Australian Research Council Centre of Excellence in
exciton science

Strategic Plan
22–24

Contents

Vision

A sustainable world made possible by Australian-led research, knowledge and technology.

Mission

To discover better ways to manipulate the way light energy is absorbed, transported and transformed in advanced molecular materials.

Future of Exciton Science

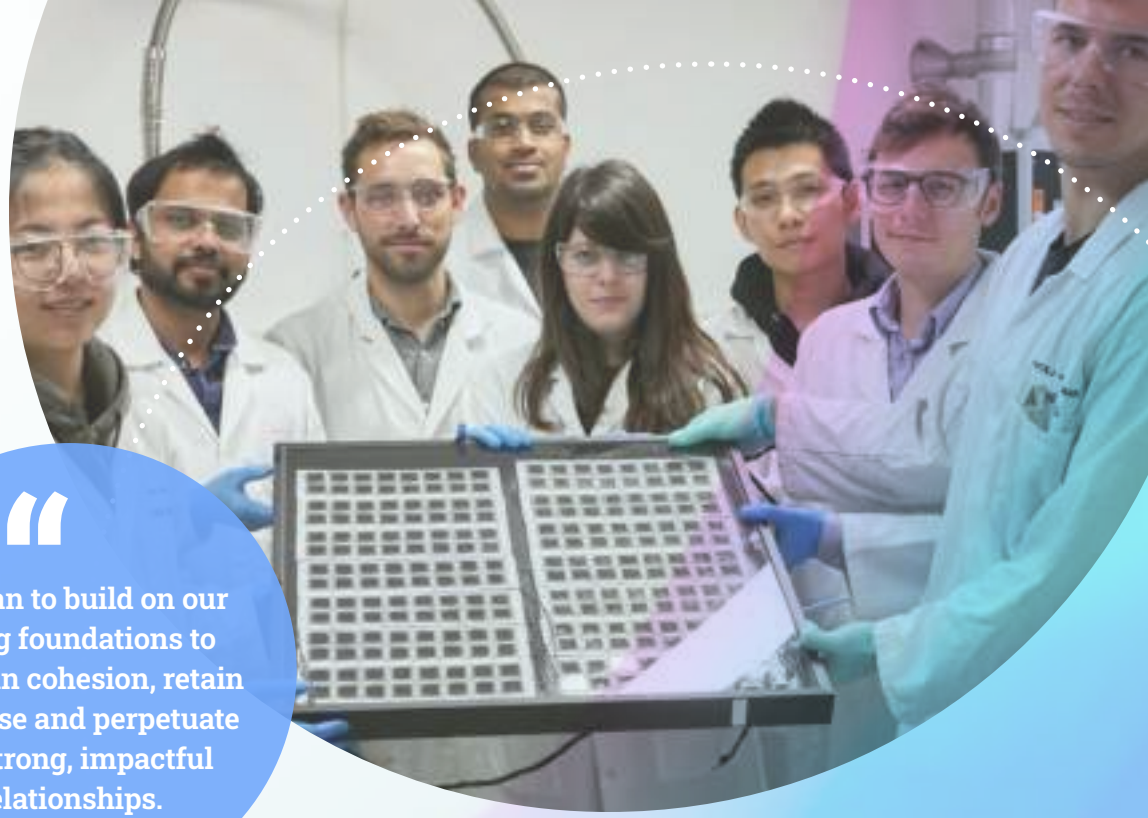
Exciton Science is now a mature organisation built on strong collaborations and with a diverse, dynamic membership.

We have key strengths in:

- Advanced molecular materials and systems;
- Light harvesting, energy transfer and conversion;
- Optical sensing and novel optical security features;
- High impact, interdisciplinary research.

The Centre and its members have developed new technologies, expertise, infrastructure and capabilities that will define our legacy as a landmark vehicle for advancing Australia's fundamental understanding of the processes that govern new and emerging energy technologies.

In doing so, we will have trained the next generation of researchers and innovators in the energy and advanced materials sector, and equipped them to have a transformative impact on academia, the renewable energy industry and associated sectors.



> **We plan to build on our strong foundations to maintain cohesion, retain expertise and perpetuate our strong, impactful relationships.**

In this updated strategic plan, we set clear pathways to achieving further success in our stated areas of expertise.

