Alexander A. Solovev, PhD

Former Tenured Professor, Fudan University
Founding Director, NanoTRIZ Innovation Institute
Brisbane, Queensland, Australia

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WORK RIGHTS & CITIZENSHIP: Australian Permanent Resident (Subclass 858; unrestricted work rights) | German citizen

ACADEMIC PROFILE

Internationally recognised materials scientist and interdisciplinary engineering leader specialising in strain-engineered nanomembranes, functional micro- and nanomaterials, active materials, microfluidics, biomaterials and clean-energy microsystems. His research integrates materials processing, interface science, microfabrication, engineering physics, fluid mechanics and quantitative characterisation to create three-dimensional micro-/nanoarchitectures, energy-conversion platforms, lab-on-chip systems, active microdevices and materials-enabled biomedical technologies.

Former Professor (tenured) at Fudan University, with research and teaching experience spanning Harvard University, University of Toronto, Max Planck Institute for Intelligent Systems, Technical University of Munich and UQ's ARC Centre of Excellence for Quantum Biotechnology. Academic record: H-index 36; more than 6,700 citations; 74 peer-reviewed publications and 80+ total scholarly outputs; AUD 1.3 million secured through six PI awards (approximately USD 655,000 using the indicative conversions in this CV); two patents; seven academic years of course leadership; and six completed PhD supervisions or co-supervisions. Founder of the remote NanoTRIZ Junior Research Scholar Program, which has attracted more than 350 expressions of interest worldwide.

36	6,700+	80+	30+
H-INDEX	CITATIONS	SCHOLARLY OUTPUTS	INVITED TALKS

RESEARCH EXPERTISE AND INTERESTS

- Functional nanomaterials, strain-engineered nanomembranes, rolled-up micro-/nanostructures, interface design and microfabrication.
- Energy-conversion materials and microsystems, including catalytic surfaces, hydrogen-peroxide fuel cells, CO_2 conversion and clean-energy devices.
- Smart hydrogels, polymers, biomaterials, microcapsules and responsive material systems.
- Microfluidics, lab-on-chip systems, droplet and capsule engineering, diagnostics and microreactors.
- Active micro-/nanosystems: magnetic and catalytic microrobots, soft microswimmers, cargo and cell manipulation, imaging, tracking and control.
- Biosensing, theranostic microbubbles and nanodroplets, multimodal biomedical imaging, environmental-health technologies, translation and responsible AI-assisted R&D.

SELECTED SENIOR APPOINTMENTS

2025–present	Founding Director — NanoTRIZ Innovation Institute, Brisbane, Australia
2024	Visiting Academic — The University of Queensland, ARC Centre of Excellence in Quantum Biotechnology, Brisbane, Australia
2015–2024	Professor (tenured) — Department of Materials Science, Fudan University, Shanghai, China
2017	Visiting Scholar — Harvard John A. Paulson School of Engineering and Applied Sciences, USA

ACADEMIC AND PROFESSIONAL APPOINTMENTS

Jan 2025–present	**Founding Director — NanoTRIZ Innovation Institute, Brisbane, Queensland, Australia** Founded an independent Brisbane-based research, innovation and mentoring initiative. Leads international research mentoring and structured research-enrichment programs, including a remote Junior Research Scholar Program that has attracted more than 350 expressions of interest; develops AI-assisted R&D workflows for reproducibility, systematic problem-solving and translation.
Nov–Dec 2024	**Visiting Academic — University of Queensland, ARC Centre of Excellence in Quantum Biotechnology, Australia** One-month visiting appointment hosted by Professor Warwick Bowen; engaged with UQ’s interdisciplinary research environment and Brisbane academic network.
Sep 2015–Feb 2024	**Professor (tenured) — Fudan University, Department of Materials Science, Shanghai, P. R. China** Led PI-funded research and academic programs spanning strain-engineered nanomembranes, functional and active materials, microfluidics, microrobotics, biomaterials, sensing and clean-energy systems; secured six PI awards, led corresponding-author publications, designed and coordinated curriculum, and supervised doctoral, master’s, undergraduate and postdoctoral researchers. Appointment concluded upon permanent relocation to Australia.
Apr–Jul 2017	**Visiting Scholar — Harvard University, John A. Paulson School of Engineering and Applied Sciences, USA** Hosted by Professor David A. Weitz; conducted collaborative research in microfluidics and droplet and hydrogel microcapsule engineering, with subsequent outputs on dynamic microcapsules and lab-on-chip systems.
Mar–Aug 2015	**Postdoctoral Fellow — University of Toronto, Department of Chemistry, Canada** Worked in Professor Geoffrey Ozin’s group within the Solar Fuels Cluster on photoelectrochemical cell assembly and materials integration for solar-driven CO_2-to-fuel conversion.
Aug 2013–Dec 2014	**Postdoctoral Fellow — Max Planck Institute for Intelligent Systems, Germany** Conducted research in Professor Peer Fischer’s group on catalytic micro-/nanorobotics, including propulsion, magnetic guidance, quantitative characterisation and externally controlled motion.
Aug 2011–Aug 2013	**Postdoctoral Fellow — Technical University of Munich, Germany** Investigated functionalised electrode surfaces in Professor Katharina Krischer’s group using scanning tunnelling microscopy and electrochemical methods, with emphasis on interfacial catalysis and enhanced electrochemical CO_2 conversion.
Feb 2007–Jun 2011	**PhD Candidate — Leibniz Institute for Solid State and Materials Research (IFW Dresden)** Developed strain-engineered rolled-up nanomembranes, catalytic microtubular engines and microfluidic transport systems in Professor Oliver G. Schmidt’s group for controlled propulsion, pumping and energy-conversion applications.

EDUCATION

2012	**PhD in Physical Chemistry, magna cum laude — Leibniz Institute for Solid State Research and Chemnitz University of Technology, Germany** Doctoral research in integrative nanoscience conducted at IFW Dresden and the Max Planck Institute for Solid State Research, Stuttgart; strain-engineered nanomembranes and catalytic micro-/nanomachines with direct relevance to microfluidics, sensing and biomedical microrobotics. Supervisor: Prof. Oliver G. Schmidt
2003–2006	**Master of Science in Engineering Physics — Technical University of Munich, Germany** Walter Schottky Institute; interdisciplinary training in engineering physics, semiconductor and nanoscale device science, measurement and quantitative analysis. Supervisors: Prof. G. Abstreiter and Prof. M. Tornow
2004	**Exchange Study in Chemistry** **Princeton University and Columbia University in the City of New York, USA** Conducted research on STM characterisation of organic-molecule self-assembly on electrode surfaces in Prof. George Flynn's group at Columbia University, and organophosphonate-based biofunctionalisation of silicon surfaces for silicon-on-insulator biosensor development in Prof. Jeffrey Schwartz's group at Princeton University
2003	**Diploma in Mechanical Engineering and Materials Science — Kyrgyz-Russian Slavic University, Kyrgyzstan** Diploma research on the effects of powder-milling parameters and particle-size distribution on the processing and properties of ceramic materials. Supervisor: Prof. Yakov I. Rudaev.

COMPETITIVE RESEARCH FUNDING

Funding leadership summary. Secured six competitive and institutional awards as Principal Investigator totalling RMB 4.75 million (approximately USD 655,000 using the indicative conversions shown below). Awards span national, municipal, talent-program and university schemes. Additional participation in international consortia is reported separately; consortium figures denote total project awards rather than funds personally held or controlled.

Grants as Principal Investigator

Period	Sponsor / project	Role / funding
2022–2023	**National Natural Science Foundation of China, RFIS-II** *High-Performance Membraneless Hydrogen Peroxide Fuel Cells with Three-Dimensional Electrodes*	**PI:** RMB 800,000 (approx. USD 110,000)
2019–2021	**National Natural Science Foundation of China, International Scholar Grant** *Bio-Inspired Multifunctional Hydrogel Nano-/Micromotors for Water Purification*	**PI:** RMB 600,000 (approx. USD 83,000)
2015–2018	**Central Government of the People's Republic of China, Young "1000 Talent" Start-Up Grant**	**PI:** RMB 2,000,000 (approx. USD 275,000)
2015–2016	**Fudan University Start-Up Grant**	**PI:** RMB 1,000,000 (approx. USD 138,000)

Period	Sponsor / project	Role / funding
2017–2018	**Shanghai Municipal Education Commission, Shanghai "Dawn Program"** *Self-Powered Micro-Engine, Rotor, and Pump for Clean Energy Conversion*	**PI:** RMB 250,000 (approx. USD 35,000)
2021	**Fudan University "Zero to One" Program** *Energy Conversion Based on Colloidal Motors in Non-Equilibrium Conditions*	**PI:** RMB 100,000 (approx. USD 14,000)

Collaborative, International, and Mobility Grants

Period	Sponsor / project	Role / funding
2019 call	**BRICS STI Framework Programme — China, India and Russia** Bioactive Ultrasound-Driven Microbubbles for Theranostics.	**Research contributor** Total consortium award: RMB 1,600,000 (approximately USD 220,000).
2009–2011	**Volkswagen Foundation, Germany; Grant I/84 072** *Rolled-Up Integrative Bioanalytic Microsystem for Single-Cell and Biological Applications*	**Research contributor** Total project award: EUR 6,300,000 (approximately USD 6,800,000).
2011–2013	**German Federal Ministry of Education and Research (BMBF)** *iC4 Cluster: Integrated Carbon Dioxide Capture, Conversion and Cycling*	**Research contributor** Total cluster award: EUR 5,000,000 (approximately USD 5,400,000).
2005	**DFG Germany / Princeton University** *A Novel Method of Biofunctionalization of Silicon Surfaces by Organophosphonates for Electrical Detection of DNA Hybridization*	**Participant; research travel grant**
2004	**Columbia University in the City of New York** *Scanning Tunneling Microscopy of Self-Assembled Monolayers of Molecules at the Solid–Liquid Interface*	**Visiting student grant**

RESEARCH PROGRAM LEADERSHIP AND TEAM DEVELOPMENT

Research program established through six PI awards totalling RMB 4.75 million, 21 corresponding-author papers, two patent assets, six completed PhD supervisions or co-supervisions, seven academic years of course leadership, and research partnerships spanning Australia, China, Germany, the United States, Canada, India and Russia.

Funding and project direction. Obtained and administered six PI awards spanning hydrogel micro-/nanomotors for water purification, active materials, microfluidic energy conversion, colloidal motors and three-dimensional-electrode fuel cells; developed project concepts, work plans, collaborations, reporting and publication pathways.

Multidisciplinary coordination. Directed project-based teams connecting materials science, physical chemistry, engineering physics, microfluidics, sensing, imaging and device development, with collaborators across seven countries and participation in BRICS, Volkswagen Foundation and BMBF-supported research activity.

Researcher development. Supervised or co-supervised six completed PhD researchers and mentored master's, undergraduate and postdoctoral researchers. Documented trainee outcomes include graduate distinctions, government scholarships, innovation awards, international mobility and progression to professorial and senior technology-industry roles.

Publication and translation leadership. The publication record identifies 21 corresponding-author papers across advanced materials, active matter, microfluidics, hydrogels, microrobotics, fuel-cell microsystems and biomedical technologies. Translation outputs comprise a granted patent for real-time micromotor imaging, tracking and control and a published patent application for surfactant-enhanced membraneless hydrogen peroxide fuel cells.

