

Conference Program

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Welcome from the Director

It is my great pleasure to welcome you to Hobart for the 2026 TMOS Meta Together Conference.

Our annual conference is always a highlight of the TMOS calendar. It is an opportunity to step away from the busy laboratories and daily commitments, come together as one Centre, celebrate our achievements, exchange ideas and strengthen the collaborations that make TMOS such a vibrant research community.

As we approach the final stages of our Centre's journey, this year's gathering carries particular significance. Over the past six years, we have built an extraordinary community of researchers, students, industry partners and professional staff across five universities, united by a shared ambition to transform the way we generate, manipulate, and detect light.

Together, we have pushed scientific boundaries, developed exciting new technologies, forged valuable partnerships and taken important steps towards translating our discoveries into real-world applications. Just as importantly, we have nurtured a new generation of researchers and created connections that will continue well beyond the life of the Centre.

The Meta Together 2026 program reflects both the breadth of our research and the strength of our community. We look forward to outstanding presentations from our international and Australian invited speakers, exciting research updates from across our nodes, and opportunities to explore new ideas and collaborations.

I am pleased to see our continued emphasis on research translation and innovation, including the DRAGO(n)'s DEN, where entrepreneurial thinking and scientific creativity come together.

Our poster sessions, career discussions, professional development, and IDEA activities are equally important, reminding us that scientific excellence is built not only on discovery, but also on people, opportunity and an inclusive and supportive research culture.

Of course, Meta Together is about much more than the formal program. Some of our most valuable ideas and collaborations begin over a coffee, during a shared meal or through a conversation with someone working in a different field. I encourage everyone, particularly our students and early-career researchers, to make the most of these opportunities, ask questions, share ideas, and build new connections.

Our Gala Dinner and Awards evening will also give us a wonderful opportunity to recognise the exceptional contributions of our colleagues and celebrate the talent, dedication and generosity that underpin the success of TMOS.

I would like to sincerely thank our Conference Chairs, Professor Madhu Bhaskaran and Professor Kenneth Crozier, the Organising Committee, our Business Team, and everyone who has contributed to bringing this event together.

My thanks also go to our invited speakers, presenters, and guests for sharing their expertise and enriching our discussions.

I acknowledge the Traditional Custodians of the land on which we gather, the muwinina people, and pay my respects to Elders past and present.

I hope the next few days will leave you inspired by the science, energised by new ideas and, above all, reminded of the remarkable community we have built together.

Enjoy the conference, the conversations, and the beautiful surroundings of Hobart!

Professor Dragomir Neshev



Welcome from the Conference Chair

On behalf of the Conference Organising Committee, we are delighted to welcome you to beautiful Hobart for Meta Together 2026!

After months of planning, preparation, and anticipation, it is wonderful to see everything come together. We have an exciting few days ahead, filled with fascinating science, fresh perspectives, lively discussions and, we hope, a few surprises and plenty of laughter along the way!
In putting together this year's program, we wanted to create an event that offers something for everyone - whether you are presenting your latest research, exploring ideas beyond your own field, considering your next career move or simply looking forward to catching up with colleagues from across the Centre.

We welcome our distinguished invited speakers and look forward to the diverse range of presentations showcasing the latest advances in meta-optics and related technologies. With poster sessions, DRAGO(n)'s DEN, career discussions and professional development activities, there will be no shortage of opportunities to learn, participate and be inspired.
And because a great conference should be as enjoyable as it is intellectually stimulating, we have also made room for some lighter moments! From team-building activities to our Gala Dinner and Awards evening, we hope there will be plenty of opportunities to relax, have fun and enjoy each other's company.

Hobart provides a wonderful setting for this year's gathering, and we hope you will have a chance to experience some of its charm, beautiful surroundings, and famous hospitality.

Of course, none of this would be possible without the enthusiasm, hard work, and generosity of so many people.

Our heartfelt thanks go to everyone who has contributed to bringing Meta Together 2026 to life.

Professor Madhu Bhaskaran and Professor Kenneth Crozier
On behalf of the Meta Together 2026 Organising Committee

Olga Bazaka, Eleanor Bowles, Peter Elango, Julie Leroux, Mariusz Martyniuk, Liz Micallef, Dragomir Neshev, Toby Severs Millard, Galina Shadrivova, Hoe Tan, Krisztina Thurzo.





Conference Program

	Time	Event
Tue 10th November		
Rivera Room	11:00	TMOS Planning Day Chief Investigators, Research Program Managers and Flagship Program Managers only
Green Room Bar	16:00	Registration
Wrest Point Front Lawn	18:00	Welcome to Country - NITA Education
Green Room Bar	18:30 - 21:00	Welcome Function

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Time	Event
Day 1 **Wed 11th** **Derwent Room**	Self Organised Activities Beach walk/ Yoga/ Swim
9:00	Welcome comments - Dragomir Neshev, Madhu Bhaskaran & Kenneth Crozier
9:30	**Team building activity - Experiential Edge** The Sandy Bay Quest, A team adventure in the streets and parks of The Bay
11:00	MORNING TEA
Session 1 *Chair:* *Lincoln Clark*	
11:20	Invited: Willie Padilla (Duke Uni), "Autonomous Agentic Frameworks for the End-to-End Inverse Design of Electromagnetic Metamaterials"
12:00	Tuomas Haggren (ANU), "All-optical Active Terahertz Metasurfaces for Ultrafast Polarisation Control"
12:15	Oleg Kameshkov (ANU), "Development of Terahertz Meta-Optical Components for Polarisation Control: Polarisers and Waveplates"
12:30	Tongmiao Fan (ANU), "Tailored quantum states from nonlinear metasurfaces"
12:45	Wei Wen Wong (ANU) & Yiyang Cui (UniMelb), "Coupling black phosphorus emission with bottom-up III-V microring cavities for mid-infrared lasing"
13:00	LUNCH
Session 2 *Chair:* *Fahia Munna*	
14:00	Invited: Heike Ebendorff-Heidepriem (Adelaide University), "Specialty optical glasses and fibres: a powerful platform for the exploration of new concepts and applications"
14:40	Farid Khoshkhati (UniMelb) & Dr Yana Izdebskaya (ANU), "Active Colour Tuning of Dielectric Mie voids using Liquid Crystals"
14:55	AFTERNOON TEA
Session 3 *Chair:* *Yang Yu*	
15:15	Phuong Le (RMIT), "Non-volatile tuning of Fano resonances in a phase-change"
15:30	Gurpreet Singh Gill (UWA) "Resolution-Enhanced Spectral Reconstruction Using MEMS Fabry–Pérot Filters"
15:45	EPD Committee activity - Panel Discussion - Moderator: Toby Severs Millard
16:45	POSTER SESSION
18:30	DINNER - LONGHORN RESTAURANT