We plan to build on our strong foundations to maintain cohesion, retain expertise and perpetuate our strong, impactful relationships.

Exciton Science's mature capacity now significantly exceeds the expectations and remit of a newly established Centre of Excellence.

As such, the Centre is identifying new directions for our leadership teams, seeking independent advice and acquiring further research development support.

We are creating mechanisms for interested parties to develop and progress ideas in collaboration with our members and existing partners.

Identified Opportunities

New Centre of Excellence bids

Existing members and associates may form small, cohesive teams to explore grand challenges in photochemistry, semiconductors, and near/mid-infrared materials. This could involve combining our high-achieving Research Fellows and established Associate Investigators to create new Chief Investigator teams.

Australian Renewable Energy Agency (ARENA) bids

Existing members and associates are building on the foundations in photovoltaic research conducted within the Centre to establish new projects, programs and Centres funded through ARENA.

New submissions to the Industrial Transformation Research Program

Teams featuring established industry partners and developed technologies will take their outcomes from Exciton Science to the next technology readiness level (TRL), and work to develop scaled-up technologies and prototypes through Research Hubs. They will seek to upskill the next generation of industry-ready graduates through the establishment of Training Centres.

Venture Capital and Angel Investment

Small, entrepreneurial teams of graduates and research alumni will take their innovative technologies to market. External consultants will provide objective and comprehensive analysis of market potential and TRLs. Our newly established Industry Advisory Board will provide connections and help us advocate for the success of these technologies as competitive Australian businesses.

Discovery and Linkage Program Grants

Small teams will build up new fundamental research ideas through the Discovery scheme to perpetuate and progress their established collaborations, or strengthen productive industry collaborations through the Linkage scheme with our Connect Program partners.

Involvement in International Grant Opportunities

Look beyond the Australian funding schemes and participate in leading international initiatives.

Support Mechanisms

To ensure our teams have every chance of success and can continue the important work begun within the Exciton Science framework, we will capitalise on the following resources:

Advisory Boards

The members of our advisory boards are among our most valuable resources. Currently, we have an International Scientific Advisory Committee, a Centre Advisory Board, and a newly formed Industry Advisory Board.

These groups are tasked with providing specific advice, informed by their world-class expertise, on the direction of the Centre and its operations and legacy beyond the agreed funding period.

Beyond the existing groups, a further group of independent and objective advisors will be convened to guide any new teams being established to pursue our emerging grant opportunities.

Networking

In the final years of the Centre's agreed ARC funding period, we will instil a specific focus on the future in our meetings, workshops and seminars. We will invite our world-leading international collaborators to visit Australia and attend these events. We will run international workshops with our colleagues in Japan, Germany, the UK, USA and elsewhere.

In November 2023, the Centre will host the Asian and Oceanian Photochemistry Conference for the first time in Australia. This will bring collaborators from all over the world to these shores and allow us to showcase the best of what Exciton Science has achieved.

Administrative Support

The Centre will provide administrative support to all teams who wish to pursue any of the pathways listed above. This support will be provided in the forms of grant development, compliance, access to independent advisors, writing and editing assistance, data entry and cleaning, as well as organisation of research development meetings and events.

Centre Strategy

Pursue continued **Research Excellence** in new and emerging technologies in renewable and light-driven energy, and collaborate with world-leading academics to tackle the most significant and challenging research problems.

Expand and accelerate **Industry Engagement** to foster valuable relationships with representatives of industry, develop innovation in solar energy technology, lighting, and security systems, and train the next generation of researchers.

Research Excellence

Each of our Centre's research themes is broken into multiple platforms designed to achieve specific targets and goals as set by the multi-institutional research teams. Detailed approaches and expected outcomes are recorded in Centre platform research plans to measure success and are annually reviewed by our Centre's Science Committee and International Scientific Advisory Committee. The research teams then update and refocus their goals to ensure that the Centre is meeting its research objectives.