INDUSTRY ENGAGEMENT AND INTERNATIONAL PARTNERSHIPS

- Developed and led research programs linking functional materials, nanomembranes, microfluidics, biomedical imaging, microbubbles and theranostics, biosensing, microrobotics, environmental remediation and clean-energy microsystems.
- Built an intellectual-property portfolio comprising one granted patent in real-time micromotor imaging, tracking and control and one published patent application for surfactant-enhanced membraneless hydrogen peroxide fuel cells.
- Participated in nanotechnology commercialisation and innovation-bridge activity through the Jiangsu–Ontario Nanotech Innovation Center and Suzhou Industrial Park.
- Played a coordinating role in establishing the Fudan–Skoltech Memorandum of Understanding for institutional collaboration in science and technology.
- Built cross-border research collaborations involving Australia, China, Germany, the United States, Canada, India and Russia, including BRICS-linked research activity.
- Founded NanoTRIZ Innovation Institute as a distributed research and innovation platform integrating structured problem formulation, evidence assessment, responsible AI-assisted workflows and translation-oriented research mentoring; its Junior Research Scholar Program has attracted more than 350 expressions of interest.

TEACHING AND ACADEMIC PROGRAM LEADERSHIP

2025–present	**Founder and Program Lead, NanoTRIZ Research Scholar Program (Remote) — NanoTRIZ Innovation Institute, Australia** Designed and leads an international research-enrichment model integrating project mentoring, responsible AI-assisted workflows, literature analysis, research communication, TRIZ-based problem formulation and translational innovation training. The Junior Research Scholar Program has generated more than 350 expressions of interest internationally.
2016–2023	**Curriculum Development and Teaching Leadership — Fudan University** Developed interdisciplinary content under the university's "Double First-Class" framework, connecting microfluidics, nanotechnology, functional materials, device fabrication, biomedical applications and research translation across taught and project-based learning.
2016–2023	**Microfluidics and Lab-on-a-Chip — Fudan University** Designed, coordinated and delivered a semester course over seven academic years. Content covered transport at the microscale, droplet and capsule technologies, microfabrication, diagnostics, pharmaceutical and biomedical applications and environmental analysis, supported by design projects, technical presentations and research-literature evaluation.

2016, 2018	**Materials in Life — Fudan University** Four-week international intensive on biomaterials, smart materials, nanotechnology, and sustainable technologies for health, energy, and environmental applications.
2012	**Self-Organization in Physical Science: Patterns, Chaos, and Rhythms — Technical University of Munich** Seminar on nonlinear dynamics, self-organization, fractals, chaos, pattern formation, and rhythmic processes.
2009–2011	**Nanomachines: Self-Propelled Catalytic Nanomotors — IFW Dresden** Laboratory instruction in catalytic tubular nanomotor design, fabrication, characterisation, and applications.
2000–2003	**Physics and Mathematics — Private tutoring** Individual instruction for students preparing for advanced study in science and engineering.
Approach	**Contemporary, Inclusive and Research-Integrity-Focused Teaching Practice** Uses active and flipped learning, design projects, literature mapping, staged technical presentations, peer critique, transparent rubrics and structured feedback. Responsible AI use is framed through verification, disclosure, source checking and research-integrity expectations.

RESEARCH TRAINING, MENTORING, AND SUPERVISION

Supervised or co-supervised six completed PhD researchers and mentored master's, undergraduate and postdoctoral researchers in microfluidics, biomedical microtechnologies, catalytic micromotors, nanomembranes, hydrogel micro-/nanomotors, microbubbles and bioinspired microstructures. Supervisory practice combines project scoping, experimental design, research integrity, publication strategy, staged feedback and career development. Documented outcomes include Fudan graduate awards, national scholarships, international mobility, professorial appointments, progression to leading universities and senior technology-industry roles.

Selected Graduate Supervisees

Hong Zhu - PhD, 2022

Thesis: Novel Hydrogel Materials and Their Motility Characteristics for Miniaturized Robots

Selected distinctions: Most Energetic Award, 2nd "Si Ji Qing" Youth Forum (2021); Outstanding Graduate Student (2021); Shanghai MindMotion Scholarship (2021); Top Graduate Student Scholarship (2017, 2020); Silver Award, 12th "Challenge Cup" College Students Business Plan Competition (2020); Chinese Government Scholarship for Visiting PhD Study (2020); First Prize, 6th "Pan-Sea Cup" College Students Innovation Competition (2020).

Jinrun Liu - PhD, 2022

Thesis: Microfluidic-Based Fabrication of Microstructures and Applications in Transformable Microrobots

Selected distinctions: First-Class Scholarship (2018); Second-Class Scholarship (2020).

Hong Chen - Master's, 2021

Thesis: Study on Microfluidic Fabrication of Structural-Colored Microbubbles and Their Coloration Mechanism

Selected distinctions: First-Class Scholarship (2018); Second-Class Scholarship (2020).

Xiaojie Shi - Master's, 2021

Thesis: A Strain-Engineered Helical Structure as a Self-Adaptive Magnetic Microswimmer

Selected distinctions: Outstanding Graduate Student, Fudan University; Excellent Member of the Communist Youth League; Excellent Student, Fudan University.

Summayah Naeem - PhD, 2021

Thesis: Mechanism and Optimization of Catalytic Micromotors Made of Inorganic Nanomembranes

Selected distinctions: Chinese Government Scholarship for Graduate Study.

Selected Former Postdoctoral Researchers and Trainee Outcomes

- Dr Vladimir Bolanos — Senior Engineer, Infineon Technologies, Germany
- Dr Jawayria Mujtaba — Associate Professor, Anhui Normal University, China
- Walther Shen — continued academic trajectory at Northwestern University, USA
- Wei Chenyun — continued academic trajectory at Cornell University, USA

HONOURS, FELLOWSHIPS, AND DISTINCTIONS

2024	**Australian Global Talent Program, Permanent Residency (Subclass 858)** — Government of Australia
2021	**Graduate Student Supervisor "Best 10 Groups" Award** — Fudan University, China
2018	**Emerging Leader Award** — IOP Publishing / Institute of Physics, UK
2016	**Shanghai "Dawn Program" Award** — Shanghai Municipal Government, China
2015	**"1000 Talents" Program Award for High-Level Foreign Expert** — People's Republic of China
2015	**Feodor Lynen Research Fellowship** — Alexander von Humboldt Foundation, Germany
2012	**STIBET–DAAD Prize for International Scholars** — Technical University of Munich, Germany
2011	**Guinness World Record: World's Smallest Man-Made Jet Engine** — Guinness World Records, 2012 Edition
2010	**DECHEMA Honourable Mention** — Society for Chemical Engineering and Biotechnology, Germany
2009	**DSM Science & Technology Award Finalist** — DSM, Zürich, Switzerland
2001	**First Place, National Students' Olympiad in Theoretical Mechanics** — Kyrgyzstan

PATENTS

1. Xu, J.; Fan, S.; Liu, X.; Zheng, X.; Ark, Y.; Solovev, A. A.; Yang, H.; He, Y. Real-Time Imaging and Tracking Methods for Micromotors, and Device and Control Method for Micromotors. China Patent No. CN113397591B; Application No. 202110665439.6; Certificate No. 5616219. Granted 2022.
2. Solovev, A. A.; Mei, Y.; Huang, G.; Xu, K.; Zhu, F.; Chen, G. Method for Improving Performance of Membrane-Free Hydrogen Peroxide Fuel Cell by Using Surfactant. China Patent Application No. CN117438627A. Filed 2023; published 2024.

EDITORIAL LEADERSHIP AND PEER REVIEW

2025–present	**Founder and Editor-in-Chief — SciViD, Publisher of Video Science** Developing video-science publishing platform. Leads editorial strategy, author guidance, peer-review framework, platform structure, editorial-board development and international outreach, with emphasis on experimental transparency, reproducibility and visual scientific communication.

2024	**Invited Guest Editor — Springer Nature** Applied-sciences journal/collection covering micro- and nanodevices, functional materials, sensors, microfluidics, and fluidic systems.
2020–2021	**Guest Editor — Micromachines (MDPI)** Special Issue: “Dream Nanomachines”.

Peer-Review Service

Completed more than 50 journal reviews. Reviewer for leading international journals including Advanced Materials, Advanced Functional Materials, ACS Nano, Nano Letters, Small, Nanoscale, Angewandte Chemie International Edition, Journal of the American Chemical Society, Progress in Materials Science, Materials Today, Accounts of Materials Research, ACS Applied Materials & Interfaces, ACS Catalysis, Langmuir, Applied Physics Letters, Lab on a Chip, Soft Matter, Sensors and Actuators B: Chemical, Scientific Reports, Micromachines and other Journals. Review activity has focused on originality, methodological rigour, experimental reproducibility, mechanistic interpretation, and interdisciplinary significance.

SELECTED INVITED TALKS, SEMINARS, AND CONFERENCES

Selected record from more than 30 invited presentations, seminars, and conference contributions.

Year	Venue / role	Presentation
2024	**Invited seminar** - University of Melbourne, Australia	Breaking Down Barriers Among Disciplines: From Nanotech Records to Global Academic Networks
2023	**Invited speaker; Plenary Session Chair** - IEEE MARSS, Abu Dhabi, UAE	High-Performance Hydrogen Peroxide Fuel Cells
2022	**Invited speaker** - International Conference on Frontier Materials, Zhuhai, China	Perspectives on Chemical Machines, Robots and Computers
2020	**Invited talk** - Technion — Israel Institute of Technology	Man-Made Nanomachines: Discovery and Applications
2019	**Co-organiser** - Fudan University, China	Celebration of 10 Years Nanorockets Research
2019	**Invited talk** - Hefei University, China	Man-Made Nano- and Micromachines
2019	**Invited speaker** - The University of Hong Kong	Man-Made Micro- and Nanomachines
2019	**Invited speaker** - The Chinese University of Hong Kong	Nanoparticle-Shelled Microbubbles
2019	**Invited speaker** - 2nd International Conference on Nanomotors, Harbin, China	Catalytic Nanomotors: Man-Made Nanomachines
2018	**Invited speaker** - 7th China Soft Matter Day, Chengdu, China	Nanoparticle-Shelled Bubbles and Hydrogel Microcapsules for Dynamic Materials