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Day 2
Thu 12th

Derwent Room

Time	Event
	Self Organised Activities Beach walk/ Yoga/ Swim
9:00	DRAGO(n)'s DEN
10:30	MORNING TEA
11:00	IDEA Committee activity part 1 - Introduction to Cultural Capability workshop - Olga Bryukhovets
12:00	LUNCH
Session 4 *Chair: Rohini Ramachandran* 13:00	IDEA Committee activity part 2
14:15	Invited: Sejeong Kim (SKKU), "Structured light and chiral photonics"
14:55	Jiajun Meng (UniMelb), "Snapshot MWIR Polarimetric Imaging Enabled by a Metalens"
15:10	Chaohao Chen (UTS) & Yang Yu (ANU), "Filter-free multidimensional eSWIR vision via in-sensor encoding in nanosheet-array photodiodes"
15:25	AFTERNOON TEA
Session 5 *Chair: Taskil Dastoor* 15:45	Invited: Kristinn Gylfason (KTH), "A guide to the design and packaging of silicon photonic MEMS"
16:25	Wenwu Pan (UWA), "Metalens-Integrated MWIR HgCdTe Detectors for High Operating Temperature: Front- and Back-Illuminated Architectures"
16:40	Wenyi Li (FSU Jena), "Reflective Diffractive Optical Neural Network with Metasurfaces"
16:55	FREE TIME
19:00 – 23:00	GALA DINNER & AWARDS - WATER FRONT ROOM

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Time	Event

Day 3

Fri 13th

Derwent Room

Self Organised Activities
Beach walk/ Yoga/ Swim

Session 6

Chair: Srishti

9:00	Outreach Committee update
9:30	Invited: Mark Brongersma (Standford) "The Future of Metamaterials is Soft"
10:10	Deepanshu Chaudhary (ANU), "Nanowire Breath Sensors for Metabolic Health Diagnosis and Monitoring"
10:25	MORNING TEA

Session 7

Chair: Ziwei Yang

10:45	Invited: Irina Kabakova (UTS), "Brillouin and quantum imaging"
11:25	Rohini Ramachandran, (RMIT) "Portable Multi-Wavelength Optical Sensor for Decentralised Haemoglobin Testing"
11:40	Awards & Closing
12:00	LUNCH

Important Information

Please Direct your email enquiries before, during, or after the conference to tmos@anu.edu.au.

On Site Contact Details - Conference Organising Committee

- Olga Bazaka, Chief Operations Officer
- Liz Micallef, Events Coordinator
- Eleanor Bowles, Inclusion, Diversity, Equity and Access (IDEA) Officer
- Julie Leroux, Centre Coordinator
- Krisztina Thurzo, ANU Node Administrator

Communication During the Conference

Please use our Conference Slack channel for all communications. Members of the Conference Organising Committee can be contacted via the Slack channel.

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WREST POINT LAYOUT MAP



Invited Speakers

Professor Irina Kabakova

Brillouin and quantum imaging

University of Technology Sydney, School of Mathematical and Physical Sciences, Harris Street, building 4, Sydney, NSW, 2007

Label-free optical spectroscopies and imaging techniques are becoming increasingly popular for characterisation of live cells and tissues due to their non-contact and non-destructive nature to capture structure and physical properties of living matter. The growing evidence suggests that any form of exogeneous labelling perturbs the natural biological processes in cells and tissues and degrades the vitality of the sample, reaffirming the importance of developing high-sensitivity and specificity label-free imaging methods. In this talk, I will introduce two modes of label-free spectroscopic imaging my team established at the University of Technology Sydney: Brillouin microscopy and quantum mid-infrared (MIR) spectroscopic imaging. Brillouin microscopy is used for micromechanical mapping of living tissues, cells and biomaterials, while quantum mid-IR spectroscopy allows to reduce complexity and cost of instrumentation by shifting the detection and excitation wavelength range to visible wavelengths where many cheap and reliable equipment choices exist. Thus, together these two techniques can completement conventional toolbox of optical imaging methods, without the use of labels but with preserving a high degree of specificity in terms of mechanical and chemical contrast, respectively.



Dr Irina Kabakova is a Professor in Optical Physics with the School of Mathematical and Physical Sciences, UTS. She specialises in developing novel microscopy techniques based on Brillouin light scattering that can be directly applied to map local compressibility and viscoelasticity of cells and tissues at the microscale. She also has interests in photonic integration and miniaturisation of imaging setups that will enable translation of laboratory techniques towards clinical use.

Irina is an alumna of Moscow State University (2004-2007), where she did her Masters Degree in nonlinear optics, and the University of Sydney (2008-2011) where she undertook her PhD in nonlinear optics, high-Q cavities and all-optical switching. Irina held various research positions at the University of Sydney, Nanoscience Centre AMOLF in Amsterdam, and Imperial College London before moving to UTS in 2017.

In 2018, Irina received a prestigious Australian Research Council Discovery award to construct the first in Australia Brillouin Imaging (BI) Facility and study application of BI to understanding mechanobiology of bone and lung cells. This research aims to explain how pathological processes within these biological systems alter their micromechanical properties and apply BI as a diagnostics tool for various human diseases and conditions.

As a dedicated educator, Irina has contributed to the development of several teaching programs for UTS's Bachelor of Science in Physics degree (Optics, Medical Devices and Diagnostics, Medical Imaging Technology). She is a core member of the Institute of Biomedical Materials and Devices (IBMD@UTS). To date, she has attracted a combined total of over $70m in research funding – a major achievement in a relatively short scientific career. She is a Chief Investigator in the Australian Research Council Centers of Excellence in Quantum Biotechnology (QUBIC) and Optical Microcombs for Breakthrough Science (COMBS).

In 2022, Irina received the Australian and New Zealand Optical Society (ANZOS) Award for Mid-Career Scientists and the Mid-Career Researcher Award from UTS in 2023. She has published widely in top tier journals and books including Nature Methods, Nature Communications, Small and Biofabrication. She has also been a keynote, plenary and invited speaker at conferences in Australia, Europe and USA.

Professor Kristinn Gylfason

A guide to the design and packaging of silicon photonic MEMS

Microsystem Technology Laboratory, School of Electrical Engineering, Royal Institute of Technology (KTH), Osquldas väg 10, SE-10044 Stockholm, Sweden

Photonic integrated circuits (PICs) promise to be the optical equivalent of electronic integrated circuits (ICs). However, current PICs fall far short of electronic ICs in terms of the number of devices per chip. One roadblock is the power consumption and the footprint of active photonic components. By micromechanical (MEMS) actuation of PICs, we show many orders of magnitude reduction in power consumption compared to current thermo-optic counterparts. We demonstrate our approach by implementing tunable MEMS-based photonic devices, such as phase shifters, couplers, and wavelength filters. We realize our technology on a silicon photonics foundry platform and show complex circuits on a small chip. Furthermore, we show wafer-level vacuum sealing of the silicon photonic MEMS circuits.



Kristinn B. Gylfason received the title of Docent in Micro- and Nanosystems in 2015 and the PhD degree in Electrical Engineering in 2010, both from KTH. He received the MSc and BSc degrees in Electrical Engineering from the University of Iceland in 2003 and 2001, respectively. In the spring term of 2002, he did an exchange at the University of California, Santa Barbara, USA.

From 2003 through 2005, he was a research engineer at Lyfjathroun Biopharmaceuticals, Iceland, and in 2005 he received the Steinmaur Foundation nanotechnology graduate study scholarship. He received the Göran Gustafsson Young Researcher Price as well as the largest Young Researcher grant awarded by the Swedish Research Council to KTH in 2011. During spring 2013, Kristinn was a visiting post-doctoral scholar at the Photonics Group, Ghent University, Belgium.

Kristinn Gylfason is researching nanophotonics and how they can enhance our environmental monitoring and communication systems. The localization of hidden sources of greenhouse gas emissions, such as carbon dioxide and methane, is becoming increasingly important due to global warming. Through the tools of nanophotonics, small and inexpensive gas sensors can be manufactured in large volumes to establish global networks of environmental monitoring sensors. Kristinn and his research team have developed miniaturized optical carbon dioxide and methane sensors that can be integrated into smartphones or flown around in drones to ensure air quality and locate emissions. As the need for data communication continues to grow, more of our communication systems are becoming optical. By employing nanophotonic methods, energy-intensive microelectronic circuits can be replaced with light circuits capable of handling large amounts of data with minimal energy consumption. Kristinn and his research group have developed such light circuits that can dramatically reduce power consumption in data centers.