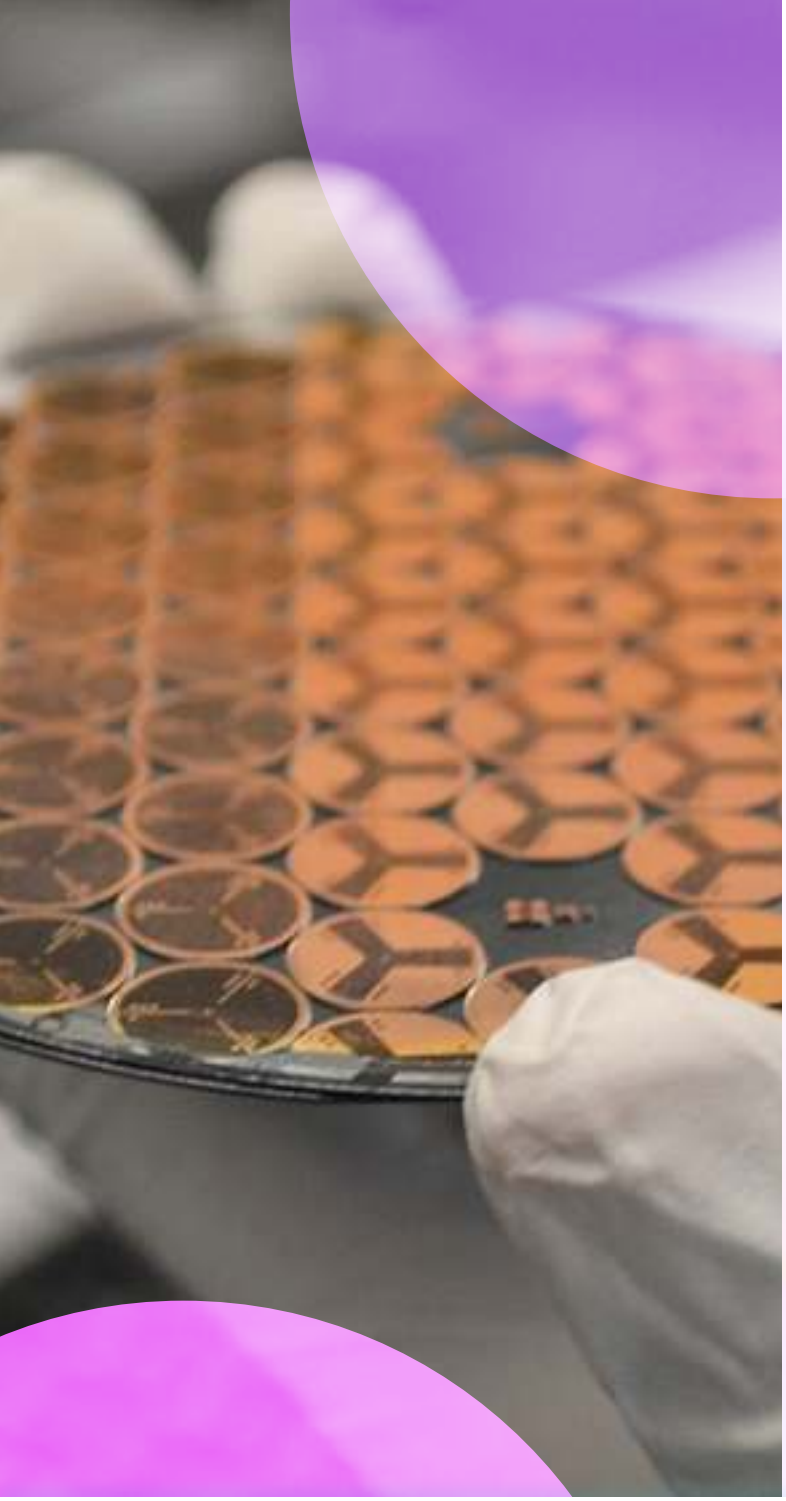
Research Excellence

Theme 1: Excitonic Systems for Solar Energy Conversion

We are building the ultimate light-harvesting system by efficient conversion and transport of excitons.

Currently, the fundamental maximum theoretical efficiency for conversion of light into current for a single solar cell, called the Shockley-Queisser (SQ) limit, is approximately 30% for silicon-based technology. One key focus of activities in Theme 1 is to design hybrid solar cell systems which can surpass the SQ limit. This involves spectral and spatial manipulation of the solar spectrum, with downshifting and upconversion to compress broadband sunlight into a narrow band for efficient harvesting by next-generation, solution-processed excitonic solar cells.

