nano Administrative Support Unit

The Sydney Nano Administrative Support Unit provides administrative and operational support to the Sydney Nano Directorate.



Trudy Fernan
Executive Officer



Jessica Coburn
Executive Assistant



Eugena Li
Project Officer (Academic)



John Janetzki
Project Officer (Data)



Rex Wang
Project Officer (Data)



Nicola Horton
Project Administrator

Our members

Our membership now consists of close to 800 academic and professional staff from all faculties and service units. A unique group of people from different backgrounds and disciplines, we all share an interest and passion for nanoscience. We love working in multidisciplinary teams and creating translational and transformational outcomes that are only possible in the unique Sydney Nano environment.

The Sydney Nano structure

- Our structure brings together nearly 800 academic and professional staff from all faculties and service units.
- Members are conducting nano-related research at the University of Sydney.
- Participants are PhD students and postdocs working with Members.
- Both receive defined benefits including funding opportunities.
- Our community comprises academic and professional staff at the University who work with Sydney Nano or have a general interest in nanoscience and technology.
- We seek a wide and inclusive representation from all disciplines and a higher proportion of women than usual in STEM areas.



Total number of University of Sydney staff engaged



131 Members lead nano research programs as Chief Investigators

Nearly one third are **female**



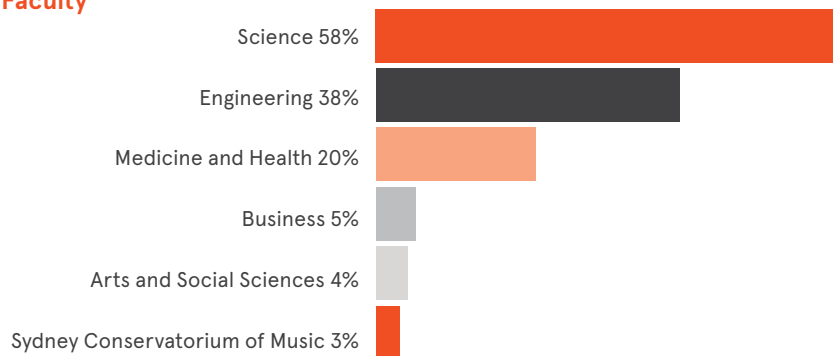
Spread over 7 Faculties/University School

40% Senior academics

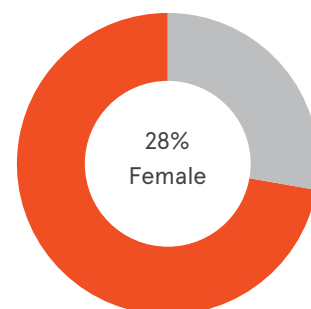
34% Mid-Career Researchers

26% Early-Career Researchers

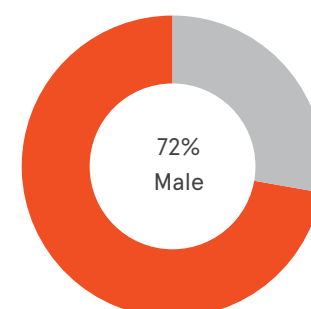
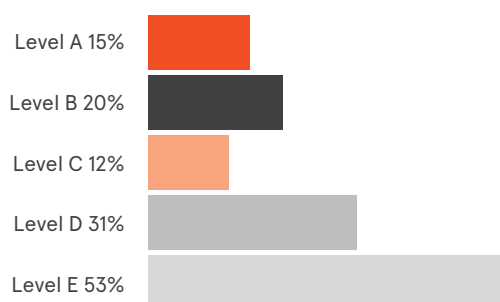
Faculty



Gender



Academic level



STRATEGIC FIELDS

In 2019, we were pleased to launch six inaugural research nodes within our flagship Grand Challenge scheme.

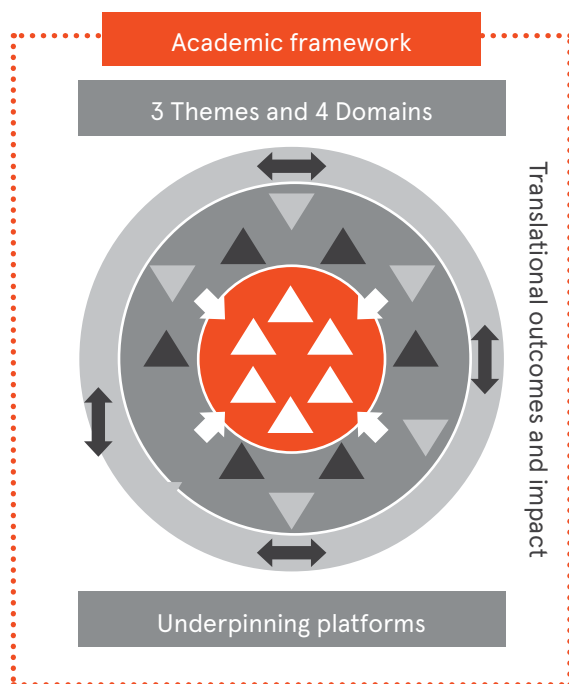
Research Excellence

The Grand Challenge nodes are unique in their structure, governance, support model and performance measures.

Based on the immediate success of the Grand Challenge scheme, Sydney Nano expanded its academic framework and launched three new schemes. These are known as Frontiers, Catalysts and Kickstarters. They are complementary to

our Grand Challenges as they share the same principles, however they aim to build capacity and focus in areas that have been established to complement or support the Grand Challenges or have the potential to become future Grand Challenge projects. The Catalyst scheme is designed specifically to deal with societal aspects of Sydney Nano's research.

Expanding the Academic Framework



Launch of new schemes

- To build capacity and focus in areas that complement/support the Grand Challenges
- As precursors to new Grand Challenges or deal with societal aspects of Sydney Nano's research

△ Grand challenges
flagships that focus on finding multidisciplinary solutions for one grand challenge of our society

▲ Kickstarters
seed funded individual nodes of multidisciplinary research that could develop in to grand challenges

▼ Frontiers
nodes that develop one technology platform in multidisciplinary applications. An individual application could evolve into a grand challenge if additional disciplines might be required

↔ Catalysts
nodes that enhance and influence how we approach our programs and how they impact the ecosystem of our economy and environment

12 Active research nodes:

- 6 Grand Challenges
- 1 Frontier
- 2 Catalysts
- 3 Kickstarters



149 academics and students engaged.