Professor Willie Padilla

Autonomous agentic framework for the end-to-end inverse design of electromagnetic metamaterials

Department of Electrical and Computer Engineering, Duke University, Durham, North Carolina 27708, USA

Artificial electromagnetic materials (AEMs) provide unprecedented control over the scattering of electromagnetic waves, enabling exotic responses unrealizable with naturally occurring materials. The design of complex functional metasurfaces is typically cast as a challenging inverse problem. Because the design space is frequently massive and the fundamental physics are often ill-posed, conventional optimization approaches struggle to find optimal geometrical configurations within a reasonable computational timeframe. While deep inverse models (DIMs) have demonstrated significant success in overcoming these limitations, the recent evolution from large language models (LLMs) to autonomous agentic systems has created a new frontier for automated scientific discovery.

We present an autonomous agentic framework that automates the complete end-to-end workflow of metamaterial research and inverse design. When prompted with a target optical scattering response, the agent autonomously reasons, plans, and utilizes external tools via APIs to first develop a custom forward deep learning surrogate model, and subsequently execute a deep inverse method to yield the optimized AEM geometry. We demonstrate the framework's effectiveness within highly dimensional all-dielectric metasurface (ADM) design spaces, illustrating the agent's capacity to adapt its strategy in real-time, store short- and long-term memory, and utilize internal reflection to achieve performance on par with published human studies. In view of the great potential for the future of this exciting research area, we review recent advances, open challenges, and future directions for agent-driven electromagnetic research.



Willie Padilla has been in the metamaterials field since 2000, when he co-authored the first paper on negative index materials with Smith. Padilla is particularly well known for his work at terahertz (THz) frequencies, as well as in the area of active and dynamically controlled metamaterials.

While working under a Director's Postdoctoral Fellowship at Los Alamos National Laboratory, Padilla led efforts to demonstrate dynamic tuning of a semiconductor hybrid metamaterial by photodoping and voltage control. Both of these key experiments are now widely recognized and cited. Padilla's lab specializes in the THz, infrared, optical and magneto-optic properties of novel materials utilizing various spectroscopic methods, including Fourier transform spectroscopy and ellipsometry. Padilla's recent interests include tailoring the emissivity of objects with metamaterial coatings, and the use of active metamaterial arrays as components in THz and infrared imaging systems.

Professor Heike Ebendorff-Heidepriem

Specialty optical glasses and fibre: a powerful platform for the exploration of new concepts and applications

School of Physics, Chemistry and Earth Sciences; and Institute for Photonics, Advanced Sensing and Quantum Technologies (IPAS-QT), Adelaide University, Adelaide, South Australia, Australia.

Optical glasses and fibres provide a broad range of tailorable photonic and quantum properties, such as transmission window, fluorescence, plasmonics and nonlinear light conversion, through design of chemical composition, nano-/micro-structuring, adding dopants such as luminescent lanthanide ions and nano-/micro-crystals, and surface functionalization. This wide tunability of properties make specialty optical glasses and fibres a powerful platform to explore new science and engineering concepts as well as new applications as illustrated by these examples:

- tellurite glasses doped with luminescent lanthanide ions for new avenues in temperature sensing and volumetric display [1,2,3]
- exposed-core silica glass microstructured fibres as a waveguiding substrate for utilizing light manipulation properties of thin films and 2D materials [4,5,6]
- extrusion-based glass shaping techniques for fabricating soft glass optical fibres with new structures for exploring new photonics concepts [7,8]
- soft glass fibres doped with luminescent diamond particles for quantum-based magnetic field sensing [9,10]
- tellurite glass with in-situ grown gold nanoparticles for extraordinary plasmonic tuning [11]
- ZBLAN fluoride glass fibres drawn in microgravity for ultra-low-loss fibre optics cables [12]

[1] Stavrevski, et al., Sci. Rep. 14, 15084 (2024).
[2] Li, et al., Opt. Lett. 43, 1682 (2018).
[3] Wei, et al., Adv. Phot. Res. 6, 2500158 (2025).
[4] Khalid, et al., Sensors and Actuators B 311, 127864 (2020).
[5] Q. Ngo, et al., Nature Photonics 16, 769-776 (2022).
[6] A. K. Lühder, et al., Light: Adv. Manufact. 2, 262-273 (2021).
[7] Afshar V., et al., Opt. Lett. 34, 3577 (2009).
[8] C. Warren-Smith, Opt. Express 26, 33604 (2018).
[9] Ruan, et al., Sci. Rep. 8, 1268 (2018).
[10] Bai, et al., APL Materials 8, 081102 (2020).
[11] Wei, et al., Light: Sci. & Appl. 12, 293 (2023).
[12] A. Arat, et al., Space: Science & Technology, 6, 0572 (2026).

Heike Ebendorff-Heidepriem is Professor in Photonic Materials and Optical Fibres and Deputy Director of the Institute for Photonics, Advanced Sensing and Quantum Technologies (IPAS-QT) at Adelaide University. She is also Director of the Optofab Adelaide Hub at the Australian National Fabrication Facility (ANFF).

She received the Ph.D. degree in 1994 at the University of Jena, Germany, where she continued until 2000. In 2001, she moved to the Optoelectronics Research Centre in Southampton, UK; and since 2005, she is with the University of Adelaide, which is since 2026 Adelaide University, Australia.

In 2023, she was awarded a South Australian State Government Future Making Industry Fellowship and an ARC Laureate Industry Fellowship on “Breaking through the manufacturing ‘glass ceiling’ for ZBLAN glass fibres”.



Since 2024, she is Chief Investigator at the ARC Centre of Excellence in Optical Microcombs for Breakthrough Science (COMBS). Her research focuses on the development of novel and advanced optical glasses and specialty optical fibres for science and industry applications.

Professor Mark Brongersma

The Future of Metamaterials is Soft

Department of Materials Science and Engineering at Stanford University, California, USA

Optical metamaterials offer unprecedented control over the flow of light by harnessing the light scattering properties of judiciously arranged nanostructures or molecules. Exciting new opportunities have recently emerged for the use of metamaterial optics in the fields of biology, wearables, medicine and neuroscience. These fields critically rely on the development of sophisticated technologies for the delivery and collection of complex light fields to understand, influence, and communicate with living systems. Examples include endoscopic imagers, optogenetic probes and wearable sensors. However, their development faces a notable materials challenge: most metasurfaces are currently fabricated from rigid, inorganic metal and semiconductor structures that do not interface well with the soft, curved, and dynamic surfaces that we encounter in biology. In my presentation, I will argue that soft materials can bring powerful advantages in the creation of nanostructured metasurface optical elements and photonic skins, such as flexibility, compliance, biocompatibility and large stimuli-driven responses.



Mark Brongersma is the Stephen Harris Professor of Engineering at Stanford University. He leads a research team of eight students and three postdocs. Their research is directed towards the development and physical analysis of new materials and structures that find use in nanoscale electronic and photonic devices.