Year	Venue / role	Presentation
2018	**Invited speaker** - Soochow University, China	Man-Made Nanomachines: History and Applications
2017	**Invited speaker** - 1st International Conference of Nanomachines, Wuhan, China	The Smallest Man-Made Nanomotor
2016	**Invited speaker** - Conference of Higher Education, Shaanxi Province, China	How Do Chinese Universities Become Leading Without Losing Their National Characteristics?
2016	**Invited speaker** - Micro- and Nanomotors Workshop, Shenzhen, China	Biocompatible Microengines for Bio-Applications
2015	**Invited speaker** - ChiNANO Conference, Suzhou, China	Self-Propelled Nanojets for Cargo Delivery
2015	**Invited talk** - AVS International Shanghai Conference, China	Man-Made Micro- and Nanomachines
2015	**Invited seminar** - University of Toronto, Canada	The Reversed Fuel Cell: Converting Carbon Dioxide into Fuels
2014	**Invited talk** - Max Planck Institute for Intelligent Systems, Stuttgart, Germany	Nanomotors for Interdisciplinary Research
2014	**Invited talk** - Skolkovo Institute of Science and Technology, Russia	Shapeable Nanomembranes: Concepts and Perspectives of a 3D Nanoworld
2013	**Invited talk** - Massachusetts Institute of Technology, USA	The Smallest Man-Made Jet Engine
2011	**Invited seminar** - Ludwig Maximilian University of Munich, Germany	Catalytic Nanojet Engines in Applications for Nanotechnology
2011	**Invited talk** - Max Planck Institute of Biochemistry, Martinsried, Germany	Synthetic Catalytic Nanomachines
2011	**Invited talk** - Technical University of Munich, Germany	Catalytic Microjet Engines
2008	**Invited / award presentation** - DSM Science and Technology Awards, Switzerland	Self-Assembled Microjet Engines
2004	**Invited talk** - Columbia University, USA	Biofunctionalized Thin-Film SOI Transistors for DNA Biosensing Applications

INSTITUTIONAL, GOVERNMENTAL, AND PUBLIC ENGAGEMENT

2025	Submitted a proposal for a Brisbane microfluidics innovation hub; received formal acknowledgement from the Lord Mayor of Brisbane and referral to Brisbane Economic Development Agency for further engagement
2023	Invited expert commentator on Chinese national television on clean-energy innovation and CO_2 conversion.
2021	Coordinating role in establishing the Fudan–Skoltech Memorandum of Understanding for science and technology cooperation.
2021	Faculty mentor/adviser, Fudan University Top Ten “Three-Good” Graduate Student Team (Materials Science “Mina” doctoral team).
2019	Strategic academic-cooperation discussion with Prof. Cai Jingmin, Party Secretary of Hefei University, China.
2018	Participant in an official Shanghai briefing on international development, foreign-expert engagement, and science and technology cooperation.
2016	Invited scientific delegate attending a meeting with Premier Li Keqiang at the Great Hall of the People, Beijing.
2016	Formal acknowledgement from the State Administration of Foreign Experts Affairs of P. R. China for contribution to international expert exchange and Silk Road-related academic engagement.
2016	Invited foreign expert at a meeting with the Mayor of Shanghai.
2016–2018	Nanotechnology-commercialisation engagement with the Jiangsu–Ontario Nanotech Innovation Center / Suzhou Industrial Park.
2013	Invited visit to the Massachusetts Institute of Technology through the MIT–Skoltech Initiative; technical presentation and discussions on research, education, and innovation.

PROFESSIONAL MEMBERSHIPS AND LEARNED SOCIETIES

- Sigma Xi, The Scientific Research Honor Society — Full Member, 2026–present
- Harvard Club of Australia — Full Member, 2026–present

SELECTED MEDIA AND SCIENTIFIC RECOGNITION

- Guinness World Record recognition for a 600 nm, 1 pg micro-/nanojet described as the world’s smallest man-made jet engine.
- IFW Dresden / idw press release, “Guinness-Rekord: Kleinster Düsenantrieb der Welt.”
- Nanowerk News, Scinexx, Pro-Physik, and Spektrum der Wissenschaft coverage of the Guinness-certified micro-/nanojet.
- MIT / The Tech public lecture listing: “The Smallest Man-Made Jet Engine (Guinness World Record).”
- Nanowerk Spotlight features on catalytic microstriders and tubular catalytic microbots.
- RSC Nanoscale Blog coverage of self-propelled micro-/nanosystems and rolled-up magnetic microdrillers.
- Additional coverage in Zeit Wissen, Welt.de, Bild, derStandard.at, and educational science media.

PUBLICATIONS AND SCHOLARLY OUTPUTS

Selected Research Contributions in Materials Science, Engineering, Energy and Biomedical Applications

Representative outputs trace a sustained materials-science trajectory from strain-engineered nanomembranes and three-dimensional micro-/nanoarchitectures to functional active materials, energy-conversion microsystems, microfluidics, biomaterials, sensing, imaging and biomedical microrobotics. The complete publication record follows.

Strain-engineered nanomembranes and functional microstructures. Foundational work established rolled-up nanomembranes, catalytic microtubes, microstriders and self-propelled micro-/nanojets as controllable three-dimensional materials architectures for active devices, transport, pumping and microscale energy conversion (Small, 2009; Advanced Materials, 2010; Angewandte Chemie International Edition, 2011; ACS Nano, 2012).

Energy-conversion materials and microsystems. PI-led research connected catalytic interfaces, three-dimensional electrodes, hydrogen-peroxide fuel cells, valveless micropumps, hydrogen evolution and solar-fuels materials with microscale energy conversion and clean-energy applications (Advanced Materials Technologies, 2024; ACS Applied Nano Materials, 2021; University of Toronto Solar Fuels Cluster, 2015).

Multimodal biomedical imaging. Co-authored work on polymer-shell perfluoropentane nanodroplets for ultrasound, magnetic-resonance and optoacoustic imaging (Laser & Photonics Reviews 17, 2300137, 2023; DOI: 10.1002/lpor.202300137).

AI-enabled ultrasound localisation. Contributed to generative-adversarial-network acceleration of super-resolution ultrasound localisation microscopy (Acta Physica Sinica 71, 224301, 2022; DOI: 10.7498/aps.71.20220954).

Integrated biomedical microsystems. Corresponding author of the Advanced Materials review unifying micromotors, microfluidics and nanozymes as Micro-Bio-Chemo-Mechanical Systems for biomedical applications (33, 2007465, 2021; DOI: 10.1002/adma.202007465).

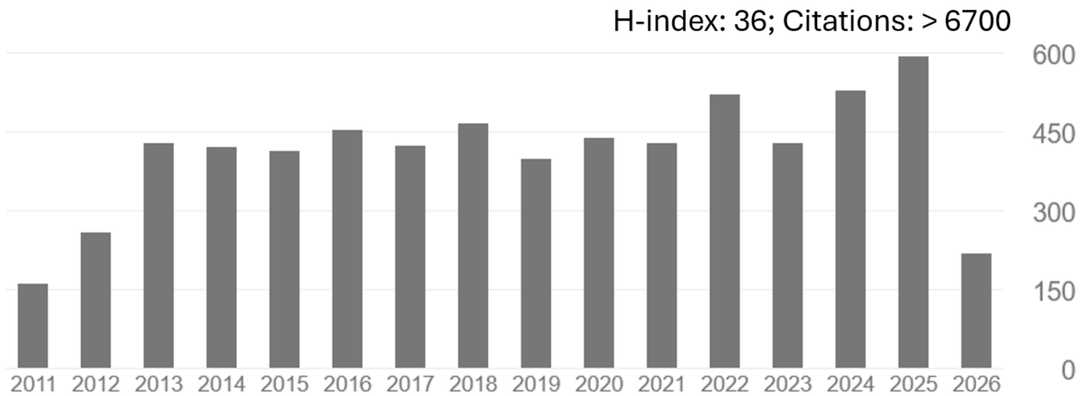
Theranostic microbubbles. Contributed to air-filled and albumin-based microbubbles functionalised for multimodal imaging and photodynamic applications (Micromachines; Nanomaterials; Colloids and Surfaces B: Biointerfaces, 2021–2024).

Hydrogel micromotors and soft microswimmers. Corresponding-author research and reviews addressed material capabilities, motility, biomedical requirements and operation in constrained microenvironments (Research, 2020; ChemNanoMat and Applied Materials Today, 2021; Current Opinion in Colloid & Interface Science, 2022).

Biomedical microrobotics. Foundational contributions include magnetic microdrillers for minimally invasive surgery (Nanoscale, 2013), self-propelled nanotools (ACS Nano, 2012), and catalytic microbots for cell manipulation and transport in microfluidic channels (Chemical Communications and JACS, 2011).

Biosensing and analytical platforms. Recent outputs span electrochemical cancer-biomarker detection, wireless sensor materials, DNA biosensing, molecular chemosensors and microfluidic analysis, connecting advanced materials with practical sensing architectures.

Imaging, tracking and control IP. Co-inventor of a granted patent covering real-time imaging, tracking and control of micromotors, providing a translation pathway from active materials to instrumented biomedical systems.



Peer-Reviewed Articles, Reviews, Book Chapters and Conference Papers

*Publication conventions: Alexander A. Solovev is highlighted in bold; * corresponding author; # equal contribution. Duplicate online/final records have been consolidated. The complete list contains 74 peer-reviewed articles, reviews, chapters and conference papers, including 21 records identifying Solovev as a corresponding author. Together with books, reports, research highlights and other scholarly materials, the CV records more than 80 total scholarly outputs.*