Our members spread over
5 Faculties/University Schools:



Spanning all academic levels:





Grand Challenge Results in 2019



7 external grants



1 philanthropy donation



32 international collaborators



18 industry engagements

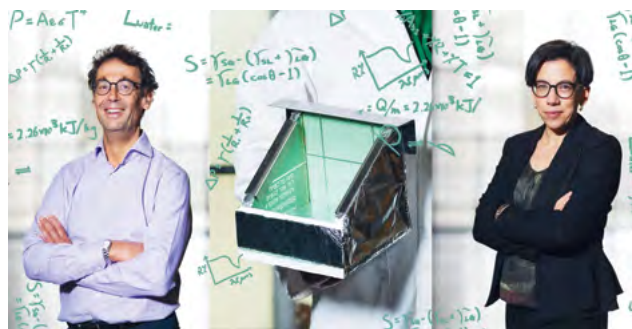


11 publications

Grand Challenges

The Sydney Nano Grand Challenges are the flagship programs of our institute. They all align with the strategic priorities of the University. Grand Challenges engage researchers across the whole University and comprises both senior academics and early career researchers. They provide opportunities for multidisciplinary research and education while presenting opportunities for partnerships with industry, end-users and other institutions around the world.

The inaugural Grand Challenges were launched in 2019 and aimed at discovering and developing groundbreaking solutions to the world's greatest challenges. They include:



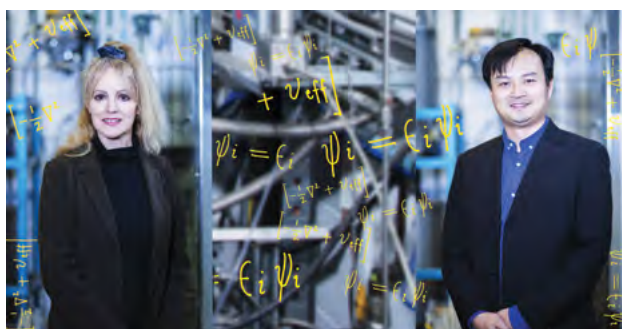
**Professor Martijn de Sterke
and Associate Professor Chiara Neto**
**Advanced Capture of Water from the Atmosphere
(ACWA)**

Developing a low-cost method to capture enough water from the atmosphere to alleviate the effect of drought by providing water for consumption by humans and animals, and for irrigating plants.

Our aim is to develop large surfaces with incorporated nano- and micro-scale chemical patterns which can capture water passively.

Our technology is more advantageous than other technologies available today because they either require active cooling, or, if not cooled, they only work for part of the night. Our proprietary technology, produced over a large surface, will capture water passively, i.e. without any energy input and we aim to sustainably collect 10 litres of water per hour per square meter, 24 hours a day.

Our passive water capture technology offers a myriad of possible applications. Apart from the more obvious application in water capture which include water harvesting in remote locations for defence, emergency services, and outdoor activities, our technology also offers an optimisation in the condensation process and this benefits all applications that require nucleation of liquids, such as cooling towers, distillation, and desalination.



**Associate Professor Jun Huang
and Professor Catherine Stampfl**
CO₂ Zero

Developing new nanocatalysts to reduce CO₂ emissions in manufacturing processes and to convert CO₂ into fuels and valuable chemicals.

This Grand Challenge assembles leading scientists and cross-faculty capacities to develop innovative nanotechnology solutions for smart and sustainable manufacturing.

We will achieve this through the creation of novel concepts and methodologies that utilise CO₂ as a resource for fuels and valuable industrial products. We will also discover new industrial systems with unprecedented high performance and efficiency for CO₂ conversion and reduction. New paradigms will be realised via a new way of thinking in nanoscience and nanotechnology: through the combination of nanomaterials synthesis, process engineering, data science, molecular science and computation, augmented by Artificial Intelligence (AI) and in situ/operando nanoscale characterisation tools of unprecedented power.

The ultimate goal is a new smart and sustainable Australian manufacturing sector which aims to increase CO₂ conversion and energy efficiency as well as reducing CO₂ emissions and energy consumption.



**Associate Professor Wojciech Chranowski
and Associate Professor Elizabeth New**
Safe-by-Design Nanotechnology

Developing new technologies and a regulation framework to assess safety, efficacy and toxicity, and guiding the future development of nanomaterials across drug formulations, food additives and biosensors.

This Grand Challenge will develop underpinning science to guide the development of 'safe-by-design' drug formulations, food products, nanomaterials and biosensors and to protect health and the sustainability and benefits of nanomaterials.

Within the Grand Challenge we have three foci:

1. New methods and technologies

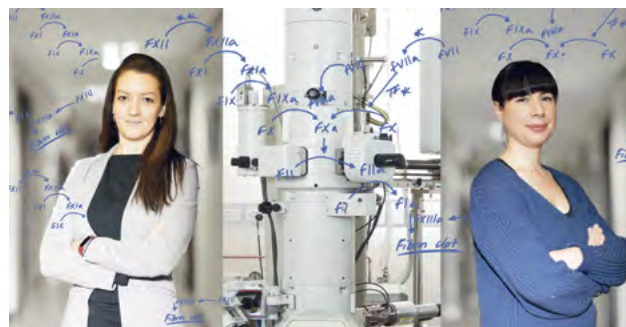
The development of high-throughput screening/nanodosimetry patho/physiology mimicking models, supported by machine learning, for testing safety, efficacy and toxicity of nanomaterials; potentially to replace animal models.

2. Nanotechnology and people

The development of socio-economic protocols to accompany and assess this emerging technology, its market and public regulation.

3. New functional materials

The development of nano-enabled materials for medical application including antimicrobial materials and biosensors.