He is on the list of Global Highly Cited Researchers (Clarivate Analytics). He received a National Science Foundation Career Award, the Walter J. Gores Award for Excellence in Teaching, the International Raymond and Beverly Sackler Prize in the Physical Sciences, The IET Harvey Engineering Prize, and is a Fellow of the OSA, the SPIE, and the APS. Dr. Brongersma received his PhD from the FOM Institute AMOLF in Amsterdam, The Netherlands, in 1998. From 1998-2001 he was a postdoctoral research fellow at the California Institute of Technology.

Professor Sejeong Kim

Structured light and chiral photonics

Department of Electrical and Electronic Engineering, Faculty of Engineering and IT, University of Melbourne



Dr Sejeong Kim is an Associate Professor at the School of Electronic and Electrical Engineering at Sungkyunkwan University. She received her PhD in Physics from KAIST (Korea Advanced Institute of Science and Technology) and was a research fellow at the University of Technology Sydney before joining Melbourne.

She led the Melbourne Integrated Nanophotonics Engineering (MINE) lab, where her research focuses on light-matter interactions at the nanoscale, particularly involving photonic and plasmonic cavities, quantum light sources, and 2D materials. Dr. Kim is an OPTICA Ambassador and the Chair of OPTICA's Nanophotonics Technical Group. Her contributions to integrated nanophotonics have been recognized with several awards, including the 2022 Ivan P. Kaminow Outstanding Early Career Professional Prize, the Young Tall Poppy Science Award.

Contributed Presentations

Dr Tuomas Haggren

All-optical active terahertz metasurface for ultrafast polarisation control

Luyao Wang [a], Kun Peng [b], Tuomas Haggren [a], Ford M. Wagner [b], Sarah Norman [b], Daria A. Smirnova [a], Hark Hoe Ta [a], Chennupati Jagadish [a], Ilya V. Shadrivov [a], Michael B. Johnston [b]

[a] ARC Centre of Excellence for Transformative Meta-Optical Systems (TMOS), Research School of Physics, The Australian National University, Mills Road, Canberra, 2601, ACT, Australia.

[b] Department of Physics, University of Oxford, Clarendon Laboratory, Parks Road, Oxford, OX1 3PU, UK

Terahertz (THz) technologies increasingly require active photonic components that can manipulate electromagnetic waves on ultrafast timescales. However, dynamic THz metasurfaces remain limited by modulation speed, efficiency, and architectures based on passive metallic structures. Here we demonstrate an all-optical semiconductor metasurface for ultrafast THz polarisation control. The metasurface consists of stand-alone, S-shaped GaAs meta-atoms transferred onto a quartz substrate, enabling low-loss operation while allowing the electromagnetic response to be governed by the semiconductor resonator volume. Femtosecond optical excitation injects free carriers into the 2-μm-thick GaAs structures, transiently driving them from a dielectric-like to a metallic-like electromagnetic regime. This activates a broadband chiral response that converts linearly polarised THz radiation into the orthogonal polarisation, with cross-polarised transmission amplitudes up to 0.4 across 0.5–3 THz. Full-wave simulations based on a carrier-dependent Drude model reproduce the measured response and show how increasing free-carrier density turns on the resonant behaviour. Direct comparison with geometrically identical gold metasurfaces confirms that photoexcited GaAs approaches the response of metallic resonators. These results provide a scalable route to ultrafast, optically reconfigurable THz meta-optics.

Dr Haggren is a research fellow at the Australian National University. He received his PhD degree in 2016 in the field of nanofabrication from Aalto University, Finland. Prior to that, he received Master's Degree from Aalto University in 2011 (passed with distinction). His PhD studies focused on nanowire epitaxy and nanofabrication of optoelectronic nanowire devices. During the PhD work, he was granted a doctoral school position (incl. 3yrs salary) as well as a total of six incentive grants. In 2017-2018 he worked as a postdoctoral researcher in another group at Aalto University focusing on epitaxy of planar III-V structures and fabrication of thermophotonic devices. He then received funding for a personal research project that he planned, executed and led at the Australian National University in 2019-2021. In the research project he developed epitaxial lift-off methods for III-V thin films and flexible optoelectronic devices. In 2021, he joined TMOS at the Australian National University as a research fellow. His research focuses on metamaterials, III-V semiconductors, thin-film devices and nanofabrication. He is TMOS Research Program Manager for "Nanoscale lasers and laser arrays". Dr. Haggren has published ~30 research articles and has written one patent.

Oleg Kameshkov

Development of terahertz meta-optical components for polarisation control: polarisers and waveplates

Oleg Kameshkov [a], Vladlen Shvedov [a], Yana Izdebskaya [a], Rajour Tanyi Ako [b], Peter Francis Mathew Elango [b], Madhu Bhaskaran [b], Ilya V. Shadrivov [a]
[a] ARC Centre of Excellence for Transformative Meta-Optical Systems (TMOS), Research School of Physics, The Australian National University, Canberra, ACT 2601, Australia.
[b] ARC Centre of Excellence for Transformative Meta-Optical Systems (TMOS) and Functional Materials and Microsystems Research Group, RMIT University, Melbourne, Australia.

Over the past year, we have advanced the research and development of the devices presented within terahertz meta-optics startup from TMOS Shark Tank 2025 pitch. Our work focused on two key component families: terahertz polarisers and waveplates, which are essential building blocks for spectroscopy, imaging, sensing, and polarisation-sensitive terahertz systems.

In this presentation, we will demonstrate freestanding wire-grid polarisers, which are approaching market readiness. These devices are fabricated using laser micromachining and are designed to provide high transmission, high extinction ratio, and substrate-free operation. We will also present our progress in developing broadband terahertz waveplates based on structured silicon, with emphasis on polarisation conversion efficiency, fabrication feasibility, and suitability for integration into terahertz time-domain spectroscopy systems.

Beyond technical results, we will outline the business traction achieved since Shark Tank, including a more detailed market analysis, clearer customer segments, and progress in protecting our intellectual property. Finally, we will present the next steps to attract new investment, expand the product line, and build a specialized terahertz component company focused on customizable polarisation optics.

Oleg Kameshkov received the B.Sc. and M.Sc. degrees in physics from Novosibirsk State University, Novosibirsk, Russia, in 2018 and 2020, respectively. He is currently pursuing the Ph.D. degree in physics with the Research School of Physics, the Australian National University, Canberra, ACT, Australia.

His research interests include terahertz plasmonics, metamaterials, sensors, and polarization optics. His current work focuses on the development of terahertz meta-optical elements for polarization and phase control.

Tongmiao Fan

Tailored quantum states for nonlinear metasurfaces

Tongmiao Fan [a], Jinyong Ma [a,b], Frank Setzpfandt [c], and Andrey A. Sukhorukov [a]

[a] ARC Centre of Excellence for Transformative Meta-Optical Systems (TMOS), Department of Electronic Materials Engineering, Research School of Physics, Australian National University, Canberra, Australia

[b] Institute of Quantum Precision Measurement, State Key Laboratory of Radio Frequency Heterogeneous Integration, College of Physics and Optoelectronic Engineering, Shenzhen University, P. R. China

[c] Institute of Applied Physics, Abbe Center of Photonics, Friedrich Schiller University Jena, Germany

Quantum states are key resources for high-dimensional quantum communications, information processing, imaging, and fundamental studies of nonclassical light. Conventional biphoton quantum sources typically rely on bulk nonlinear crystals and external optical assemblies to engineer spontaneous parametric downconversion (SPDC). Although powerful, these platforms are often large, alignment-sensitive, and difficult to deploy beyond laboratory environments, creating a need for miniaturized, stable, and designable quantumlight sources.