Globally, 95% of the solar cell market is dominated by silicon photovoltaics. This theme is exploring novel materials and device architectures that can go beyond conventional silicon solar cells in terms of their cost, form factor and function. In particular, key focus areas include printable perovskites solar cells, solar window technologies and back-contact perovskite devices.



Research Excellence

Theme 2: Control of Excitons

Realising control over excitons to build new excitonic devices and technology.

Through theory, advanced spectroscopic analysis and new materials, we are getting better understanding and control of the four dimensions of an exciton: Energy, Lifetime, Position and Spin/Polarisation. The outcomes of this theme include new ways to coherently control excitons, new excitonic materials, nanostructure controlled excitonic motifs and new theories of exciton transport.

Excitons are short-lived electron-hole bound pairs which are created when a light particle (photon) interacts with an atom, molecule, nanocrystal or polymer. The conversion of light into electrical energy (in solar cells) and electrical energy into light (LEDs) occurs via excitonic processes, and understanding their properties is essential to the development of new materials that have a higher light-to-electrical-energy conversion efficiency (and vice versa).

In Theme 2 we seek to understand the fundamental processes that govern exciton generation, lifetime and transport across different length scales. A key result of Theme 2's research is to unify the theoretical and computational techniques developed in the physics community with the understanding and development of novel molecular systems developed in the chemistry community.

Research Excellence

Theme 3: Excitonic Systems for Security, Lighting and Sensing

Manipulation, detection and use of light through excitonic materials are key concepts that will enable a raft of future technologies.

The overarching mission of this theme is to design and create materials with properties specifically defined for target applications that are relevant to industry. The Centre has worked closely with our core partners in this theme – Defence Science and Technology Group, Reserve Bank of Australia and CSIRO – and has achieved significant targets and milestones including:

- The development of new materials for toxic-chemical sensing,
- fabrication of blue-emitting quantum dot light-emitting diodes;
- and creating new materials for document securitisation.

A Grand Challenge goal in this theme is to build an electrically pumped organic polariton laser, which would be significantly more energy efficient than existing technology and have transformative potential across research and industry.

Succession Planning

Continuity of Leadership

Exciton Science understands that leadership originates in many different forms within the Centre. Our committees rotate membership every two years at minimum. The rotating membership of each of our committees, from Executive and Advisory Boards, through to our ECR and student committees, provides opportunities for a range of members to play their part in leading and shaping the Centre's direction and programs. This provides members with valuable experience and equips them to step into vacated formal leadership roles at short notice.

If one of our key leaders resigns or takes an extended leave of absence from the Centre, Exciton Science has developed the following plan to ensure continuity of the operational and research programs of the Centre:

Director

If the Centre Director leaves or resigns from Exciton Science or The University of Melbourne, an interim Director will be appointed from one of the four Deputy Directors and Executive Board members. The University of Melbourne will then conduct an international search for a replacement Director, with suitable research and leadership skills, to be appointed within the Faculty of Science at the University of Melbourne. In the instance that the Director takes an extended period of leave, one of the Deputy Directors will take up the role of Acting Director in their absence.

Chief Operating Officer

If the Centre's Chief Operating Officer (COO) is to resign or take an extended period of leave from their position, The University of Melbourne will conduct a university-wide search for a suitable interim COO with appropriate experience in handling major projects and understanding of the ARC organisational structure and requirements in a professional secondment role. If the COO does not intend to return, the University will then conduct a recruitment round to ensure the position is filled until the end of the Centre. In the meantime, the Centre has built an expert team of research administration professionals who work closely with the COO on all aspects of business operations. The Centre Coordinator, Centre Finance Manager, Media and Communications and Outreach Officers and the Science and Industry Liaison Manager will all ensure business as usual continues in the COOs absence.

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Succession Planning: Continuity of Leadership

Chief Investigators

If one, or more, of the Centre's Chief Investigators (CIs) is to leave the Centre, or become ineligible to hold the role, the Centre requires under the Centre Participants Agreement that the relevant University must notify the Centre Executive, within 7 days of the eligibility status becoming known, of the CIs intent to be removed as a CI. All remaining funding is to be held on trust by that University, until a new funding agreement can be negotiated with all other parties. The Centre Executive, at their sole discretion, may decide whether to recruit a new CI to the Centre to carry out the strategic research goals of the Centre or to redistribute the funding across the remaining CIs, or any other such purpose as to further the strategic goals of the Centre.