1. B. Mohan*; B. Najafov; H. Wen; L. M. T. Frija; **A. A. Solovev**; G. Singh; A. J. L. Pombeiro; R. K. Gupta; W. Sun. Understanding synergistic bridging of MOFs in mechanical energy harvesting through triboelectric generation. Journal of Energy Chemistry 113, 1030-1047, 2026
2. V. Virender; V. Pandey; G. Singh; P. K. Sharma; P. Bhatia; **A. A. Solovev**; B. Mohan*. Hybrid Metal-Organic Frameworks (MOFs) for Various Catalysis Applications. Topics in Current Chemistry 383, 3, 2025
3. B. Mohan, A. Kumar, K. Modi, I. M. Garazade, J. Parikh, A. Pombeiro, **A. A. Solovev***. Detecting cancer biomarkers using electrochemical composite nanomaterials tools. Vietnam Journal of Chemistry 2025. DOI: 10.1002/vjch.202300399
4. B. Mohan, R. Kadiyan, K. Modi, I. M. Garazade, J. Parikh, A. Pombeiro, **A. A. Solovev***. Heavy metal ions monitoring using molecular ligands: Optical properties and analytical performances. Vietnam Journal of Chemistry 2025. DOI: 10.1002/vjch.202300401
5. J. Parikh, K. Bhatt, K. Modi, J. Sangwan, **A. A. Solovev**, B. Mohan. Data Analysis in Bioanalysis for Interpretation of Experimental Data. Bioanalytical Techniques: Principles and Applications. Wiley 2025. DOI: 10.1002/9781394314133.ch20
6. B. Mohan, Virender, R. Kadiyan, S. Kumar, V. Gupta, B. Parshad, **A. A. Solovev**, A. J. L. Pombeiro, K. Kumar, P. K. Sharma. Carbon dioxide capturing activities of porous metal-organic frameworks (MOFs). Microporous and Mesoporous Materials 366, 112932, 2024. DOI: 10.1016/j.micromeso.2023.112932
7. J. Mujtaba, A. Kuzin, G. Chen, F. Zhu, F. S. Fedorov, B. Mohan, G. Huang, V. Tolstoy, V. Kovalyuk, G. N. Goltsman, D. A. Gorin, A. G. Nasibulin, S. Zhao, Y. Mei, **A. A. Solovev***. Synergistic Integration of Hydrogen Peroxide Powered Valveless Micropumps and Membraneless Fuel Cells: A Comprehensive Review. Advanced Materials Technologies 9, 14, 2302052, 2024
8. B. Mohan*, Virender, R. K. Gupta, A. J. L. Pombeiro, **A. A. Solovev**, G. Singh*. Advancements in Metal-Organic, Enzymatic, and Nanocomposite Platforms for Wireless Sensors of the Next Generation. Advanced Functional Materials 2024. DOI: 10.1002/adfm.202405231
9. P. Dhara, N. Shah, V. Sundaram, A. Srivastava, **A. A. Solovev**, Y. Mei, D. A. Gorin, K. K. Dey*. Influence of protein nativity on the stability of bovine serum albumin coated microbubbles. iScience 27, 3, 2024. DOI: 10.1016/j.isci.2024.109286
10. Archana Chauhan, Ashwani Kumar, Gurjaspreet Singh, **A. A. Solovev**, Jichuan Xiong, Xuefeng Liu, B. Mohan*. Photonic properties and applications of multi-functional organo-lanthanide complexes: Recent advances. Journal of Rare Earths 42, 16, 2024
11. V. Tolstoy*, K. Nikitin, A. Kuzin, F. Zhu, X. Li, G. Goltsman, D. Gorin, G. Huang*, **A. A. Solovev**, Y. F. Mei. Rapid Synthesis of Pt(0) Motors-Microscrolls on Nickel Surface via H2PtCl6-Induced Galvanic Replacement Reaction. Chemical Communications 2024. DOI: 10.1039/d3cc05766f
12. B. Mohan*, G. Singh, R. K. Gupta, P. K. Sharma, **A. A. Solovev**, A. J. L. Pombeiro, et al.. Hydrogen-bonded organic frameworks (HOFs): Multifunctional material on analytical monitoring. TrAC Trends in Analytical Chemistry 117436, 2023
13. E. A. Maksimova, D. Nozdriukhin, S. K. Kalva, S. Lyu, B. Lafci, M. A. Augath, P. G. Rudakovskaya, **A. A. Solovev**, Y. Mei, X. L. Deán-Ben*, D. Razansky*, D. A. Gorin*. Multilayer Polymer Shell Perfluoropentane Nanodroplets for Multimodal Ultrasound, Magnetic Resonance, and Optoacoustic Imaging. Laser & Photonics Reviews 17, 9, 2300137, 2023. DOI: 10.1002/lpor.202300137
14. A. Kuzin, G. Chen, F. Zhu, D. Gorin, B. Mohan, U. Choudhury, J. Cui, K. M. Modi, G. Huang, Y. Mei, **A. A. Solovev***. Bridging the Gap: Harnessing Liquid Nanomachines Know How for Tackling Harmful Airborne Particulates. Nanoscale 15, 17727, 2023
15. G. Chen, Z. Zhao, H. Zhu, **A. A. Solovev**, G. Huang, Y. Mei. Pt nanoparticle embedded metal-organic framework nanosheets for efficient alkaline hydrogen evolution. Sustainable Energy & Fuels 7, 20, 5120-5128, 2023
16. G. Chen, F. Zhu, A. S. J. Gan, B. Mohan, K. K. Dey, K. Xu, G. Huang, J. Cui, **A. A. Solovev***, Y. Mei*. Towards the next Generation of Nanorobots. Next Nanotechnology 2, 100019, 2023
17. F. Zhu, A. Kuzin, G. Chen, D. A. Gorin, B. Mohan, G. Huang, S. Zhao, Y. Mei, **A. A. Solovev***. Green Power Source: Membraneless Hydrogen Peroxide Fuel Cells with Surfactant-Mediated Performance Enhancement. Proceedings of IEEE 2023

18. F. Zhu, A. Kuzin, G. Chen, D. A. Gorin, B. Mohan, G. Huang, S. Zhao, Y. Mei, **A. A. Solovev**. Green energy for autonomous devices: Surfactant-enhanced membraneless hydrogen peroxide fuel cells. 2023 International Conference on Manipulation, Automation and Robotics at Small Scales (MARSS) 2023
19. F. Zhu, G. Chen, A. Kuzin, D. A. Gorin, B. Mohan, G. Huang, Y. Mei, **A. A. Solovev***. Membraneless Hydrogen Peroxide Fuel Cells as a Promising Clean Energy Source. JoVE 2023. DOI: 10.3791/65920
20. B. Mohan, G. Singh, A. J. L. Pombeiro, **A. A. Solovev**, P. K. Sharma, Q. Chen. Metal-organic frameworks (MOFs) for milk safety and contaminants monitoring. TrAC Trends in Analytical Chemistry 116921, 2023
21. Z. Zhao, G. S. Huang, Y. Kong, J. Cui, **A. A. Solovev**, X. Li, Y. F. Mei*. Atomic Layer Deposition for Electrochemical Energy: from Design to Industrialization. Electrochemical Energy Reviews 5, 1, 2022
22. V. Madaan, B. Mohan, V. Bhankar, R. Ranga, P. Kumari, P. Singh, M. Sillanpaa, A. Kumar, **A. A. Solovev**, K. Kumar*. Metal-Decorated CeO2 Nanomaterials for Photocatalytic Degradation of Organic Pollutants. Inorganic Chemistry Communications 110099, 2022
23. R. A. Barmin, E. A. Maksimova, P. G. Rudakovskaya, A. V. Gayer, E. A. Shirshin, K. S. Petrov, D. A. Terentyeva, O. I. Gusliakova, O. A. Sindeeva, O. A. Klimenko, R. N. Chuprov-Netochin, **A. A. Solovev**, G. Huang, A. V. Ryabova, V. B. Loschenov, D. A. Gorin*. Albumin microbubbles conjugated with zinc and aluminum phthalocyanine dyes for enhanced photodynamic activity. Colloids and Surfaces B 112856, 2022
24. Y.-H. Sui, X.-Y. Guo, J.-J. Yu, **A. A. Solovev**, D.-A. Ta, K.-L. Xu. Accelerating Super-Resolution Ultrasound Localization Microscopy Using a Generative Adversarial Network. Acta Physica Sinica 71, 22, 224301, 2022. DOI: 10.7498/aps.71.20220954
25. G. Yan, **A. A. Solovev**, G. S. Huang, J. Cui, Y. F. Mei*. Soft microswimmers: Material capabilities and biomedical applications. Current Opinion in Colloid & Interface Science 101609, 2022
26. **A. A. Solovev***. Nanomembrane Robotics. Wiley, Book Chapter ISBN-10: 3527344462, 2022
27. A. Kumar*, B. Mohan, **A. A. Solovev**, M. Saini, H. K. Sharma. Development of 2-hydroxynaphthaldehyde functionalized Schiff base chemosensor for spectroscopic and colorimetric detection of Cu2+ and Pd2+ ions. Microchemical Journal 180, 107561, 2022
28. R. A. Barmin*, P. G. Rudakovskaya, V. S. Chernyshev, E. N. Obukhova, O. I. Guslyakova, O. A. Sindeeva, E. S. Prikhozhdenko, D. N. Bratashov, A. S. Abdurashitov, E. A. Maksimova, P. A. Demina, E. V. Khaydukov, A. V. Gayer, E. A. Shirshin, **A. A. Solovev**, D. A. Gorin. Impact of fluorescent dyes on the physicochemical parameters of ultrasound-assisted formed microbubbles stabilized by albumin-dye complex. Colloids and Surfaces B 647, 129095, 2022
29. J. Liu, S. Yu, B. Xu, Z. Tian, H. Zhang, K. Liu, X. Shi, Z. Zhao, L. Chang, X. Lin, G. S. Huang, **A. A. Solovev**, J. Cui, T. Li, Y. F. Mei. Magnetically Propelled Soft Microrobot Navigating Through Constricted Microchannels. Applied Materials Today 25, 101237, 2021
30. E. A. Maksimova, R. A. Barmin, P. G. Rudakovskaya, O. A. Sindeeva, E. S. Prikhozhdenko, A. M. Yashchenok, B. N. Khlebtsov, **A. A. Solovev**, G. S. Huang, Y. F. Mei, K. K. Dey, D. A. Gorin*. Air-filled Microbubbles Based on Albumin and Functionalized with Gold Nanocages and Zinc Phthalocyanine for Multimodal Imaging. Micromachines 12, 10, 1161, 2021
31. X. Shi, J. Liu, Y. Kong, B. Xu, T. Li, **A. A. Solovev**, Y. F. Mei*. A Strain-Engineered Helical Structure as a Self-Adaptive Magnetic Microswimmer. ChemNanoMat 7, 6, 607, 2021
32. H. Chen, H. Zhu, Y. Wang, J. R. Liu, Y. Wang, X. Hu, **A. A. Solovev**, G. S. Huang, Y. F. Mei*. Structural Coloration by Internal Reflection and Interference in Hydrogel Microbubbles and Their Precursors. Advanced Optical Materials 2100259, 2021
33. S. Yan, J. Liu, X. Guo, D. Ta, G. Huang, **A. A. Solovev**, Y. Mei, K. Xu. Ultrafast ultrasound imaging for micro-nanomotors: A phantom study. 2021 IEEE International Ultrasonics Symposium 1-4, 2021
34. R. A. Barmin, P. G. Rudakovskaya, O. I. Gusliakova, O. A. Sindeeva, E. S. Prikhozhdenko, E. A. Maksimova, E. N. Obukhova, V. S. Chernyshev, B. N. Khlebtsov, **A. A. Solovev**, G. B. Sukhorukov, D. A. Gorin*. Air-Filled Bubbles Stabilized by Gold Nanoparticle/Photodynamic Dye Hybrid Structures for Theranostics. Nanomaterials 11, 2, 415, 2021
35. J. Mujtaba, L. He, H. Zhu, Z. Xiao, G. S. Huang*, **A. A. Solovev***, Y. F. Mei. Co9S8 Nanoparticles for Hydrogen Evolution. ACS Applied Nano Materials 4, 2, 1776, 2021
36. X. Lin, B. Xu, H. Zhu, J. R. Liu, **A. A. Solovev***, Y. F. Mei*. Requirement and Development of Hydrogel Micromotors towards Biomedical Application. Research, a Science Partner Journal 2020. DOI: 10.34133/2020/7659749
37. S. Naeem, F. Naeem, J. Zhang*, J. Mujtaba, K. Xu, G. S. Huang, **A. A. Solovev***, Y. F. Mei. Parameters Optimization of Catalytic Tubular Nanomembrane-Based Oxygen Microbubble Generator. Micromachines 11, 7, 643, 2020