Here, we present collaborative progress in generating tailored quantum states from ultrathin nonlinear metasurfaces. Optical resonances in these metasurfaces provide a compact mechanism for enhancing SPDC and controlling the symmetry, polarization, spatial-mode structure, spectrum, and directionality of emitted photon pairs. Using a nonlocal metasurface consisting of a silica grating integrated with a lithium niobate film, we demonstrate tunable generation of spectral entanglement through resonant dispersion engineering [1], as in Fig. 1(a). We also show enhanced biphoton generation from a van der Waals nonlinear metasurface based on 3R-MoS2 in Fig. 1(b) [2]. Finally, building on hyperentanglement generation from [110]-oriented InGaP metasurfaces, we develop programmable quantum-state generation driven by complex pump fields. Together, these studies highlight how collaborative development of nonlinear metasurfaces can enable compact, stable, and engineered quantum-light sources.

[1] Tongmiao Fan et al. “Tailored biphoton entanglement from a nonlinear metasurface”, under preparation
[2] Tongmiao Fan et al. “Enhanced Photon-Pair Generation from a van der Waals Metasurface”, Nano Letters 2025 25 (31), 11844-11851
[3] Tongmiao Fan et al. “Hyperentangled photon-pair generation from a nonlinear metasurface”, under preparation

Tongmiao Fan completed his master’s degree in Quantum Technology at the Australian National University, where he focused on the fields of metasurfaces and photon-pair generation. He is currently pursuing a PhD under the esteemed guidance of Professor Andrey Sukhorukov.

Dr Wei Wen Wong & Yiyang Cui

Coupling black phosphorus emission with bottom-up III-V microring cavities for mid-infrared lasing

Yiyang Cui a, Huan Liu a,b, Sudhanshu Kumawat a, Wei Wen Wong c, Hark Hoe Tan c, and Kenneth Crozier a
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Black phosphorus (BP), a two-dimensional allotrope of phosphorus, has emerged as a promising material for next-generation optoelectronic applications. Its direct bandgap is readily tunable via its layer number or external electric fields – spanning from ~ 1.7 eV in monolayers to 0.31 eV in bulk – making it an ideal material for photodetection and emission in the technologically critical mid-infrared (MIR) region [1,2]. While recent demonstrations of bright, room-temperature photoluminescence [3] and scalable exfoliation techniques [4] highlight the potential for BP-based MIR lasers, achieving coherent lasing action in compact devices remains a challenge. To date, reports have been largely limited to optically pumped lasing in BP flakes embedded within distributed Bragg reflector cavities [5,6], which have limited potential for high-density integration.

Here, we demonstrate the optical coupling of spontaneous emission from BP to whispering-gallery modes supported in epitaxially grown InP microring cavities, establishing a pathway toward compact MIR BP micro-cavity lasers. Our bottom-up microrings were grown directly on their native substrate via selective area epitaxy, effectively eliminating the etching-induced sidewall damage that typically introduces scattering and non-radiative recombination losses.

Through numerical modelling, we optimised the ring cavity design to maximise both the quality factor and the spectral overlap between the spontaneous emission and the cavity mode. Following the mechanical exfoliation and transfer of BP flakes onto the microrings, we characterised the coupled systems via room-temperature photoluminescence measurements. Key findings elucidating the optical coupling between the BP flakes and the resonant cavities will be presented.

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Dr Wei Wen Wong is currently a Research Fellow at the Research School of Physics, Australian National University (ANU), and a Research Program Manager at the Australian Research Council Centre of Excellence for Transformative Meta-Optical Systems (TMOS). He received his Bachelor's degree from Multimedia University, Malaysia, in 2016, and completed his PhD at ANU in 2023. From 2016 to 2018, he worked as a Product and Failure Analysis Engineer at Cypress Semiconductor.

Dr Wong's research focuses on the epitaxy of low-dimensional compound semiconductor structures, as well as the design and fabrication of novel photonic, optoelectronic, and metasurface optical devices. He has co-authored over twenty papers in high-impact journals, including Science Advances, Nano Letters, Laser & Photonics Reviews, and ACS Nano. He was a recipient of the Jim Williams Award and the Director's Award for Early and Mid Career Researcher Publication at the ANU Research School of Physics for excellence in research and teaching, and was selected as the sole ANU early career researcher representative at the 2024 Global Young Scientists Summit in Singapore. In 2025, he received the Early Career Researcher of the Year Award from the Australian Research Council Centre of Excellence for TMOS. In recognition of his ongoing research impact, he was selected to contribute to the 2027 Rising Stars Collection in the Journal of Physics D: Applied Physics.

Yiyang Cui is a PhD student at the University of Melbourne under the supervision of Prof. Kenneth Crozier. He is working on wavelength-selective thermal emitter. Yiyang has completed his Bachelor of Science and Master of Engineering at the University of Melbourne.

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Farid Khoshkhati & Dr Yana Izdebskaya

Active colour tuning of dielectric Mie voids using liquid crystals

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In contrast to conventional Mie resonators, which typically consist of high-refractive-index nanopillars embedded in a low-refractive-index medium, Mie voids are formed by introducing subwavelength air holes within a high- efractive-index material. This inverted geometry has recently emerged as an alternative platform for Mie-resonant metasurfaces, offering several advantages, including stronger electromagnetic field confinement, improved accessibility to the fields within the voids, reduced dispersion, and lower optical losses [1]. These characteristics may lead to promising applications in areas such as nanoprinting and nanoplastics detection [2].

Such metasurfaces are typically limited by their fixed optical properties defined at a fabrication step. However, a key direction in metasurface development is the realization of tunable and switchable functionalities for practical photonic devices. Recently, it was demonstrated that elliptical Mie voids can enable switching functionality by changing the polarisation state of the incident light [3]. Nevertheless, active control of Mie-void metasurfaces has not been demonstrated so far. In this work, we have integrated silicon Mie voids with liquid crystals (LCs) to investigate the feasibility of actively tuning their optical response using external stimuli. It has been demonstrated that both rotation of the polarization direction of the incident light and elevation of the temperature above the nematic-to-isotropic transition temperature of the LC material induce significant

shifts in the reflected colour from the voids. This strategy provides several key advantages, including spectral tunability across a wide wavelength range.

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Farid is a PhD student at the University of Melbourne and a member of TMOS. With a solid background in electronics and experimental experience with liquid crystals, he is working to develop tunable metasurfaces in the visible region. His research focuses on creating active optical devices with applications in adaptive optics and photonics.

Dr Yana Izdebskaya is a Research Fellow at TMOS at the Australian National University. Additionally, Dr Izdebskaya serves as a Research Program Manager at TMOS within Theme 2, "Manipulate". Dr Izdebskaya is the recipient of several awards and fellowships, including the ARC Australian Postdoctoral Fellowship, ARC Discovery Project, and SPIE Educational Scholarships in Optical Science and Engineering. Some of her publications have been featured in special December issues of the Optics and Photonics News, OSA "Spotlight on Optics," Physics Today, and Physics World. She also actively participates as a reviewer for prestigious scientific journals and has served as a reviewer for the European Commission's Research and Innovation programs, including "Horizon Europe – Pathfinder Open 2022", "Horizon 2020 FET-Open", "Novel Ideas for Radically New Technologies" and "Challenging Current Thinking". She has been a Technical Program Committee Member of the Australian and New Zealand Conference on Optics and Photonics (ANZCOP) for 2022 and 2023. Dr Izdebskaya's current research focuses on the development of dynamically tunable dielectric metasurfaces using liquid crystals for reconfigurable devices that enable efficient light modulation for various applications. Dr Izdebskaya holds a PhD degree in Optics and Laser Physics from Taurida National University in Ukraine.