**Dr Anna Waterhouse
and Dr Shelley Wickham**
Nanorobotics for Health

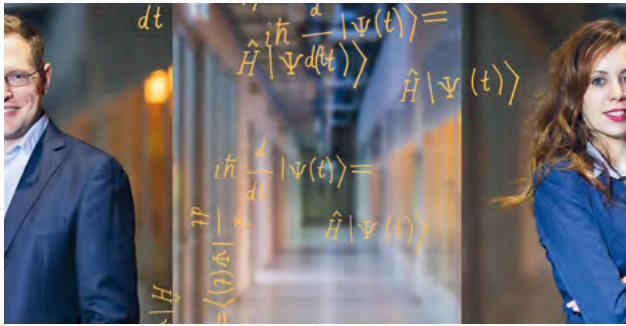
Building autonomous, programmable nanorobots to navigate through the body to detect and treat early diseases.

Unsustainable growth of healthcare costs is one of the greatest challenges faced by humanity. To address this requires a paradigm shift away from the 'break-fix' model of healthcare to a focus on prevention and early intervention.

Nanotechnology is one of the key exponential technologies with potential to dramatically disrupt healthcare over the next decade, through the development of nanoscale devices that can enter the body for non-invasive early diagnosis.

The molecular-level changes in early heart disease occur on the nanoscale. To detect these changes, we are building nanoscale robots, smaller than cells, that will navigate the body. This will enable us to see inside even the narrowest blood vessels, to detect the fatty deposits (atherosclerotic plaque) that signal the start of arterial blockage and allow treatment before the disease progresses.

The impact of this project will be extensive. It will improve health outcomes for all Australians with heart disease and reduce healthcare costs. It has potential to benefit other health challenges, including cancer, dementia and other neurodegenerative diseases. It will provide a world-class collaborative environment to train the next generation of Australian researchers, driving innovation and development of new industries and jobs in Australia.



**Dr Ivan Kassal
and Dr Lamiae Azizi**

Computational Materials Discovery

Simulating new materials from a single atom to fully functioning devices using quantum computers, multiscale simulation, artificial intelligence and machine learning.

This Grand Challenge contains three themes, each addressing a major challenge in computational materials science:

1. Quantum computing to model tricky quantum effects

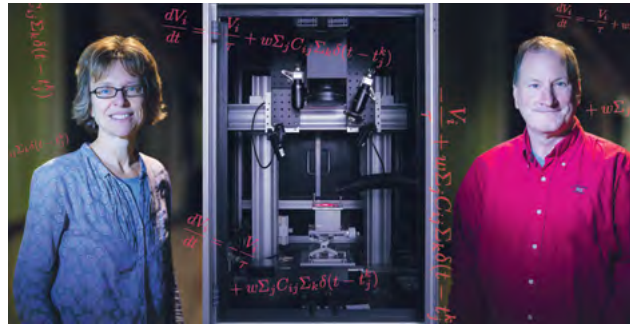
Matter is fundamentally quantum mechanical, and accurately capturing quantum effects can be exponentially difficult on ordinary computers. Materials science will be the killer app for quantum computation because of the ease of simulating quantum effects on quantum computers. We are putting this idea into practice on existing, small-scale quantum computers here at the University of Sydney.

2. Multiscale modelling to span disparate length scales

We are developing new approaches for connecting simulations at different levels of complexity—from the subatomic to the macroscopic—to show how the function of materials emerges from interactions across vastly different length scales.

3. Machine learning to sift through vast chemical space

We are using the latest in artificial intelligence to make sense of the wealth of data accumulated through our simulations, and training machine-learning models to identify promising new candidates from the vast space of possibilities.



**Professor Gregg Suaning
and Professor Zdenka Kuncic**

Unlocking the Neural Interface

Rethinking the means of intervention into the human nervous system to make untreatable neurological diseases treatable, and to transform treatments into comprehensive cures.

This Grand Challenge harnesses the combined capacity of neural biology, electrical stimulation and nanotechnology to transform and restore neurons from a state of disease or dysfunction to a state of robust performance indistinguishable from normal function.

We achieve this by approaching the problem from three novel and distinct directions:

1. Regrowth of the neuron utilising stem cells with their differentiation mediated by electrical stimulation.
2. Redeployment of existing neural cell functionality through gene transfection utilising nanoparticle delivery vectors and electroporesis.
3. Creation of synthetic neural synapses utilising neuromorphic nanowires to replace lost neural function that cannot otherwise be established through biological means.

Our goal is to unlock the neural code through the convergence of neural biology and electrical stimulation with nanotechnology.



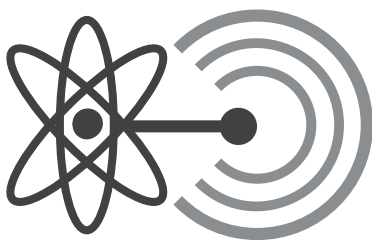
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Frontier

The Frontier scheme was designed to assess and develop one emerging technology platform in multiple applications to identify technology transfer opportunities over a diverse range of sectors. There was one Frontier project in 2019:

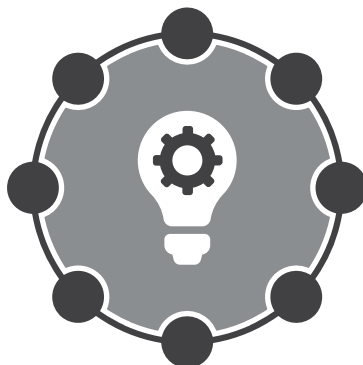
Catalyst

The Catalyst scheme underpins the Grand Challenges and encourages new ways of thinking about research. It aims to bring together researchers from social sciences, design, law and business with scientists from science, health sciences, medicine and engineering. There were two Catalyst projects in 2019:



Quantum Sensing

A global perspective on the applications where quantum sensing technologies could play a transformational role in areas such as archaeology, defence, infrastructure, medicine and mining. (Professor James Rabeau)



Engaged Innovation Scholarship for Impact

Simultaneous teaching and research about innovation, entrepreneurship and related topics by social scientists who are embedded in Sydney Nano’s multidisciplinary nodes to study and contribute to innovation ‘in the making’. (Professor Steven Maguire)



NanoResonance

Creative interpretations of scientific data derived from nano research through virtual reality and spatialised audio. (Dr Diana Chester)