Research Platform Leaders

Each of the Centre's Research Platforms has both a Platform Leader and a Deputy Leader. Some Platforms also have senior postdoctoral fellows in Platform Co-Ordinator roles. Each of these roles is involved in the everyday organisation and co-ordination of the research platforms, so that at any time they can be relied upon to maintain business as usual if one of those in the role is unable to perform their duties. Additionally, the way in which the Centre's research platforms are structured means that another CI working within this area can be relied upon to fill a vacant position and maintain continuity if a CI resigns or needs to undertake an extended period of leave.

Leadership Preparedness

The Centre offers leadership training opportunities to our CIs as well as Associate Investigators (AIs) in the form of Australian Institute of Company Directors training, mentoring for major grant writing and leadership positions, as well as supporting applications to the science academies both in Australia and internationally.

Succession Planning: Continuity of Leadership

Funding Support

Exciton Science provides funding support to our AIs and Early Career Researchers (ECRs) through the Exciton Science Research Support Fund, and the Associate Investigator Support Fund. These funding schemes allow the Centre to redirect strategic Science Committee funding through our CIs to work on projects with our AIs and ECRs. This gives our AIs the opportunity to pursue further research and collaborative projects with the Centre and our ECRs the opportunity to develop, explore and drive small research projects that serve the strategic research directions of the Centre, but which would not necessarily have arisen with the business-as-usual research scope. These projects so far have led to new discoveries and new directions, and have given our AIs and ECRs a stronger connection to the Centre.

Mentoring Programs

At Exciton Science we offer a Centre-wide mentoring program which rotates each year. We give all students and ECRs the opportunity to nominate a more senior member as their mentor for the year, and then we match every member within a mentoring relationship. The program has been successful and was especially beneficial during the COVID-19 pandemic lockdowns, when members were unable to meet in person for an extended period of time. The Centre also offers regular group mentoring sessions, during which members are given the opportunity to meet and discuss a number of different issues that affect them, ranging from how to understand and work within industry relationships, to tactics for maintaining research momentum amid external disruption.

Fellowship Development and Support

We will encourage those graduate students and postdoctoral research fellows who wish to pursue a career in academia to identify relevant fellowship opportunities here in Australia and internationally.

By providing development support and training for writing applications, as well as access to mentoring and advice from successful researchers in their fields, our members will be given the tools they need to succeed.

We will also work with our international partners to identify candidates and support and mentor our members through applications to international fellowships, to ensure our researchers have every opportunity to pursue their careers overseas.

Industry Engagement

In developing our strategy in response to this recommendation, we:

- **reviewed how we are preparing Centre personnel for ongoing career readiness;**
- **focused on how to protect and leverage intellectual property generated in the Centre;**
- **and determined how to better promote and maintain the Centre's legacy.**

In understanding what we wanted to achieve by engaging with industry partners, and leveraging our Exciton Science Connect Program, our industry liaison, outreach, and comms-related personnel, we developed the following strategy:

Engage

Hold Connect Program workshops to arrange for industry representatives to address Centre members, and provide space for networking.

Visit industry partners onsite and invite them to our labs to discuss projects, problems, and identify how we can work with them to help them achieve their goals.

Identify

Understand the needs of our industry partners through collaboration and networking opportunities.

By utilising our Science and Industry Liaison Manager, we can identify the research groups who can investigate industry problems and work with them to create proof-of-principle concepts.

Establish

Establish and cement Connect Program relationships through formal contract research agreements and by using internal funding mechanisms.

If applicable, utilise existing contractual mechanisms at node universities to formally establish projects, cross funding of students and postdocs, and other contractual research.

Industry Engagement

Utilise

The Exciton Science Connect program offers funding for seed project grants to work with our industry partners as well as funding for short term (3-6 month) industry internships.

Leverage other external funding opportunities, such as research connect grants and internal funding opportunities to develop proof-of-principle solutions and identify feasibility of scale up.