Dr Phuong Yen Le

Non-volatile tuning of Fano resonances in a phase-change single-layer two dimensional photonic crystal slab metasurface

Benjamin J. Russell [a,b], Krishna Murali [c,d], Peter Francis Matthew Elango [c,d], Phuong Y. Le [c,d], Huan Liu [a,b,e], Madhu Bhaskaran [c,d], and Kenneth B. Crozier [a,b,f]

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Low-loss Fano resonances in photonic crystal slabs are central to nanophotonic devices such as nanolasers, refractometric biosensors, and twisted bilayer metasurfaces. However, their utility is limited by the fact that their resonant behavior is generally fixed after fabrication. The Pockels, Kerr and thermo-optics effects have been used to tune Fano resonances, but in a volatile fashion. Recent works have demonstrated the non-volatile tuning of leaky guided-mode resonances using phase change materials incorporated into structures with multiple layers. Here, we experimentally demonstrate the non-volatile tuning of low-loss Fano resonances in a photonic crystal slab metasurface comprising a single nanopatterned layer, exhibiting remarkable modulation depth and high fidelity with simulation. Our design uses an ultra-thin film of antimony triselenide (Sb2Se3) patterned with a square unit cell on fused silica, optimized to maximize transmission contrast between amorphous and crystalline phases. Infrared spectra show redshifts of the Fano dip from 1441 nm to 1553 nm (112 nm) and transmission contrast up to 15.4 dB.

Dr Phuong Le is a Research Fellow affiliated to RMIT node of the ARC CoE for TMOS. Before joining TMOS group, she worked as a research fellow in the ARC Discovery Project led by The University of Sydney and RMIT University. She has a wealth of experience in micro/nano fabrication and material characterisation. Her work has focused on metal oxide-based devices including resistive switching, optoelectronic and sensing devices.

Dr Gurpreet Singh Gill

Resolution-enhanced spectral reconstruction using MEMS Fabry-Pérot Filters

Gurpreet Singh Gill [a], Jiajun Meng [b], Gilberto Umana-Membreno [a], Mariusz Martyniuk [a], Dilusha Siliva [a], Kenneth Crozier [b] and Lorenzo Faraone [a]

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Spectral reconstruction is a computational technique used to recover spectral information from a limited number of spectrally selective optical measurements. It is particularly useful for compact spectroscopic systems, where the measured response may be limited by filter bandwidth, tuning step size, signal-to-noise ratio, or available instrumentation. By combining calibrated filter responses with suitable reconstruction algorithms, target spectra can be estimated with improved effective spectral resolution without relying on bulky or highly specialised spectroscopic equipment. In this work, we use microelectromechanical systems (MEMS)-based Fabry–Pérot filters (FPFs) [1–3] to validate resolution-enhanced spectral reconstruction over the 1.3–1.6 μm wavelength range. The MEMS-FPFs were designed and fabricated at the University of Western Australia in a standard microelectronics cleanroom environment. Their spectral responses were characterised using a monochromator setup at UWA and used as the calibration basis for reconstruction performed at the University of Melbourne.

The preliminary results demonstrated the feasibility of this approach. As shown in Fig. 1, the reconstructed narrowband spectrum agrees well with the monochromator reference, while showing a much sharper response than the direct MEMS-filter measurement. This indicates that computational reconstruction can recover spectral features broadened by the filter response and improve the effective resolving capability of the MEMS FPF measurement system. We anticipate extending the study using the latest MEMS-FPF device batch with improved optical

performance and implementing a more robust automated measurement system capable of repetitive measurements with finer voltage sampling steps to obtain a larger and more accurate calibration dataset. We also plan to demonstrate the method by reconstructing the transmission spectra of fixed bandpass filters and broadband polymer samples, providing a more systematic evaluation of the reconstruction accuracy, robustness, and practical limitations of the proposed MEMS-FPF-based spectroscopic platform.

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Gurpreet Singh Gill was born in India. He received his B.Tech. and M.Tech. degrees in electronics and communication engineering from Punjab Technical University and Sri Guru Granth Sahib World University, Punjab, India, in 2013 and 2015, respectively. He completed his Ph.D. within the Microelectronics Research Group and the Department of Electrical, Electronic and Computer Engineering at The University of Western Australia (UWA), Perth, Western Australia, Australia in 2022. He is currently working as a Postdoctoral Research Associate within the same group. Before commencing his Ph.D. at the UWA, he worked as a Senior Research Fellow and Research Trainee at the Central Electronics Engineering Research Institute, Pilani, India, which is one of the pioneering research labs in electronics and is a constituent laboratory of the Council of Scientific & Industrial Research, India and primarily worked on micro and nano electro-mechanical systems (MEMS/NEMS) and their applications. He is currently leading research activities in the area of MEMS/NEMS and his current research activities involve thin-film materials and mechanics, optical MEMS, optoelectronic devices and Infrared sensing and imaging as well as their applications.

Dr Jiajun Meng

Snpshot MWIR polarimetric imaging enabled by a metalens

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Polarimetric thermal imaging provides information beyond conventional infrared intensity imaging, including surface orientation, material properties and polarisation signatures. Existing mid-wave infrared (MWIR) polarimetric imaging systems typically rely on rotating polarisers, beam splitters or detector-integrated micropolariser arrays, increasing system complexity and limiting compact implementation.

Here we present the design, optimisation and experimental demonstration of a snapshot MWIR polarimetric imaging system enabled by a polarisation-sensitive metalens. The metalens simultaneously forms multiple polarisation-resolved thermal images on a commercial bolometer-based infrared focal plane array (FPA), enabling linear polarisation information to be recovered from a single exposure without moving parts or additional polarisation optics. The optical design was optimised to improve imaging performance and polarisation discrimination while maintaining compatibility with a conventional thermal infrared camera.

The four simultaneously acquired linear-polarisation images, corresponding to analyser orientations of 0°, 45°, 90° and 135°, are processed to reconstruct the linear Stokes parameters (S0, S1 and S2). These parameters yield the total intensity, degree of linear polarisation (DoLP) and angle of linear polarisation (AoLP) of the observed scene. Experimental results demonstrate thermal polarimetric imaging of representative targets, revealing polarisation-dependent image contrast

associated with surface geometry and material properties that is not apparent in conventional thermal images. Real-time measurements further demonstrate stable snapshot operation and continuous tracking of dynamic linear-polarisation changes.

The proposed metalens provides a compact optical solution for infrared polarimetric imaging while remaining compatible with commercially available thermal cameras. This work highlights the potential of metasurface optics combined with computational polarimetric image reconstruction to realise compact and scalable MWIR polarimetric imaging systems for applications including autonomous sensing, machine vision, remote inspection and environmental monitoring.

Dr Jiajun Meng is a postdoctoral research fellow in meta-optical devices at the School of Physics, University of Melbourne. He currently works on optical microspectrometers and chemical classifiers based on silicon nanowires, plasmonic metasurfaces and machine learning.

He has pursued his PhD study in Professor Kenneth B. Crozier's group at the University of Melbourne from 2017 to 2021. He has previously received his Master of Engineering degree in Electrical Engineering from the University of Melbourne in 2016. He completed his Bachelor of Science degree in Electronic Engineering at Fudan University, Shanghai, China in 2013.