38. S. Naeem, J. Mujtaba, F. Naeem, K. Xu, G. S. Huang*, **A. A. Solovev***, J. Zhang, Y. F. Mei. Catalytic/magnetic assemblies of rolled-up tubular nanomembrane-based micromotors. RSC Advances 10, 60, 36526, 2020
39. V. P. Tolstoy, L. B. Gulina*, **A. A. Solovev**, G. S. Huang, V. E. Gurenko, Y. F. Mei*. Interface technique as a simple method to produce inorganic microtubes. Progress in Natural Science: Materials International 30, 3, 279, 2020
40. J. Liu, C. Hong, X. Shi, S. Nawar, J. Werner, G. S. Huang, M. Ye, D. A. Weitz, **A. A. Solovev***, Y. F. Mei*. Water cleaning using hydrogel micro-capsules containing photocatalytic nanoparticles. Environmental Science: Nano 2020. DOI: 10.1039/C9EN01108K
41. L. Adams, D. Lee*, Y. F. Mei, D. A. Weitz, **A. A. Solovev***. Nanoparticle-shelled catalytic bubbles micromotors. Advanced Materials Interfaces 2020. DOI: 10.1002/admi.201901583
42. C. Li, J. Zhang, S. Wang, Z. Zhu, H. Li*, A.-B. Xu, Y. Yu, X. Wang, J. Yao, L. Wang*, **A. A. Solovev**, L. He*. Silica nanocapsules with unusual shapes accessed by simultaneous growth of the template and silica nanostructure. Chemistry of Materials 32, 1, 575, 2020
43. C. Li, Y. Yu, L. Wang*, S. Zhang, J. Liu, J. Zhang, A.-B. Xu, Z. Wu, J. Tong, S. Wang, M. Xiao, Y. Fang, J. Yao, **A. A. Solovev**, B. Dong, L. He. A step-by-step strategy for controlled preparations of complex heterostructured colloids. Chemistry of Materials 31, 22, 9513, 2019
44. S. Naeem, F. Naeem, J. Liu, V. A. Bolanos Quinones, J. Zhang, L. He, G. Huang, **A. A. Solovev***, Y. F. Mei*. Oxygen Microbubble Generator Enabled by Tunable Catalytic Microtubes. Chemistry - An Asian Journal 14, 2431, 2019
45. W. Ying, G. S. Huang*, **A. A. Solovev**, Y. F. Mei. Light controlled two dimensional TiO2 plate micromotors. RSC Advances 9, 29433-29439, 2019
46. S. Naeem, F. Naeem, M. Manjare, F. Liao, V. A. Bolanos Quinones, G. S. Huang, **A. A. Solovev***, Y. F. Mei*. Tubular catalytic micromotors in transition from unidirectional bubble sequences to more complex bidirectional motion. Applied Physics Letters 114, 033701, 2019
47. H. Zhu, S. Nawar, J. G. Werner, J. Liu, G. Huang, Y. F. Mei, D. A. Weitz*, **A. A. Solovev***. Hydrogel micromotors with catalyst-containing liquid core and shell. Journal of Physics: Condensed Matter 31, 214004, 2019
48. J. Werner, S. Nawar, **A. A. Solovev**, D. A. Weitz*. Hydrogel Microcapsules with Dynamic pH-Responsive Properties from Methacrylic Anhydride. Macromolecules 51, 5798, 2018
49. Y. Zhang, H. Zhu, W. Qiu, Y. Zhou, G. Huang*, Y. Mei, **A. A. Solovev***. Biocompatible CO2 bubble-propelled microengines in carbonated water and beverages. Chemical Communications 2018. DOI: 10.1039/c8cc01011k
50. C. Li, S. Zhang, B. Zhang, J. Liu, H. Li, H. Zhou, **A. A. Solovev**, R. Tang, F. Bao, J. Yu, B. Sun, Y. Lifshitz, L. He, X. Zhang. Local curvature controlled non-epitaxial growth of hierarchical nanostructures. Angewandte Chemie International Edition 130, 3834, 2018
51. E. Riyanto, Z. Yuting, G. Huang, S. J. Shi, Z. Jing, **A. A. Solovev**, Y. F. Mei*. TiO2 nanosheets synthesized by atomic layer deposition for photocatalysis. Progress in Natural Science 26, 5, 493-499, 2016
52. S. Sanchez, W. Xi, **A. A. Solovev**, L. Soler, V. Magdanz, O. G. Schmidt. Tubular Micronanorobots: Smart Design for Bio-related Applications. Small-Scale Robotics: From Nano-to-Millimeter-Sized Robotic Systems and Applications. Lecture Notes in Computer Science, Springer 8336, 16-27, 2014
53. W. Xi, **A. A. Solovev**, A. N. Ananth, D. H. Gracias, S. Sanchez*, O. G. Schmidt*. Magnetic Micro-drillers: Towards Minimally Invasive Surgery. Nanoscale 5, 1294, 2013
54. S. Sanchez, W. Xi, **A. A. Solovev**, O. G. Schmidt. Self-propelled nanotools drilling into cells and tissues. Nanotechnology in Biomedical Engineering 426-428, 2013
55. G. Wang, **A. A. Solovev**, G. Huang, M. Maitz, N. Huang, Y. F. Mei*. Dynamic curvature control of rolled-up metal nanomembranes activated by magnesium. Journal of Materials Chemistry 22, 12983, 2012
56. **A. A. Solovev**, W. Xi, D. H. Gracias, S. Harazim, C. Deneke, S. Sanchez, O. G. Schmidt*. Self-Propelled Nanotools. ACS Nano 6, 1751, 2012
57. **A. A. Solovev**, E. Smith, Carlos C. Bof' Bufon, S. Sanchez*, O. G. Schmidt*. Light-Controlled Propulsion of Catalytic Microengines. Angewandte Chemie International Edition 50, 10875-10878, 2011
58. S. Sanchez, **A. A. Solovev**, S. Harazim, Ch. Deneke, Y. F. Mei, O. G. Schmidt*. The Smallest Man-Made Jet Engine. The Chemical Record 11, 367, 2011
59. **A. A. Solovev***, S. Sanchez*, Y. F. Mei, O. G. Schmidt. Tunable Catalytic Tubular Micropumps Operating at Low Concentration of Hydrogen Peroxide. Physical Chemistry Chemical Physics 13, 10131, 2011
60. U. Vogl, A. Sass, F. Vewinger, M. Weitz*, **A. A. Solovev**, Y. F. Mei, O. G. Schmidt*. Light Confinement by a Cylindrical Metallic Waveguide in a Dense Buffer Gas Environment. Physical Review A 83, 053403, 2011

61. S. Sanchez*, **A. A. Solovev**, S. Harazim, O. G. Schmidt. Microbots Swimming in the Flowing Streams of Microfluidic Channels. Journal of the American Chemical Society 133, 701, 2011

62. S. Sanchez*, **A. A. Solovev**, S. Schulze, O. G. Schmidt. Controlled Manipulation of Multiple Cells using Catalytic Microbots. Chemical Communications 47, 698, 2011

63. S. Sanchez*, **A. A. Solovev**, Y. F. Mei, O. G. Schmidt. Dynamics of Biocatalytic Micro-Engines Mediated by Variable Friction Control. Journal of the American Chemical Society 132, 13144, 2010

64. **A. A. Solovev**, Y. F. Mei*, O. G. Schmidt. Catalytic Micro-Strider at the Air-Liquid Interface. Advanced Materials 22, 4340, 2010

65. **A. A. Solovev**, S. Sanchez*, M. Pumera, Y. F. Mei*, O. G. Schmidt. Magnetic Control of Catalytic Microbots for the Delivery and Assembly of Microobjects. Advanced Functional Materials 20, 2430, 2010

66. O. G. Schmidt, Y. F. Mei, G. S. Huang, **A. A. Solovev**, E. Bermudez Urena, I. Monch, F. Ding, T. Reindl, R. K. Y. Fu, P. K. Chu. Massgeschneiderte Nano-Komponenten: Herstellung und Funktionalisierung (MANAKO): Abschlussbericht: Berichtszeitraum: 01.07.2007-30.11.2008. Technische Informationsbibliothek, Hannover 2009

67. **A. A. Solovev**, Y. F. Mei*, E. B. Urena, G. S. Huang, O. G. Schmidt*. Catalytic Microtubular Jet Engines Self-Propelled by Accumulated Gas Bubbles. Small 5, 1688, 2009

68. Y. F. Mei*, G. S. Huang, **A. A. Solovev**, E. B. Urena, I. Monch, F. Ding, T. Reindl, R. K. Y. Fu, P. K. Chu, O. G. Schmidt*. Versatile Approach for Integrative and Functionalized Tubes by Strain Engineering of Nanomembranes on Polymers. Advanced Materials 20, 4085-4090, 2008

69. J. Mujtaba#, J. Liu#, K. K. Dey, T. Li, R. Chakraborty, K. L. Xu, D. Makarov, R. A. Barmin, D. A. Gorin, V. P. Tolstoy, G. S. Huang, **A. A. Solovev***, Y. F. Mei*. Micro-Bio-Chemo-Mechanical-Systems: Micromotors, Microfluidics, and Nanozymes for Biomedical Applications. Advanced Materials 33, 22, 2007465, 2021. DOI: 10.1002/adma.202007465

70. S. Naeem, F. Naeem, J. Mujtaba, A. K. Shukla, S. Mitra, G. S. Huang, L. Gulina, P. Rudakovskaya, J. Cui, V. Tolstoy, D. Gorin, Y. F. Mei, **A. A. Solovev**, K. K. Dey. Oxygen Generation Using Catalytic Nano/Micromotors. Micromachines 2021. DOI: 10.3390/mi12101251

71. V. A. Bolanos Quinones, H. Zhu, **A. A. Solovev**, Y. F. Mei, D. H. Gracias*. Origami Biosystems: 3D assembly methods for biomedical applications. Advanced Biosystems 2018. DOI: 10.1002/adbi.201800230

72. H. Ning, Y. Zhang, H. Zhu, A. Ingham, G. Huang*, Y. Mei, **A. A. Solovev***. Geometry Design, Principles and Assembly of Micromotors. Micromachines 9, 75, 2018

73. **A. A. Solovev**, S. Sanchez*, O. G. Schmidt. Collective Behaviour of Self-Propelled Catalytic Micromotors. Nanoscale 5, 1284, 2013

74. Y. F. Mei, **A. A. Solovev**, S. Sanchez*, O. G. Schmidt. Rolled-up Nanotech on Polymers: From Basic Perception to Self-Propelled Catalytic Microengines. Chemical Society Reviews 40, 2109, 2011

Research Highlights, Reports, and Brochures

1. S. Sanchez, **A. A. Solovev**, E. J. Smith, C. C. Bof' Bufon, V. M. Fomin, A. N. Ananth, M. Viehrig, O. G. Schmidt. External Sources for controlling the propulsion of self-propelled microjet engines. Annual Report, IFW Dresden 2011

2. S. Sanchez, **A. A. Solovev**, S. Schulze, S. M. Harazim, Y. F. Mei, O. G. Schmidt. Catalytic and Biocatalytic Microbots. Annual Highlight, IFW Dresden 39-41, 2010

3. **A. A. Solovev**, Y. F. Mei, O. G. Schmidt. Nanorocket Experiments for High School. DECHEMA: Chemical & Biological Society, Brochure for High School, Marburg 2010

4. **A. A. Solovev**, S. Sanchez, Y. F. Mei, O. G. Schmidt. Wireless Control of Tubular Catalytic Microbots for the Transportation and Delivery of Microobjects. Annual Report, IFW Dresden 2009

5. **A. A. Solovev**, Y. F. Mei, S. Harazim, C. Deneke, G. S. Huang, O. G. Schmidt. Self-Propelled Microjets at Low Reynolds Number. Annual Highlight, IFW Dresden 44-46, 2008

Books and Academic Guides

1. **Solovev, A. A.**. Academic Career Guide: A Visiting Scholar at Harvard University. Kindle edition 2022. ASIN: B0BDW2GHM5

2. **Solovev, A. A.**. Publishing an Academic Review Paper: Scientists' Strategies for Effective Publishing. Kindle edition 2022. ASIN: B0BGCC3B89

3. **Solovev, A. A.** *Strain-Tunable Nanomembranes and Their Applications*. WILEY, book manuscript in preparation, under contract.