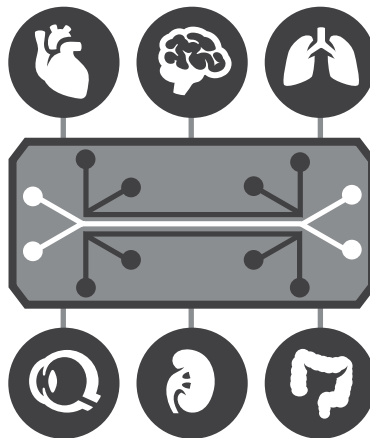
Kickstarter

The Kickstarter projects are precursors for the Grand Challenges and must comprise of a multidisciplinary team with researchers from at least two faculties, with humanitarian or environmental impact. In 2019 there were three Kickstarter projects:



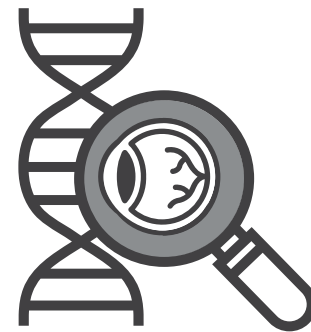
NanoVision

Identifying lipid nanoparticle carriers for cell-specific delivery of genes and drugs to the human retina. (Professor Mark Gillies, Dr Ling Zhu)



Organs-on-chips: Tissues-in-fibre

Generating highly specific engineered biofunctionalised 2D and 3D surfaces to combine with stem cell differentiation to form mature functional tissue-like structures in the dish, as well as tissue-like structures in biofunctionalised fibres. (Associate Professor Stuart Fraser, Professor Marcela Bilek)



GeneNano

Providing new approaches in therapies for genetic retinal disorders using novel carbon nanoparticle carriers. (Professor Robyn Jamieson)



Member Engagements and Achievements

In order to meet the research and educational strategies of Sydney Nano and the University, we engage members to facilitate the integration and alignment of partnerships across Themes and Domains and Sydney Nano's Grand Challenge programs. In 2019, Sydney Nano members received several prestigious awards, including the Australian Laureate Fellowship, Fellow of the Royal Society of NSW, Eureka Prize and Prime Minister's Prizes for Science, as well as joining the Australian Academy of Science. This is a recognition of the breadth, depth and quality of our research.

2019 Member Highlights



Professor Marcela Bilek: 2019 Australian Laureate Fellowship in engineering, information and computer sciences.



Professor Hala Zreiqat: Fellow of the Royal Society of NSW, Payne-Scott Professorial Distinction, Eureka Prize for Innovative Use of Technology, Fellow of the Australian Academy of Health and Medical Sciences, Order of Australia, bestowed the Order for Distinction of the Second Degree by the King of Jordan.



Associate Professor Elizabeth New: Prime Minister's Prizes for Science, the University of Sydney Alumni Award, Le Fèvre Medal, Edgeworth David Medal, Alan Sargeson Lectureship.



Professor Catherine Stampfl: Fellow of Australian Academy of Science.



Professor Steven Flammia: Pawsey Medal.



Professor Anita Ho-Baillie: inaugural John Hooke Chair of Nanoscience.



Distinguished lectures

Throughout the year we hosted distinguished lectures with visiting professors from around the world. These lectures were:

- Professor Yuri Kivshar, Nonlinear Physics Centre of the Australian National University – “All-dielectric resonant meta-optics and nanophotonics”
- Professor Keisuke Goda, University of Tokyo – “Intelligent image-activated cell sorting”
- Professor Erol Harvey, Bionics Institute Australia – “Five success factors in delivering medtech impact”
- Professor Hariharan Srikanth, University of South Florida – “Tuning magnetic anisotropy in nanostructures for biomedical applications”.



Promotions

Sydney Nano members received a total of 14 promotions across seven faculties and schools throughout 2019.

Sydney Nano awards

In recognition of our members’ journal publications, we presented the Sydney Nano Publication Award to five Sydney Nano members from three faculties this year. We also had six members from four faculties who were awarded the Early-Career Research (ECR) Travel Awards in support of their research-related travels outside of Australia, such as participation in conferences and fieldwork.

Cultural and networking events

We were proud to host a range of cultural and networking events throughout the year. These included ECR Forum networking events hosted on campus, a human ethics workshop, the International Women’s Day Morning Tea and Religious and Cultural Diversity Morning Tea.

Photos from top: Distinguished Lectures by Professor Yuri Kivshar, Professor Keisuke Goda



14 Sydney Nano Members across
7 Faculties/University Schools have been promoted.



Sydney Nano was awarded:

5 Publication Awards

6 ECR Travel awards

Our members have received several prestigious awards, such as: the Australian Laureate Fellowship, Eureka Prize, Order of Australia, Prime Minister's Prizes for Science.



Sydney Nano held

4 Distinguished lectures and

2 Sydney Nano seminars

Members have been involved in numerous cultural and networking events such as: the ECR Forum networking events hosted on campus, a Human Ethics workshop, the International Women's Day Morning Tea, the religious and cultural diversity morning tea.

Academic Partnerships

Strategic partners of Sydney Nano

We are proud of our strategic partnerships which enable us to increase our knowledge while supporting research on a global scale to find real-world applications for nanoscience in our everyday lives. The major partnerships in 2019 were:

- **MoU with Pusan National University** – In 2019, two co-authored publications were produced with Pusan National University. We were also successful in winning a joint bid for a three-year Bio-Medical Global Educational Program funded by the Korean Ministry of Health and Welfare.
- **Renewed MoU with NIMS Japan** – The renewed partnership included one publication along with the announcement that NIMS-MANA will loan specialised equipment to Sydney Nano in order to establish a neuromorphic nanotech lab.
- **University-wide MoU with Yonsei University** – We continue to collaborate with Korea’s premier university and have signed a Strategic Partner Agreement, which will foster greater collaboration in research, teaching, learning and knowledge exchange. "We are firmly in the Asian century with Australia’s future closely interlinked with Asia. This is true of our economic future as well as our research endeavours," says Vice-Chancellor Dr Michael Spence about this historic agreement.
- **IIT Bombay** – Hosted in Mumbai, the partnership involved a workshop and roundtable discussion on nanotechnology for environmental sustainability.
- **IISc Bangalore** – A roundtable discussion was hosted by IISc Bangalore and further collaboration was established.
- **IIT Delhi** – A roundtable discussion was hosted by IIT Delhi.