He is the author of more than 20 journal papers and conference papers. His current research interests include nanophotonics, nanofabrication, optical microspectrometers, chemical sensing. He is also interested in Artificial Intelligence, Machine Learning and the implementation in nanophotonic devices.

Dr Chaohao Chen & Yang Yu

Harnessing non-Boltzmann steady states in lanthanide nanocrystals for mid-infrared optoelectronics

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Converting mid-infrared (MIR) radiation to visible or near-infrared wavelengths is essential for imaging and sensing, yet achieving sensitive, low-power, and scalable detection remains challenging. Lanthanide nanocrystals provide an alternative through ratiometric luminescence but are typically constrained by Boltzmann statistics, which tie population distributions to lattice temperature and limit signal contrast. Here we show that MIR irradiation rebalances dissipative relaxation pathways, driving lanthanide emitters into a non-Boltzmann steady state that enables non-thermal control of population distributions. This allows emission behaviours inaccessible under thermal equilibrium. We exploit this regime to achieve linear MIR detection with respect to MIR power across 6.8–8.6 μm. The ratiometric response is intrinsically independent of the pump power, enabling operation at an ultralow excitation power of 10 μW, several orders of magnitude lower than conventional approaches. Using standard silicon photodetectors, we then demonstrate room-temperature MIR imaging with detection limits approaching 4 nW μm-2. Our results establish lanthanide nanoparticles as an efficient platform for MIR conversion and sensing in nanophotonic systems.

Dr Chen is working on nanophotonics and biophotonics research. Currently, he is a postdoctoral fellow under the supervision of Prof. Lan Fu at Department of Electronic Materials Engineering, Research School of Physics, ANU College of Science, to conduct the laser-free on-chip super-resolution microscopy project. Dr Chen obtained his Ph.D. in physics from the University of Technology Sydney (UTS) in 2020 with a thesis entitled " Multi-photon Nonlinear Fluorescence Emission in Upconversion Nanoparticles for Super-resolution Imaging," under the supervision of Prof. Fan Wang, Prof. Dayong Jin, Dr Qian Peter Su, and A/Prof. Peter Reece. He was employed as a postdoctoral researcher at the School of Electrical and Data Engineering, Faculty of Engineering and Information Technology, UTS, where he led the research group in nanophotonics. Dr Chen actively researches novel optical nonlinear nanomaterials and their applications in optical super-resolution imaging to form high-performance and robust on-chip devices in nanoscale sensing and advanced biophotonics technologies. Dr Chen has published over 20 peer-reviewed journal articles. Dr Chen has published as the first or corresponding author in premier international journals, including Nature Communications, Advanced Materials, Nano Letters, and Advanced Sciences, resulting in a high average impact factor over 10 of his publications.

Yang Yu is currently a PhD candidate from the Dept. of Electronic Materials Engineering, Research School of Physics and Engineering, Australia National University. Yang Yu has published five journals as co-author under supervision of Prof. Lan Fu. Yang Yu's research interests are designing, fabricating and testing optoelectronic device (photodetector) at short-wave infrared range using III-V compound semiconductor nanostructures (nanowire and nanosheet) growed using MOCVD.

Dr Wenwu Pan

Metalens-integrated MWIR HgCdTe detectors for high operating temperatures: front- and back-illuminated architectures

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High-operating-temperature (HOT) infrared detectors are important for reducing the cooling requirements, size and complexity of next-generation sensing platforms. Here, we present the design, integration and system level modelling of metalens-integrated mid-wave infrared (MWIR) HgCdTe detectors, considering both front- and back-illuminated architectures. The approach decouples the optical collection area from the detector active area. A metalens concentrates radiation collected over a comparatively large aperture onto a reduced detector volume, increasing the photon-flux density while limiting thermally generated noise. This architecture is designed to improve the signal-to-noise ratio (SNR) at elevated operating temperatures. The MWIR metalens diameter, focal length and meta-atom pitch are jointly optimised to achieve high optical efficiency and minimise the required detector size while maintaining compatibility with practical detector integration.

In both front- and back-illuminated architectures, the metalens concentrates incident radiation onto a reduced active region. The front-illuminated implementation uses a metalens array on a thin sapphire substrate bonded to an n-type HgCdTe photoconductor (PC) array, providing a comparatively simple integration route. The back-illuminated implementation forms the metalens array on the rear surface of the

CdZnTe substrate of an HgCdTe photovoltaic (PV) detector, enabling optical concentration into a reduced junction area in a PV architecture. The modelling framework incorporates photon collection, background radiation and temperature dependent detector noise. The results indicate that metalens-enabled optical concentration can improve SNR at elevated operating temperatures, while comparison of the PC and PV architectures highlights trade-offs among signal response, noise performance and integration complexity. These results establish a pathway towards compact, high-performance MWIR detectors with reduced cooling requirements through the co design of meta-optics and HgCdTe detector architectures.

Dr Pan is currently a postdoctoral research fellow for the ARC Centre of Excellence for Transformative Meta-Optical Systems (ARC TMOS) at the University of Western Australia (UWA). His research interests lie in infrared-sensitive materials & devices and their integration with meta-optics for applications in next-generation infrared sensors. Dr. Pan was awarded his PhD in Microelectronics and Solid-state Electronics from Chinese Academy of Sciences (CAS) in 2017. His PhD research was on molecular beam epitaxial (MBE) growth and characterization of III-V optoelectronic materials & devices such as lasers and infrared detectors. Since 26/02/2018, Dr Pan worked as a full-time research associate/fellow in the Microelectronics Research Group (MRG), the School of Engineering at UWA to continue his research on optoelectronics, particularly II-VI infrared semiconductors and detectors. Dr Pan has registered on the supervisor panel at UWA and co-supervised two PhD students. Dr Pan has published more than 50 peer-reviewed papers and 1 book chapter. Most of the papers have been published in well-respected journals of this field, such as Nano research, ASC photonics, Sci. Rep., Appl. Phys. Lett., J. Appl. Phys., etc.

Wenyi Li

Reflective diffraction optical neural network with metasurfaces

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As artificial intelligence models continue to advance, there is an increase in the demand for faster and more energy-efficient computing methods. Optical computing, which utilises light and optical components, offers significant advantages in terms of speed and efficiency [1]. Currently, metasurfaces have made substantial advancements, largely attributable to fabrication improvements, thus enabling realisation of novel structures and applications [2]. The convergence of these two dynamic fields offers a promising opportunity to develop more efficient and compact diffractive optical neural networks (DONNs). Despite the exploration of various DONN architectures in different wavelengths and configurations [3], challenges remain in terms of miniaturization, fabrication for visible/near-infrared operation and precise multilayer alignment.

The objective of our project is to develop cascaded metasurfaces to achieve advanced neural network performance. This approach has the potential to yield compact, efficient optical computing systems.

To address these challenges, we propose fabricating two plasmonic metasurfaces on a single wafer to implement DONNs based on the structure from Geromel et al. [4]. This method consolidates the network into a single element, resolving alignment issues between layers and improving stability. We design a reflective configuration on a wafer, enabling DONN integration within 1 cm^2 and allowing for multilayer complexity. The metasurfaces process input light signals by leveraging precise phase modulation. In our simulations the designed system can achieve a classification accuracy of 93% with the Modified National Institute of Standards and Technology (MNIST) digits database.