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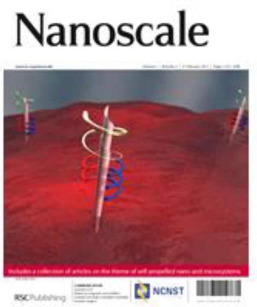

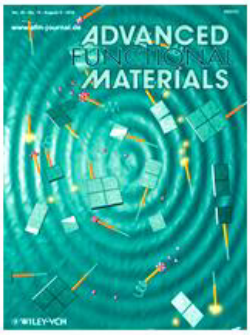

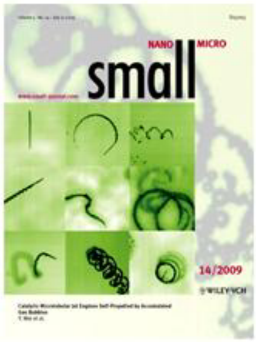

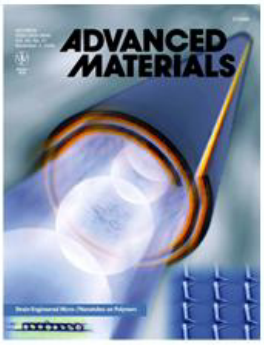

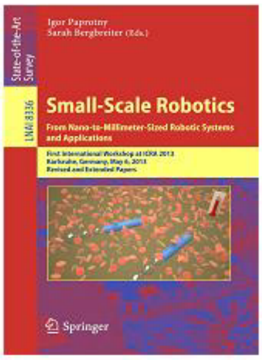

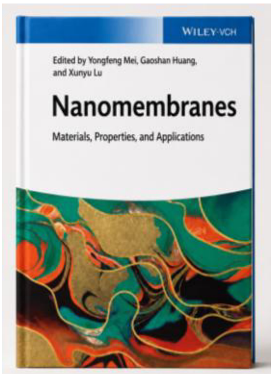

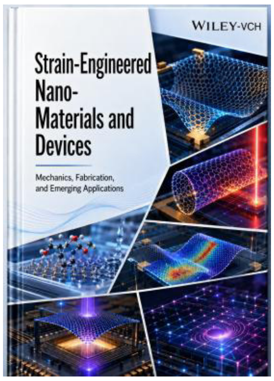

RESEARCH SUMMARY

Strain-Engineered Nanomembranes, Active Matter, Microfluidics, Functional Nano- Materials and Devices, Electrochemical Microsystems and Liquid-Interface

Alexander Solovev, PhD

Scientific vision

Scientific premise. My research develops functional materials and micro/nanosystems in which geometry, built-in strain, curvature, interfacial organisation, confinement and nonequilibrium energy flow are treated as programmable design variables alongside chemical composition. The central objective is to establish predictive, experimentally validated relationships between material architecture and emergent optical, magnetic, catalytic, mechanical, transport and sensing function.

Distinctive research position. The programme progresses from static three-dimensional thin-film architectures to dynamic, responsive and information-bearing systems. My established work spans rolled nanomembranes, catalytic and magnetic micro/nanomotors, microfluidic droplets and capsules, compact membraneless electrochemical systems, and liquid-gated thin-film sensors. These are presented below as six independent flagship programmes, each with a defined mechanism, experimental boundary and implementation pathway.

Common research logic. Each programme begins with a bounded hypothesis, measurable variables and explicit controls. Planar, passive, non-functional or compositionally matched reference systems are used to isolate mechanism; operating regimes, uncertainty, batch variation and failure modes are mapped; and models are retained only when they predict experiments not used for calibration. Applications follow from validated design rules rather than substituting for them.

Integrated research architecture

No.	Flagship programme	Fundamental focus	Application domains
1	Geometry- and strain-programmed nanomembranes	Curvature, topology and multilayer interfaces	Photonics, curved magnetism, lab-in-a-tube devices
2	Active matter and nanomotors as information-bearing systems	Energy, fluctuations, feedback and control	Active sensing, microrobotics, field reconstruction
3	Membraneless electrochemical and catalytic microsystems	Catalyst selectivity, bubbles and multiphase transport	Self-powered sensors, compact fuel cells, microreactors
4	Microfluidic soft matter for biomedical functional materials	Process-structure-property relations in soft shells	Imaging, triggered release, artificial compartments
5	Adaptive environmental materials and soft catalytic microreactors	Reaction-diffusion in permeable catalytic matrices	Remediation, water-quality monitoring, reusable reactors
6	Thin-film bioelectronics and liquid-interface sensing	Surface chemistry, screening, drift and packaging	Diagnostics, food/environmental sensing, portable bioelectronics

FLAGSHIP PROGRAMME 1. STRAIN-ENGINEERED NANOMEMBRANES AND INTEGRATIVE NANOTECHNOLOGY

Established contribution. In my early research, strain-engineered thin films were established as a practical route for transforming lithographically patterned planar multilayers into three-dimensional microtubes, helices, rolled nanomembranes and integrated lab-in-a-tube architectures [Mei et al., *Adv. Mater.*, 20, 4085–4090, 2008; Mei et al., *Chem. Soc. Rev.*, 40, 2109–2119, 2011; Wan et al., *J. Mater. Chem.*, 22, 12983–12987, 2012]. Residual stress was thereby demonstrated to be not merely a fabrication defect, but a programmable materials-design parameter through which conventional two-dimensional microfabrication could be converted into precisely defined three-dimensional functional systems [Gulina et al., *Prog. Nat. Sci.: Mater. Int.*, 30, 279–288, 2020; Solovev, "Nanomembrane Robotics," in *Nanomembranes: Materials, Properties, and Applications*, 253–285, 2022]. Rolled architectures were subsequently used to demonstrate catalytic micropropulsion, magnetic guidance, and the transport and delivery of micro-objects, establishing a direct link among thin-film mechanics, interfacial chemistry and controlled microscale motion [Solovev et al., *Small*, 5, 1688–1692, 2009; Solovev et al., *Adv. Funct. Mater.*, 20, 2430–2435, 2010; Solovev et al., *Phys. Chem. Chem. Phys.*, 13, 10131–10135, 2011]. These principles were extended to light-controlled propulsion, collective active behaviour, cell manipulation and magnetically driven microdrilling [Solovev et al., *Angew. Chem. Int. Ed.*, 50, 10875–10878, 2011; Sánchez et al., *Chem. Commun.*, 47, 698–700, 2011; Solovev et al., *Nanoscale*, 5, 1284–1293, 2013; Xi et al., *Nanoscale*, 5, 1294–1297, 2013]. Through collaborative and field-level developments, the platform was further expanded towards biointerfaces, optical resonators, curved semiconductor structures, sensor arrays, helical microswimmers and quantum-compatible cylindrical cavities [Vogl et al., *Phys. Rev. A*, 83, 053403, 2011; Bolaños Quiñones et al., *Adv. Biosyst.*, 2, 1800230, 2018; Ning et al., *Micromachines*, 9, 75, 2018; Naeem et al., *RSC Adv.*, 10, 36526–36530, 2020; Shi et al., *ChemNanoMat*, 7, 607–612, 2021]. The broader significance of this work is represented by the establishment of geometry, curvature and strain as design variables that can be engineered alongside composition to generate functions unavailable in equivalent planar materials.

Fundamental question. The central question is how magnetic, optical, electronic, catalytic and transport behaviour is reorganised by residual stress, curvature, topology, multilayer sequence, thickness, confinement and interfacial adhesion relative to compositionally matched planar structures. Elastic and electromagnetic fields may be redistributed by curvature; demagnetising factors may be modified; carrier and exciton transport may be altered; catalytic accessibility may be changed; optical modes may be concentrated; and coupling between internal and external fluidic environments may be introduced [Vogl et al., *Phys. Rev. A*, 83, 053403, 2011; Wan et al., *J. Mater. Chem.*, 22, 12983–12987, 2012; Li et al., *Angew. Chem.*, 130, 3834–3838, 2018; Ning et al., *Micromachines*, 9, 75, 2018]. These effects, however, may be confounded by surface chemistry, structural defects, strain relaxation, etching, delamination and release-induced damage. Genuine curvature- and strain-dependent function must therefore be isolated through compositionally matched planar controls, calibrated mechanical characterisation, independently fabricated batches and quantitatively predictive modelling [Bolaños Quiñones et al., *Adv. Biosyst.*, 2, 1800230, 2018; Gulina et al., *Prog. Nat. Sci.: Mater. Int.*, 30, 279–288, 2020].

Next-stage programme. Stress–thickness–curvature maps will first be established for independently fabricated semiconductor, metallic, dielectric and hybrid multilayers and will be compared with analytical and finite-element predictions. Reproducible operating regimes, instability thresholds and defect-sensitive failure modes will thereby be identified [Wan et al., *J. Mater. Chem.*, 22, 12983–12987, 2012; Gulina et al., *Prog. Nat. Sci.: Mater. Int.*, 30, 279–288, 2020]. Magnetic and magneto-elastic films will then be incorporated into rolled and helical structures so that curvature-dependent anisotropy, domain organisation, field-driven reconfiguration and mechanically coupled magnetic response can be quantified [Solovev et al., *Adv. Funct. Mater.*, 20, 2430–2435, 2010; Xi et al., *Nanoscale*, 5, 1294–1297, 2013; Shi et al., *ChemNanoMat*, 7, 607–612, 2021]. Semiconductor, two-dimensional and quantum-compatible layers will subsequently be integrated into cylindrical cavities, with micromagnetic simulation, optical spectroscopy and advanced structural characterisation being provided through specialist collaboration [Vogl et al., *Phys. Rev. A*, 83, 053403, 2011; Naeem et al., *RSC Adv.*, 10, 36526–36530, 2020; Yan et al., *Curr. Opin. Colloid Interface Sci.*, 61, 101609, 2022]. Functional coatings, catalytic interfaces, microfluidic access and embedded electrical or wireless readout will be introduced only where a defined coupling mechanism can be tested [Mujtaba et al., *Adv. Mater.*, 33, 2007465, 2021; Mohan et al., *Adv. Funct. Mater.*, 34, 2405231, 2024].

Expected scientific outcome and enabling technologies. Transferable stress-to-curvature and curvature-to-function relationships will be established so that fabrication parameters can be connected directly to measurable magnetic, optical, electronic, catalytic and transport performance. Predictive design rules will be generated for reconfigurable photonics, curved magnetism, strain-tunable electronic and quantum interfaces, adaptive microrobotic components, compact chemical and biological sensors, self-contained microreactors and multifunctional lab-in-a-tube devices. More broadly, geometry-programmed nanomembranes will be established as a general materials platform in which three-dimensional architecture is treated not as a passive fabrication outcome, but as an actively controlled source of emergent physical function.