Sydney Nano has agreements with **3** strategic partners in Asia

Established relationships with **7** institutes across **4** continents

Office of Global Engagement projects and Sydney Nano

There were 10 Sydney Nano members who successfully applied for the Partnership Collaboration Awards this year, enabling collaboration with six world-renowned universities worldwide. These collaborations included one India Development Fund awardee, one Research Alliances awardee and two Travel Grants awardees. The full list is included in the Appendix.

Photos from top: SRI International delegation visit, Yonsei University - University of Sydney Workshop on Nanoscience and Applications in Seoul, SNH visit by Professor Liz Sheffield from University of Liverpool.



Established **14** new collaborations with research groups of the University of Sydney's strategic partners

Welcomed **7** universities at the Sydney Nanoscience Hub

Industry, Innovation and Commercialisation

Creating knowledge for innovation is at the heart of what we do. We believe in working with industry partners to provide the expertise to translate research into a commercial application. Cooperative research between universities and industry provides a mutual opportunity for Sydney Nano and our industry partners.

Partnerships and projects

This year Professor Ben Eggleton (Physics) and Professor Cara Wrigley (Architecture, Design and Planning) launched the Jericho Smart Sensing Lab, a cutting-edge collaboration with the Royal Australian Air Force (RAAF). The laboratory will form a critical part of the RAAF plan and will provide world-leading sensing technology for Australia's defence.

The first Sydney Nano spin-off company, Gelion Technologies, continues to develop cheap, safe and durable zinc-bromine batteries that outcompete lithium-ion technology, and Q-Ctrl was established with the support of global venture capital firms to be a trusted provider of quantum control for all emerging quantum technologies.

The multi-year Microsoft Quantum Computing partnership also continues and is a collaborative effort between Microsoft and academia. By forging this partnership, our researchers are developing quantum computing technology to help revolutionise the future of computing, materials and the economy.

One of our affiliated start-ups, LuciGem Pty Ltd, was successful in joining the Sydney Knowledge Hub and our team assisted with the INCUBATE development of the new 'deep-tech' programming for 2020, which was created to fund up to 15 high-potential start-up teams and is focused on global thinking and talented and motivated students, researchers and alumni.

Additionally, our researchers led by Professor James Rabeau produced a report for the Office of the NSW Chief Scientist and Engineer, which formed the basis for a deeper scoping study on how to grow the semiconductor industry in Australia.

Events

Throughout the year, we offered Sydney Nano members training and networking opportunities in commercialisation and entrepreneurship through a range of events:

- Inaugural Industry and Commercialisation Q&A session with Professor Martin Wegener (co-founder of NanoScribe GmbH and joint department head at the Institute of Nanotechnology, Karlsruhe Institute of Technology)
- Commercialisation and intellectual property training workshop
- CSIRO ON Prime program Q&A session
- Physoc and Sydney Nano industry event
- Sydney Nano-CSIRO-NMI workshop held at the CSIRO Lindfield site



Photo: Industry and commercialisation Q&A session.

2 Sydney Nano Members participated in the CSIRO ON Prime program

1 spin-off joined the Sydney Knowledge Hub

Launch of Plan Jericho
Sensing project with RAAF

Inaugural Industry and
Commercialisation Q&A session

Commissioned scoping study for
the semiconductor industry in NSW

Outreach, Training and Education

Our objectives include undertaking world-class research and development in nanoscience, supporting the education of future generations, and engaging with a range of stakeholders through outreach programs.

In 2019, secondary scholarships were offered to four PhD students studying in the field of nanotechnology and science who have a passion for outreach. Mr Christopher Vega and Ms Jiarun (Veronica) Lin from the School of Chemistry, Mr Pradeep Murthy from the School of Chemical and Biomolecular Engineering, and Mr Pooria Lesani from the School of Aerospace, Mechanical and Mechatronic Engineering were selected as the inaugural Sydney Nano Student Ambassadors.

Under the mentorship of Professor Manjula Sharma, they developed an in-depth understanding of the interdisciplinary nature of nanoscience and its current and potential contributions to society, and were involved in activities that will add to their professional portfolio.



High school visits

Sydney Nano intends to build and establish ongoing relationships with schools and students to promote nanoscience and technology.

In November and December 2019, the Sydney Nano Student Ambassadors designed and presented two workshops, 'nano in food' and 'carbon quantum dots' to five classes of Year 10 students at St George Girls High School. Results from surveys conducted after the workshops show a high level of student engagement, where a majority of students found the workshops interesting and indicated that they would learn more about nanoscience.

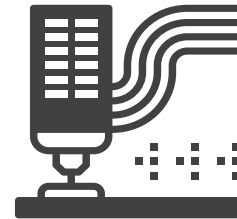
Photos from top to bottom: Sydney Nano team won the global BioMod competition. The victorious FilterPhytes team comprises (from left) Eloisa Bennetts, Donna Win, Oliver Hubbard, Andreas Orsmond, Kavya Mathur and Anh Tu Quang Lam; Sydney Nano Ambassadors presented nano-workshops at St George Girls High School; Nano Lens at the Sydney Science Festival in the Royal Botanic Gardens.

36 students attended the Design Major course: *Design Innovation Studio* featured around our ACWA Grand Challenge



Launch of the multi-disciplinary course: *Introduction to Nanoscience*

300+ attended Sydney Nano public lecture about 3D Nanoprinting



4 secondary scholarships awarded to PhD students to become Student Ambassadors supporting Outreach activities



General public and high school events conducted

Education

Education is at the heart of what we do. Nanoscience and nanotechnology are exciting, modern and rapidly moving scientific disciplines that make noticeable impact for industry and commercial enterprises. Therefore, expanding the number of nano units is a priority for the institute.

Two undergraduate units were led by Sydney Nano members this year:

- the Introduction to Nanoscience (NANO2002) undergraduate course, coordinated by Associate Professor Stefano Palomba
- the Design Innovation Studio (DEC03101) unit with a nanotechnology focus as part of the Design Major, coordinated by ERC Ambassador Dr Karla Straker.