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Wenyi is currently a PhD student in the dual degree program with Friedrich Schiller University Jena and Australian National University. Her research focuses on the design and fabrication of large-area metasurface optical neural network systems. Wenyi is generally interested in various optical fields, such as wave optics simulation, inverse design, and machine learning-based design and applications.

Deepanshu Chaudhary

Nanowire breath sensor for metabolic health diagnosis and monitoring

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Breath acetone is a promising non-invasive biomarker associated with metabolic conditions in human and veterinary healthcare. Elevated concentrations of acetone in human and animal breath have been linked to altered metabolism in conditions like diabetic ketoacidosis (DKA) and ketosis [1,2]. Current diagnosis and monitoring of these conditions rely on blood tests which are invasive, inconvenient for frequent monitoring and challenging in veterinary settings. This motivates the development of a compact, non-invasive and rapid technique for metabolic health diagnosis and monitoring.

Here, we present a light activated InP nanowire array sensor for room temperature acetone sensing. The device comprises top-down etched InP nanowires with a platinum Schottky contact and a chitosan functionalization layer for acetone specific sensing. Nanowire arrays with diameter of 120 – 300 nm and pitch size of 500 – 1500 nm were fabricated using the process developed in previous study [3]. Systematic characterization demonstrated a concentration-dependent response from 50-800 ppm in controlled conditions and dry synthetic air covering the DKA range in humans. Translating from lab-based characterization to real breath samples introduces several challenges, in particular high relative humidity, variable O2 and CO2 content and background volatile organic compounds (VOCs). A lab-based breath analysis setup with corresponding humidity minimization, gas monitoring and analysis strategies have been

developed to distinguish acetone specific signal from a complex breath matrix. Proof-of-concept clinical measurements on human DKA patient breath revealed a notably elevated acetone signal when compared to a healthy reference sample. Overall, this work demonstrates the potential of InP nanowire sensors as compact, room-temperature breath sensors for metabolic health monitoring, while identifying key challenges that need to be addressed for human and veterinary breath diagnostics.

The authors acknowledge Dr. Bronwyn Darlington (Agscent Pty Ltd) and Mr. Paul Carboon (Ketone Innovations/ Solentropy) for their valuable industry collaboration and support. This work was supported by the Australian Research Council (ARC), the Australian Government Department of Education, Australian Economic Accelerator (AEA) and the National Industry PhD Program. Device fabrication was carried out using facilities of the NCRIS Australian National Fabrication Facility (ANFF), including ANFF ACT and the Melbourne Centre for Nanofabrication (MCN).

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Deepanshu Chaudhary completed his Master's of Science in Physics from IISER Bhopal, India in 2024. He worked on 'ultrafast carrier dynamics in metal halide perovskite nanocrystals' for his master's thesis. He joined as a PhD student at the Australian National University under the supervision of Prof. Lan Fu in Jan 2025. His main focus will be the growth, fabrication and characterization of III-V Nanowire based gas sensors.

Rohini Ramachandran

Portable multi-wavelength optical sensor for decentralised haemoglobin testing

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Rohini is an engineer by profession. She completed her Bachelor of Technology in Electronics and Communication Engineering, followed by a Master of Technology in Optoelectronic and Laser Technology from Cochin University of Science and Technology, Kerala a combination that reflects her interest in the intersection of electronics and optics.

After completing her master's, she worked as a hardware design engineer in the healthcare group at Bosch Global Software Technologies in Bangalore, where she contributed to the development of a digital microscope designed for hematology and histopathology detection. This work sparked her interest in optical biomarker detection. Through her research work, she aims to tackle real-world challenges in healthcare by solving practical, impactful problems.

Poster Presentations

Poster Presentations

Poster #	Author	Title
1	Oleg Bannik *	Geometry-engineered polarization control in MEMS-integrated spectrally tunable LWIR extraordinary optical transmission filters
2	Rocio Camacho Morales	VO_2 metasurface for tuneable imaging
3	Chaohao Chen	Harnessing Non-Boltzmann Steady States in Lanthanide Nanocrystals for Mid-Infrared Optoelectronics
4	Jinyuan Chen	Infrared Hyperspectral Single-pixel Imaging System
5	Junru Chen	Geometric Phase 2D Material Metasurfaces for Polarization Entanglement
6	Lincoln Clark	Non-local Diffraction Multiplexed Image Processing
7	Yiyang Cui	Multi-channel wavelength-selective thermal emitter based on Tamm plasmon polaritons structure
8	Dayantha Lankanath Karunasena Danthure Arachchige	AC Electro-Osmotic Conveyor Belt for Nanoparticle Capture and Transportation
9	Taskil Dastoor	Towards Room-Temperature CsPbBr3 Perovskite Metasurface Lasers
10	Sarah Dean	Dual-wavelength polarisation imaging with inverse designed metasurfaces
11	Panisa Dechwechprasit	Integrated Plasmonic Metasurface Bandpass Filter on InGaAs Photodiode for Near-Infrared Optical Glucose Sensing
12	Xiaoying Huang	A Dual-Wavelength Polarization-Multiplexed Metalens for Integrated SiC Quantum Emitters
13	Sebastian Klimmer	From Classical to Quantum: Frequency Mixing in 2D Materials

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14	Sudhanshu Kumawat	Black phosphorus mid-infrared photonic crystals
15	Daniel Morley *	Electron Beam Induced Current study on Reactive Ion Etch induced pn junctions in Mercury Cadmium Telluride
16	Fahia Tarannum Munna	High-Quality MBE grown HgCdTe for Substrate Lift-Off Applications
17	Nahiya Mushtaq	Liquid Metal Synthesis of Ultra-thin oxides for Broadband Photodetection
18	Aayushi Nanda *	MEMS-Reconfigurable Bilayer Metasurface for Terahertz Bandpass Filtering
19	Jean Pierre Ndabakuranye	Portable Multi-Wavelength Optical Sensor for Decentralised Haemoglobin Testing
20	Damian Nelson	A dual-resonant plasmonic nanocavity for the optical trapping and emission enhancement of single up-converting nanoparticles
21	Niken Priscilla	Single-Shot Quantitative Phase Imaging via Polarisation-Multiplexed Dielectric Metasurfaces
22	Xiwen Qiu	Active Tuning of Quantum Entanglement via Phase-Change Nonlinear Metasurfaces
23	Hugo Quard	Moiré Photonic Crystals from Twisted Bilayer WS_2 Slabs
24	Jinliang Ren *	Two-Photon Quantum Polarimetry with Entanglement for Tissue-like Scattering Media
25	Toby Severs Millard	Epsilon-near-zero physics at the two-dimensional limit
26	Saniya Shinde	Generating complex quantum states from nonlinear metasurfaces
27	Nicholas Sloane	Multi-Wavelength Spin Dynamics of Defects in Hexagonal Boron Nitride
28	Yuzi Song	Chiral emission from symmetry-broken InP nanosheet arrays

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Poster Presentations Cont.

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29	Srishti	Metasurface laser cavity
30	Shaban Sulejman	Non-invasive in-ovo gender determination of chicken eggs before incubation
31	Katsuya Tanaka	Disorder-Enabled High-Information-Density Huygens' Metasurface Holography
32	Lakshmi Ullatil	Towards Reconfigurable emission patterns in hybrid III-V/ phase change material based metasurface lasers
33	Haiwei Wang	Meta-Optical Approaches to Quantitative Phase Imaging
34	Ziwei Yang	Ultrafast Resonant Radiation and Frequency Conversion in a Time-Variant Photonic System

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