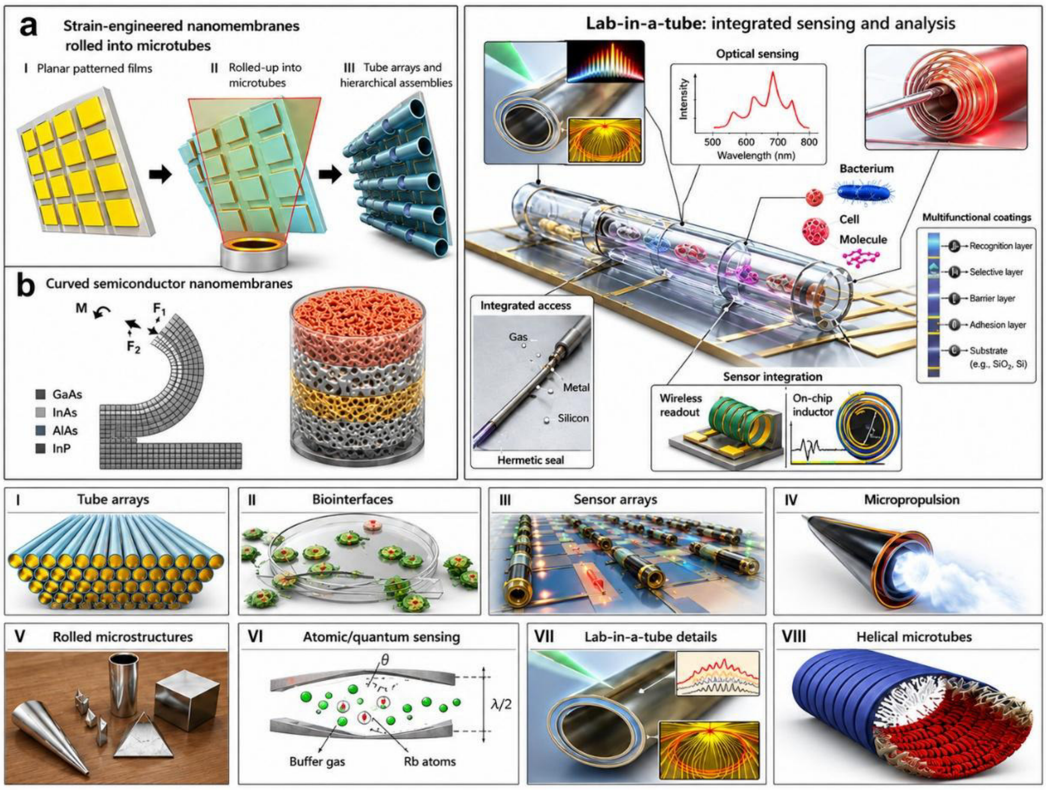

Figure 1. Geometry- and strain-programmed nanomembranes. Planar patterned multilayers roll into microtubes and hierarchical arrays; the composite illustrates curved semiconductor mechanics, integrated lab-in-a-tube sensing, biointerfaces, sensor arrays, micropropulsion, optical/quantum cavities and helical architectures. Composite figure summarising the author's published and collaborative research cited in the text.

FLAGSHIP PROGRAMME 2. ACTIVE MATTER AND NANO/-MICROMACHINES AS INFORMATION-BEARING SYSTEMS

Established contribution. Within my research, catalytic micro-/nanomotors were established as experimentally controllable nonequilibrium systems in which chemical reactions, structural asymmetry, interfacial transport and external fields are converted into directed motion. Rolled-up catalytic microtubular jet engines were demonstrated in which propulsion was generated through the accumulation and expulsion of oxygen bubbles produced by hydrogen-peroxide decomposition, providing an early platform for autonomous microscale motion [Solovev et al., *Small*, 5, 1688–1692, 2009; Sánchez et al., *Chem. Rec.*, 11, 367–370, 2011]. Magnetic layers were subsequently incorporated into tubular catalytic microbots, enabling remote steering, transport, assembly and delivery of micro-objects and thereby coupling catalytic energy conversion to programmable external control [Solovev et al., *Adv. Funct. Mater.*, 20, 2430–2435, 2010]. Propulsion at air–liquid interfaces, light-regulated velocity, low-concentration micropumping, navigation in flowing microchannels, manipulation of multiple cells and collective motor behaviour were also demonstrated [Solovev et al., *Adv. Mater.*, 22, 4340–4344, 2010; Solovev et al., *Angew. Chem. Int. Ed.*, 50, 10875–10878, 2011; Solovev et al., *Phys. Chem. Chem. Phys.*, 13, 10131–10135, 2011; Sánchez et al., *J. Am. Chem. Soc.*, 2011; Sánchez et al., *Chem. Commun.*, 47, 698–700, 2011; Solovev et al., *Nanoscale*, 5, 1284–1293, 2013]. Through later collaborative work, the materials basis of active matter was broadened to include catalytic–magnetic rolled assemblies, hydrogel micromotors, light-controlled TiO_2 plate motors, nanoparticle-shelled catalytic bubbles, strain-engineered helical microswimmers and magnetically propelled soft robots operating in confined channels [Zhu et al., *J. Phys.: Condens. Matter*, 31, 214004, 2019; Wang et al., *RSC Adv.*, 9, 29433–29439, 2019; Naeem et al., *RSC Adv.*, 10, 36526–36530, 2020; Adams et al., *Adv. Mater. Interfaces*, 7, 1901583, 2020; Shi et al., *ChemNanoMat*, 7, 607–612, 2021; Liu et al., *Appl. Mater. Today*, 25, 101237, 2021]. Magnetic bubble micromotors exhibiting rapid motion and dynamic self-assembly at liquid–gas interfaces have also been examined [Halpern et al., APS Global Physics Summit, 2026]. Collectively, these studies provide an experimental basis for treating micro-/nanomachines not only as miniature vehicles, but as active materials whose trajectories may encode information about chemical gradients, hydrodynamic flow, viscosity, confinement, boundaries, external fields and neighbouring objects [Mujtaba et al., *Adv. Mater.*, 33, 2007465, 2021; Yan et al., *Curr. Opin. Colloid Interface Sci.*, 61, 101609, 2022; Chen et al., *Next Nanotechnol.*, 2, 100019, 2023].

Fundamental question. The central question is when an active particle can be classified operationally as an information-bearing physical system rather than merely as a driven stochastic object. The trade-offs among environmental information acquisition, control accuracy, mechanical work and dissipation are expected to be governed by chemical energy input, propulsion asymmetry, rotational diffusion, wall interactions, local gradients, measurement uncertainty and feedback bandwidth. For a trajectory to be interpreted as a report of an external field or environmental state, directed responses must be separated from Brownian fluctuations, background flow, fuel heterogeneity, local heating, tracking artefacts and uncontrolled surface interactions. Operational criteria will therefore be established for distinguishing passive response, selective sensing, state estimation, feedback-dependent control and information-mediated work. In this way, established work on motor geometry, propulsion, navigation and collective behaviour will be extended towards experimentally testable questions in stochastic thermodynamics and active-matter information processing [Ning et al., *Micromachines*, 9, 75, 2018; Solovev, "Nanomembrane Robotics," in *Nanomembranes: Materials, Properties, and Applications*, 253–285, 2022; Kuzin et al., *Nanoscale*, 15, 17727–17738, 2023].

Next-stage programme. Catalytic or enzymatic active particles carrying calibrated magnetic elements will be operated within microfluidically defined chemical, geometric and hydrodynamic landscapes. Position, orientation, velocity and particle interactions will be recorded by high-speed optical imaging under real-time magnetic-field control, while fuel consumption, field input, mechanical work and dissipation will be estimated independently. The technical basis for this platform is provided by prior advances in magnetically controlled tubular motors, helical microswimmers, soft microrobots and ultrafast imaging [Solovev et al., *Adv. Funct. Mater.*, 20, 2430–2435, 2010; Shi et al., *ChemNanoMat*, 7, 607–612, 2021; Liu et al., *Appl. Mater. Today*, 25, 101237, 2021; Yan et al., IEEE International Ultrasonics Symposium, 1–4, 2021]. Passive-particle, noncatalytic, open-loop, closed-loop and no-feedback conditions will be compared so that information-dependent behaviour can be distinguished from drift, convection, local heating and image-analysis error. Mutual information, transfer entropy, entropy production, thermodynamic uncertainty bounds, bits per joule and joules per bit will be evaluated as candidate metrics, but will be retained only when they can be linked to calibrated observables, explicit system boundaries and independently validated physical models.

Expected scientific outcome and enabling technologies. Experimentally validated energy–information relationships and operating maps will be established across propulsion strength, stochastic fluctuations, sensing accuracy, feedback bandwidth and energetic cost. An experimental materials platform will thereby be created for determining when microscopic active systems acquire environmental information and convert it into controlled physical action. Enabling technologies may include active chemical and hydrodynamic sensors, trajectory-to-field reconstruction, adaptive microfluidic control, self-powered environmental probes, dynamically assembling interfaces, precision transport of cells and micro-objects, and soft microrobotic systems capable of navigation within confined or changing environments. More fundamentally, micro-/nanomachines will be established as controllable test systems for investigating how energy, information and feedback are coupled in nonequilibrium matter.

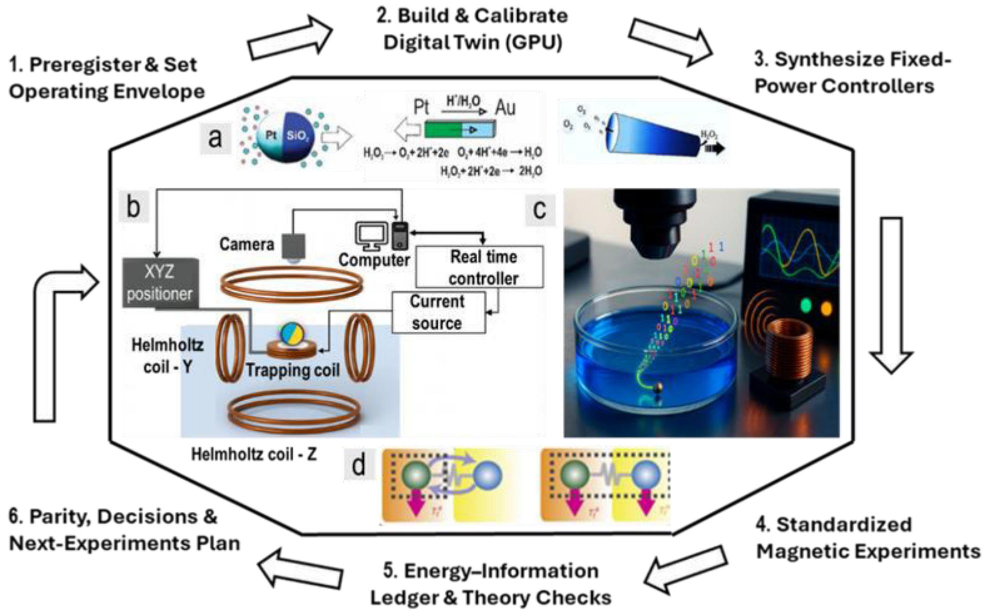

Figure 2. Active matter and closed-loop information-bearing control. The figure connects catalytic propulsion architectures, a three-dimensional magnetic-control platform, tracked trajectories and coupled active/passive dynamics within a preregistered experiment-to-theory workflow. Composite figure summarising the author's published and developing research programme cited in the text.