The Nano Lens, founded by Associate Professor Chiara Neto, Dr Chiara O'Reilly and Dr Alice Motion, is a citizen science project to enable the public to explore the nanoscale by looking closely at the details of nature through art and science. In August, the Nano Lens team from the University of Sydney brought the details of Art, Nature and Science into sharp focus as part of Sydney Science Festival at the Royal Botanic Gardens.

BioMod is an international biomolecular design competition that encourages teams of undergraduates from around the world to work together to build "the coolest stuff using the molecules of life". For the third consecutive year, Dr Shelley Wickham led an interdisciplinary team of undergraduates to design, build and test a novel nanodevice for the treatment of cardiovascular disease, and won first place in 2019.

Sydney Nano sponsored the University of Sydney's 2019 Bioengineering Innovation Outreach Challenge where high school students were asked to identify innovative solutions to some of the world's most complex medical challenges.

Public lecture

In April 2019, we invited Professor Martin Wegener from Karlsruhe Institute of Technology, Germany to present at our inaugural Sydney Ideas public lecture. Professor Wegener was in conversation with Professor Hala Zreiqat in relation to her research on the development of engineered material and the use of new 3D printed nanotechnology to improve health outcomes. The event was a great success with over 300 in attendance. We had a diverse audience including school students, general public, university students and senior academics. The event was featured in a full-page spread in the Sydney Morning Herald and a feature interview on ABC Radio Focus, generating pointed and impactful media coverage.

Other engagements throughout the year include:

- STANSW Science Teachers' Association tour
- International Science School (ISS) tour
- Girls in Physics tours
- International Day of Light
- University of California - UCEAP students tour



Photo: Public lecture on Nano 3D printing





Infrastructure and Enabling Capabilities

One of our strategic objectives is to enable access to world-class research infrastructure while maximising the return on the University's investment in state-of-the-art research infrastructure. We are achieving this through facilitating the optimal use of the Sydney Nanoscience Hub; supporting the development and use of the University's Core Research Facilities; facilitating access to the equipment platform by our members; influencing the development of the Western Sydney campus; and gaining access to national and international research infrastructure.

In 2019, we welcomed Dr John Bartholomew's research group to the Sydney Nanoscience Hub. His Quantum Integration Laboratory aims to develop quantum networking solutions to enable more powerful quantum technologies through the long-distance distribution of entanglement.

In addition, user groups at the Sydney Nanoscience Hub have developed a set of "SNH Safety DNA" that reflects our philosophy and values in relation to the safe operation of the building. These include leadership, safeguarding, accountability, continuous improvement and culture.



Sydney Nanoscience Hub hosts:



5

Research groups



3

CRF Facilities



2

Industry partners
(Microsoft, Q-CTRL)

Sydney Nanoscience Hub comprises:



10,000m²

state-of-the-art teaching and learning facilities



32

state-of-the-art nanoscience research laboratories



900m²

ISO Class 5 cleanroom

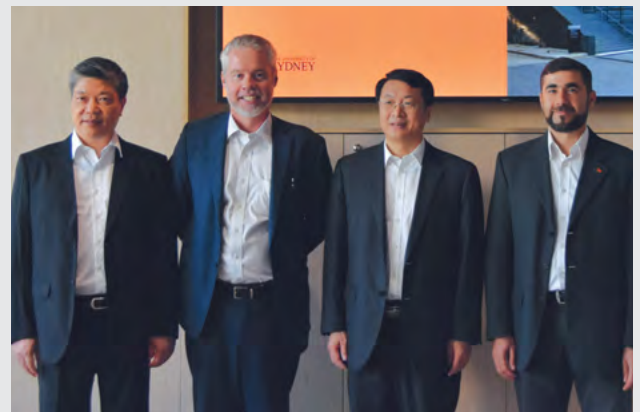
KEY EVENTS

Sydney nano ran a series of wonderful events and hosted many VIP visitors at the SNH, including donors, investors, government officials and international delegations.

- Two town halls
- End of Year Event

- Sydney Nano Annual Retreat
- VIP visits
 - Ms Emma Dowsett, Senior Advisor to the Minister for Better Regulation and Innovation
 - Professor Tanya Monro, Chief Defence Scientist

- Hon Karen Andrews MP, Minister for Industry, Science and Technology
- Mirvac Executives
- His Excellency Mr Zhang Hu, Vice Governor of Guangdong, China



Photos (clockwise from top left): Minister Karen Andrews' visit, His Excellency Mr Zhang Hu and visiting delegation from Guangdong, Town hall, Sydney Nano Annual Retreat, Professor Tanya Monro's visit.

APPENDIX

List of Members

Ahmad Jabbarzadeh, Faculty of Engineering

Alan Boddy, Faculty of Medicine and Health

Albert Zomaya, Faculty of Engineering

Alessandro Tuniz, Faculty of Science

Ali Abbas, Faculty of Engineering

Ali Hadigheh, Faculty of Engineering

Alice Motion, Faculty of Science

Alistair McEwan, Faculty of Engineering

Amandeep Kaur, Faculty of Medicine and Health

Amol Choudhary, Faculty of Science

Andrew Doherty, Faculty of Science

Anita Ho-Baillie, Faculty of Science

Ann Kwan, Faculty of Science

Anna Ceguerra, Faculty of Engineering

Anna Waterhouse, Faculty of Medicine and Health

Anusha Withana, Faculty of Engineering

Arne Grimsmo, Faculty of Science

Asaph Widmer-Cooper, Faculty of Science

Axel Spahr, Faculty of Medicine and Health

Benjamin Goldys, Faculty of Science

Benjamin Brown, Faculty of Science

Benjamin Eggleton, Faculty of Science

Benjamin Carey, Sydney Conservatorium of Music

Brian Hawkett, Faculty of Science

Brian Jones, Faculty of Science

Cameron Kepert, Faculty of Science

Cara Wrigley, The University of Sydney School of Architecture, Design and Planning