Promote and advocate

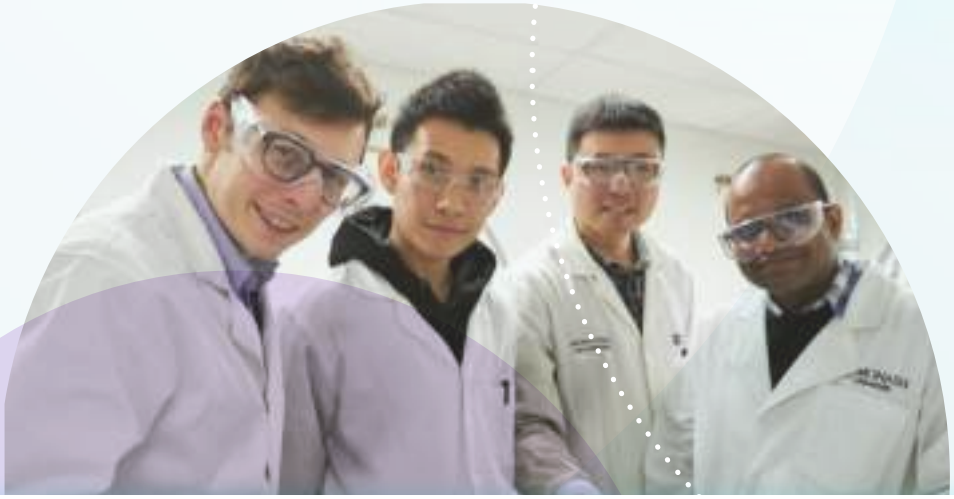
Celebrate successes and utilise media, communication and outreach teams to communicate to stakeholders and the public.

Education and Training for Job Readiness

We have developed a learning strategy which has a ratio of on-the-job, collaboration-based and formal training. In assessing the skills landscape of our ECRs and students we considered:

- **where we can improve performance;**
- **where there were skills gaps;**
- **and what skills would be needed for future roles.**

The Centre strategic plan for the training and development of our staff and students has a multi-pronged focus which will provide training opportunities in the following areas:



Skills and employability

Practical skills training – including project management, risk assessment, financial management, and intellectual property management.

Framing skills for industry workforces – identify skills gaps, differences in academic vs industry-based work, team building and collaborative skills.

Modelling employment pathways – what are the potential career pathways for graduates? How do they get there? Demonstrate through mentoring programs and industry speakers/visitors, establish industry collaborative projects for on-the-job experience.

Writing for different audiences – reports, industry, and stakeholder presentations.

Communication

Communications skills are integral for future roles. We will offer formal training in communicating to different audiences and with influence, developing confidence in public speaking, and communicating with media.

Science

Technical training skills – including a range of online and in-person tutorials on technical skills, such as coding, machine learning, DFT, LateX, etc.

Work experience program – giving postgraduate students supervision experience. Industry and Stakeholder Awareness.

Industry Engagement: Education and Training for Job Readiness

Industry and Stakeholder Awareness

We will invite external speakers from industry and other government research organisations, including our alumni working to bridge the gap between university research and industry/commercialisation, to talk about their sector problems and collaboration expectations.

Mentoring

Continue to facilitate mentorships across all Centre members and expand to include our new Partner and Associate Investigators, alumni, and other stakeholders as they become more involved in the Centre. Additionally, we will provide opportunities and motivation for Centre members to mentor relevant external colleagues and associates.

We will also provide forums for group mentoring sessions at quarterly seminars and the Centre annual workshop.

Commercialise

We will promote and encourage involvement in programs such as CSIRO On Prime, Hackathons etc, and run activities and normalise conversations around commercialisable opportunities and vocational pathways.

Measure and Review

The Centre will continue to conduct an annual membership survey to gauge members' impressions, experiences and thoughts on how the Centre is running and the opportunities it provides.

At the beginning of each year, in preparation for a new round of mentoring, we will survey Centre members to assess and refine the Centre mentoring program. Assess where barriers are formed within relationships and provide advice on how to overcome these for the next round of matches.

We will seek feedback on training offerings, including externally held training opportunities, to assess where the best added value and most beneficial experiences are occurring. We will ask past participants to speak at Centre events about their experiences and encourage other members to take up opportunities in the future.

Our research platforms are reviewed annually through our Science Committee and also present directly to the International Scientific Advisory Committee to provide feedback on operations, focus and progress.