Cary Di Lernia, The University of Sydney Business School

Catherine Hardy, The University of Sydney Business School

Catherine Stampfl, Faculty of Science

Catherine Welch, The University of Sydney Business School

Chiara Neto, Faculty of Science

Christopher Ling, Faculty of Science

Craig Jin, Faculty of Engineering

Damien Ricketson, Sydney Conservatorium of Music

Daniel Tan, Faculty of Science

Daniel Yeadon, Sydney Conservatorium of Music

David Hibbs, Faculty of Medicine and Health

David Martinez Martin, Faculty of Engineering

David Wang, Faculty of Engineering

Deanna D'Alessandro, Faculty of Science

Deepak Jain, Faculty of Science

Diana Chester, Faculty of Arts and Social Sciences

Dries Verstraete, Faculty of Engineering

Elizabeth New, Faculty of Science

Fariba Dehghani, Faculty of Engineering

Filip Braet, Faculty of Engineering

Georges Grau, Faculty of Medicine and Health

Girish Lakhwani, Faculty of Science

Gregg Suaning, Faculty of Engineering

Gregory Warr, Faculty of Science

Hak-Kim Chan, Faculty of Medicine and Health

Hala Zreiqat, Faculty of Engineering

Hamid Arandiyan, Faculty of Science

Helen Bramley, Faculty of Science

Hien Duong, Faculty of Medicine and Health

Ivan Kassal, Faculty of Science

Iver Cairns, Faculty of Science

James Der Derian, Faculty of Arts and Social Sciences

James Rabeau, Faculty of Science

Jiao Jiao Li, Faculty of Medicine and Health

Joel Mackay, Faculty of Science

John Bartholomew, Faculty of Science

Jun Huang, Faculty of Engineering

Kanchana Thilakarathna, Faculty of Engineering

Karla Straker, The University of Sydney School of Architecture, Design and Planning

Katrina Jolliffe, Faculty of Science

Lamia Azizi, Faculty of Science

Laurence Macia, Faculty of Medicine and Health

Li Chang, Faculty of Engineering

Lia Bareket, Faculty of Engineering

Liam Bray, The University of Sydney School of Architecture, Design and Planning

Lin Ye, Faculty of Engineering

Lina Markauskaite, Faculty of Arts and Social Sciences

Ling Zhu, Faculty of Medicine and Health

Liwei Li, Faculty of Engineering

Louis Rendina, Faculty of Science

Luming Shen, Faculty of Engineering

Manjula Sharma, Faculty of Science

Marcela Bilek, Faculty of Science

Margaret Sunde, Faculty of Medicine and Health

Maria Rumyantseva, The University of Sydney Business School

Mark Gillies, Faculty of Medicine and Health

Markus Muellner, Faculty of Science

Martijn de Sterke, Faculty of Science

Martina Lessio, Faculty of Science

Mary Tara Christie, Faculty of Science

Maryanne Large, Faculty of Science

Matthew Cleary, Faculty of Engineering

Michael Kassiou, Faculty of Science

Nicholas King, Faculty of Medicine and Health

Omid Kavehei, Faculty of Engineering

Peter Goodyear, Faculty of Arts and Social Sciences

Peter Lay, Faculty of Science

Peter Tuthill, Faculty of Science

Philip Gale, Faculty of Science

Philip Leong, Faculty of Engineering

Ralph Holz, Faculty of Engineering

Ramil Nigmatullin, Faculty of Engineering

Richard Payne, Faculty of Science

Robyn Jamieson, Faculty of Medicine and Health

Ronald Clarke, Faculty of Science

Rongkun Zheng, Faculty of Science

Salah Sukkarieh, Faculty of Engineering

Sergio Leon-Saval, Faculty of Science

Seyed Mirkhalaf (Mohammad) Valashani, Faculty of Engineering

Shelley Wickham, Faculty of Science

Siegbert Schmid, Faculty of Science

Simon Fleming, Faculty of Science

Simon Ringer, Faculty of Engineering

Stefano Palomba, Faculty of Science

Stephen Bartlett, Faculty of Science

Steven Flammia, Faculty of Science

Steven Maguire, The University of Sydney Business School

Stuart Fraser, Faculty of Medicine and Health

Thomas Grewal, Faculty of Medicine and Health

Thomas Maschmeyer, Faculty of Science
 Tihana Divnic-Resnik, Faculty of Medicine and Health
 Tong Li, Faculty of Medicine and Health
 Tony Weiss, Faculty of Science
 Vera Chung, Faculty of Engineering
 Vincent Gomes, Faculty of Engineering
 Wojciech Chrzanowski, Faculty of Medicine and Health
 Xiaoke Yi, Faculty of Engineering
 Xiaozhou Liao, Faculty of Engineering
 Yixiang Gan, Faculty of Engineering
 Yu Heng Lau, Faculty of Science
 Yuan Chen, Faculty of Engineering
 Zdenka Kuncic, Faculty of Science
 Zihuai Lin, Faculty of Engineering
 Zongwen Liu, Faculty of Engineering

Successful Promotion Application

Level E:

Luming Shen, Faculty of Engineering
 Lina Markauskaite, Faculty of Arts and Social Sciences
 Eric Ronald Wing Fai Knight, The University of Sydney Business School
 Chiara Neto, Faculty of Science

Level D:

Alice Elizabeth Motion, Faculty of Science
 Dries Daniel Denis Verstraete, Faculty of Engineering
 Ivan Kassal, Faculty of Science

Level C:

David Wang, Faculty of Engineering
 Tihana Divnic-Resnik, Faculty of Medicine and Health
 Shelley Wickham, Faculty of Science

Level B:

Jiao-Jiao Li, Faculty of Medicine and Health
 Moritz Merklein, Faculty of Science
 Benjamin Leigh Carey, Sydney Conservatorium of Music

Fellowships and Chairs

Marcela Bilek
 – Laureate Fellow
 Ben Eggleton
 – Fellow of Society of Photo-Optical Instrumentation Engineers
 Cathy Stampfl
 – Fellow of Australian Academy of Science
 Hala Zreiqat
 – Fellow of the Australian Academy of Health and Medical Sciences
 – Fellow of the Royal Society of NSW
 Anita Ho-Baillie
 – John Hooke Chair

Awards

Anna Waterhouse
 – Robinson Fellowship
 Alice Motion
 – SOAR Prize
 David Martinez Martin
 – SOAR Prize
 Elizabeth New
 – Prime Minister's Prize for Science
 – USyd Alumni Award
 – Le Fèvre Medal
 – Edgeworth David Medal
 – Alan Sargeson Lectureship
 Hala Zreiqat
 – 2020 Payne-Scott Professorial Distinctions
 – Eureka Prize
 – Order of Australia
 Marcela Bilek
 – 2019 Australian Laureate Fellowship in engineering, information and computer sciences
 Wojciech Chrzanowski
 – Barry Inglis Medal
 – Outstanding Paper Award
 – Sydney Catalyst Funding
 Steven Flammia
 – Pawsey Medal

Shelley Wickham
 – ACIS Lectureship
 Richard Payne
 – RACI Birch Medal
 Anusha Withanage
 – DECRA
 Alessandro Tuniz
 – DECRA
 Ali Hadigheh
 – DECRA

Sydney Fellows

– Amandeep Kaur
 – Martina Lession
 – Zengxia Pei
 – Derrick Roberts

Sydney Nano Publication

Award Recipients

– Markus Müllner, Faculty of Science
 – Karla Straker, School of Architecture, Design and Planning
 – Dipesh Khanal, Faculty of Medicine and Health
 – Ahmed Owais, Faculty of Science
 – Hansheng Chen, Faculty of Science

Sydney Nano ECR Travel

Award Recipients

– Dr Liwei Li, Faculty of Engineering
 – Dr Yu Heng Lau, Faculty of Science
 – Dr Katrina Zenere, Faculty of Science
 – Dr Amandeep Kaur, Faculty of Medicine and Health
 – Dr Diana Chester, Faculty of Arts and Social Science
 – Dr Romain Demur, Faculty of Engineering

Sydney Nano Seminars

– Professor Kai Bong, UK Quantum Technology Hub for Sensors and Metrology
 – Assistant Professor Kotaro Hiramatsu, University of Tokyo

Grand Challenge Seminars/events

– Computational Materials Discovery
 – QUSENT workshop
 – Unlocking the Neural Interface
 – Professor Themis Prodromakis, University of Southampton
 – Professor Paolo Decuzzi, Nanotechnology for Precision Medicine Laboratory, Italian Institute of Technology

- CO₂ Zero
 - Professor Haijun Yu, Beijing University of Technology
 - Professor Wen-Chang Chen, National Taiwan University
 - Professor Robert Scott, University of Saskatchewan
 - Summer School for sustainable manufacturing
 - Professor Wei Liu, Nanjing University
 - Professor Teirui Zhang, Technical Institute of Physics and Chemistry, Chinese Academy of Science
- ACWA
 - ACWA Symposium with Professor Wei Li, Stanford University
- Nanorobotics for Health
 - Professor William Shih, Harvard University
 - Bio-Engineering and Nanoscience (BEANS) Symposium
- Safe-by-design Nanotechnology
 - Professor Igor Sokolov, Tufts University
 - Associate Professor Natacha Hogan, University of Saskatchewan and Professor Steve Maguire, University of Sydney
 - Safe-by-Design Grand Challenge Symposium

OGE Projects linked to Sydney Nano

Partnership Collaboration

Award recipients

- Dr Yixiang Gan - National University of Singapore: Design and Optimisation of Advanced Composite Structures for Infrastructure Protection

- Professor Simon Ringer - Shanghai Jiao Tong University: In-situ TEM investigation on the degradation of perovskite solar cells
- Professor Stephen Bartlett - Shanghai Jiao Tong University: New topological quantum physics on an integrated photonic chip
- Dr Jiao Jiao Li - Shanghai Jiao Tong University: An optimised scaffold for osteochondral tissue regeneration designed through feedback system control
- Associate Professor Jun Huang - Zhejiang University: Nano-Photocatalysts for urban air environment restoration
- Professor Mark Gillies - Zhejiang University: Novel approaches to advance the research on human macular degeneration
- Dr Ivan Kassal - UC San Diego: Quantum simulators for photochemistry
- Associate Professor Wojciech Chrzanowski - Yonsei University: nanoJECT - light-thrusted needleless injections for pain-free cannabinoids delivery
- Professor Catherine Stampfl - Yonsei University: Design principles for engineering novel nano-catalysts for carbon dioxide activation and transformation
- Associate Professor Elizabeth New - University of Edinburgh: Fluorescent sensors for super-resolution microscopy to revolutionise the imaging of neurodegeneration

India Development Fund awardee

- Associate Professor Vincent Gomes - Indian Institute of Technology, Bombay: Quantum dot enabled biopolymer composite in 3D printed microneedles for enhanced therapeutic delivery

Research Alliances

- Professor Hala Zreiqat - Indian Institute of Technology, Madras: Multifunctional Chiral Plasmonic Nanoparticles For Photodynamic Therapy

Travel Grants

- Professor Catherine Stampfl - Shanghai Jiao Tong University: Search for Two-dimensional Anti-ferromagnetic Metallic Materials
- Dr Ling Zhu - Shanghai Jiao Tong University: CYP4V2-associated Bietti's crystalline dystrophy

SNH tours & engagements

Academic Partnererhips

- Professor Liz Sheffield tour
- Sorbonne University visit
- SRI International tour
- Beihang University visit
- Architectus & Flinders University visit
- Combined Physics poster day (USyd, UTS, Macquarie, UNSW)

Outreach

- STANSW Science teacher association tour
- International Science School (ISS) tour
- Girls in Physics tours
- International Day of Light
- University of California - UCEAP students tour

Others

- DIN (Defence Innovation Network) visit
- Professor Xiang Zhang visit
- Project Q Hub tour
- CNRS (National Centre for Scientific Research) tour of Sydney Nano & Eggleton Lab
- Mirvac Executives visit
- US Office of Naval Research visit
- Pearcey Centenary Celebration



The University of Sydney Nano Institute
Sydney Nanoscience Hub (A31),
Physics Road
The University of Sydney, NSW, 2006,
Australia
+61 2 9036 9050
sydneynano.admin@sydney.edu.au
sydney.edu.au/nano

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