FLAGSHIP PROGRAMME 3. ELECTROCHEMICAL INTERFACE AND ZERO-EMISSION MEMBRANELESS FUEL CELLS

Established contribution. Catalytic microtubes and hydrogen-peroxide-driven microsystems were established as compact platforms in which heterogeneous reaction, gas evolution and microscale transport are coupled [Solovev et al., *Small*, 5, 1688–1692, 2009; Solovev et al., *Phys. Chem. Chem. Phys.*, 13, 10131–10135, 2011]. This foundation was subsequently extended through collaborative studies of membraneless hydrogen-peroxide fuel cells, porous carbon-fibre electrodes, surfactant-regulated interfaces and selective electrocatalytic materials [Zhu et al., *JoVE*, e65920, 2023; Mujtaba et al., *Adv. Mater. Technol.*, 9, 2302052, 2024]. The accessible catalyst space was further broadened through Co_9S_8 nanoparticles, Pt-containing metal–organic-framework nanosheets, atomic-layer-deposited energy materials and Pt microscrolls, allowing catalytic activity, charge-transfer kinetics, surface area and electrode stability to be systematically varied [Mujtaba et al., *ACS Appl. Nano Mater.*, 4, 1776–1785, 2021; Zhao et al., *Electrochem. Energy Rev.*, 5, 31, 2022; Chen et al., *Sustain. Energy Fuels*, 7, 5120–5128, 2023; Tolstoy et al., *Chem. Commun.*, 60, 3182–3185, 2024]. Within this programme, micropumping is treated as a secondary transport effect, whereas selective peroxide electrocatalysis and interfacial regulation are treated as the principal scientific focus.

Fundamental question. The central question is how cell voltage, power density, faradaic efficiency and operational stability are governed by the coupled effects of catalyst selectivity, electrode architecture and surfactant-mediated interfacial chemistry. Because anodic and cathodic reactions are conducted in a shared electrolyte, mixed potentials, reactant crossover and non-productive peroxide decomposition must be suppressed through selective electrocatalysis rather than membrane separation. At the same time, surfactants may modify electrode wetting, gas-bubble nucleation and detachment, reactant transport, interfacial double-layer structure and adsorption at active sites. Beneficial improvements in mass transport and gas removal may therefore be offset by catalyst blocking, altered reaction kinetics or accelerated degradation. The programme will determine the physicochemical conditions under which surfactant addition improves useful peroxide conversion and those under which catalytic performance is inhibited [Zhu et al., *JoVE*, e65920, 2023; Mujtaba et al., *Adv. Mater. Technol.*, 9, 2302052, 2024].

Next-stage programme. Selective anodic and cathodic electrocatalysts will be synthesised and evaluated using matched electrode geometries and identical peroxide–electrolyte conditions. Catalyst composition, particle size, porosity, loading and support chemistry will be varied independently from surfactant identity, concentration, adsorption behaviour, contact angle, peroxide concentration and gas-evolution rate. Polarisation curves, power-density measurements, electrochemical impedance spectroscopy, faradaic-efficiency analysis and product quantification will be synchronised with high-speed bubble imaging and post-operation surface characterisation. Intrinsic catalytic activity will thereby be separated from apparent performance changes caused by altered wetting, gas coverage, reactant transport, surface poisoning or structural degradation [Mujtaba et al., *ACS Appl. Nano Mater.*, 4, 1776–1785, 2021; Zhao et al., *Electrochem. Energy Rev.*, 5, 31, 2022; Chen et al., *Sustain. Energy Fuels*, 7, 5120–5128, 2023; Zhu et al., *JoVE*, e65920, 2023].

Expected scientific outcome and enabling technologies. Quantitative catalyst–structure–selectivity maps and surfactant–wetting–performance relationships will be established for membraneless hydrogen-peroxide fuel cells. Operating windows will be defined in which selective anodic and cathodic pathways are preserved, crossover and parasitic decomposition are minimised, gas removal remains stable and useful electrical output is maximised. These relationships are expected to provide a predictive basis for catalyst and electrolyte formulation rather than empirical optimisation alone. The resulting design rules may enable compact membrane-free fuel cells, self-powered sensors, portable analytical systems and integrated microfluidic power modules.

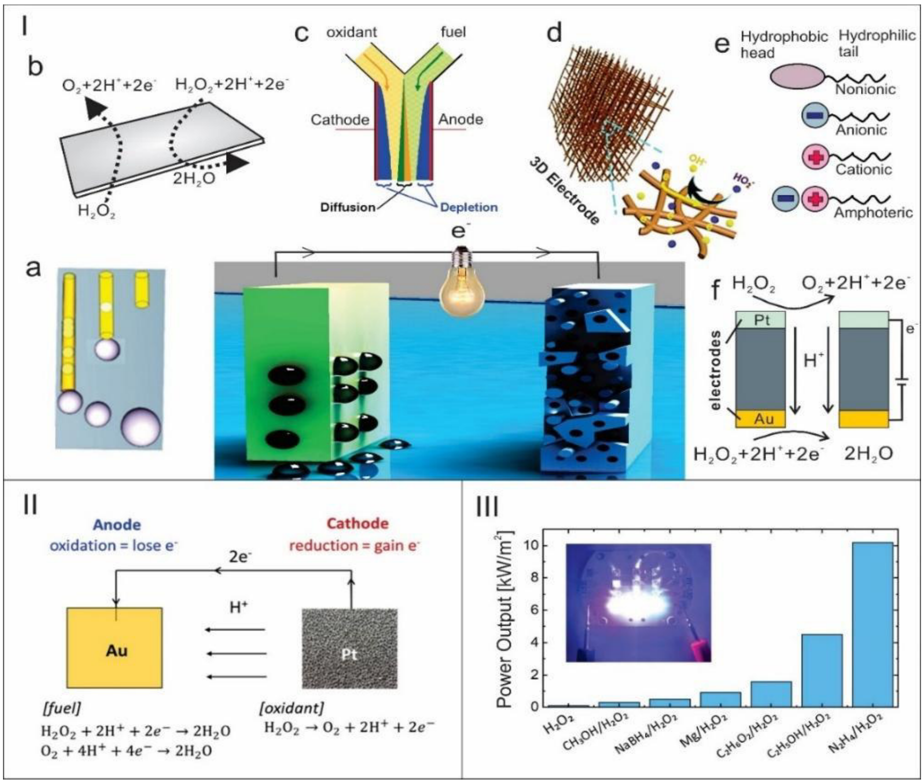

Figure 3. Membraneless hydrogen peroxide fuel cells. The composite shows gas evolution and self-pumping transport, co-laminar fuel/oxidant delivery, porous electrodes, wettability control, single-fuel reaction pathways and comparative power output. Composite figure summarising the author's published and collaborative research cited in the text.

FLAGSHIP PROGRAMME 4. MICROFLUIDICS FOR BIO- AND FUNCTIONAL MATERIALS

Established contribution. Within my research programme and collaborative work, microfluidically generated droplets, microbubbles, phase-change nanodroplets, hydrogel capsules and particle- or protein-stabilised interfaces were developed as programmable functional compartments. Dynamic pH-responsive hydrogel capsules were produced with controllable swelling and molecular release, while catalyst-containing hydrogel micromotors and photocatalytic microcapsules were established for active transport and pollutant removal [Werner et al., *Macromolecules*, 51, 5798–5805, 2018; Zhu et al., *J. Phys.: Condens. Matter*, 31, 214004, 2019; Liu et al., *Environ. Sci.: Nano*, 7, 656–664, 2020]. Nanoparticle-shelled catalytic bubbles, structurally coloured hydrogel microbubbles and protein-stabilised microbubbles were subsequently developed to connect interfacial assembly with propulsion, optical response and mechanical stability [Adams et al., *Adv. Mater. Interfaces*, 7, 1901583, 2020; Chen et al., *Adv. Opt. Mater.*, 9, 2100259, 2021; Barmin et al., *Colloids Surf. A*, 647, 129095, 2022; Dhara et al., *iScience*, 27, 2024]. Biomedical translation was extended through gold-nanocage- and photosensitiser-functionalised microbubbles, albumin-based theranostic bubbles and multilayer polymer-shell perfluoropentane nanodroplets for ultrasound, magnetic-resonance and optoacoustic imaging [Barmin et al., *Nanomaterials*, 11, 415, 2021; Maksimova et al., *Micromachines*, 12, 1161, 2021; Barmin et al., *Colloids Surf. B*, 219, 112856, 2022; Maksimova et al., *Laser Photonics Rev.*, 17, 2300137, 2023]. Collectively, these systems established microfluidic compartment fabrication as a common platform for biomedical imaging, triggered release, environmental catalysis and adaptive soft materials.

Fundamental question. The central question is how fabrication history, hydrodynamic breakup, interfacial assembly, shell composition, crosslink density and molecular state determine compartment size, viscoelasticity, permeability, gas retention, acoustic response, optical behaviour and structural failure. Flow-rate ratio, capillary number, viscosity ratio and channel geometry govern droplet and bubble formation, whereas particle packing, protein conformation, polymer-network structure and shell thickness regulate mechanical stability and molecular transport. Small changes in protein nativity, fluorescent functionalisation or interfacial composition may produce large differences in shell lifetime, gas retention and acoustic response, even when the nominal chemical formulation remains similar [Barmin et al., *Colloids Surf. A*, 647, 129095, 2022; Dhara et al., *iScience*, 27, 2024]. The programme will therefore replace empirical formulation with quantitative process–structure–function relationships and will determine how fabrication variability, ageing, leakage and defect populations affect functional performance.

Next-stage programme. Microfluidic operating maps will be established by varying flow-rate ratio, capillary number, viscosity ratio, channel geometry, interfacial composition and crosslinking conditions across independently fabricated batches. High-speed microscopy will be used to quantify breakup regimes, size distributions, satellite droplets, coalescence and shell defects, while mechanical deformation, acoustic excitation and optical measurements will be synchronised to determine shell elasticity, resonance, cavitation threshold and structural failure [Yan et al., IEEE International Ultrasonics Symposium, 1–4, 2021; Chen et al., *Adv. Opt. Mater.*, 9, 2100259, 2021]. Permeability, release kinetics, gas retention and storage ageing will be measured using population-level statistics rather than selected representative particles. Biomedical compartments will be evaluated through ultrasound, optoacoustic and multimodal-imaging response, whereas environmental capsules will be compared through pollutant uptake, photocatalytic conversion, catalyst retention and reuse under matched free-catalyst and capsule-free controls [Liu et al., *Environ. Sci.: Nano*, 7, 656–664, 2020; Maksimova et al., *Laser Photonics Rev.*, 17, 2300137, 2023]. Orthogonal optical, acoustic and transport measurements will be used to separate shell-composition effects from size, loading and fabrication effects.

Expected scientific outcome and enabling technologies. Predictive fabrication–structure–function maps will be established for microfluidic soft compartments and adaptive membranes. Quantitative relationships will be derived among shell composition, mechanical properties, permeability, acoustic response, optical behaviour and failure probability, allowing reproducibility and storage stability to be incorporated directly into materials design. Enabling technologies may include ultrasound and optoacoustic contrast agents, phase-change nanodroplets, triggered-release carriers, artificial cell-like compartments, reusable photocatalytic capsules, high-throughput diagnostic assays and microfluidically manufactured functional materials.

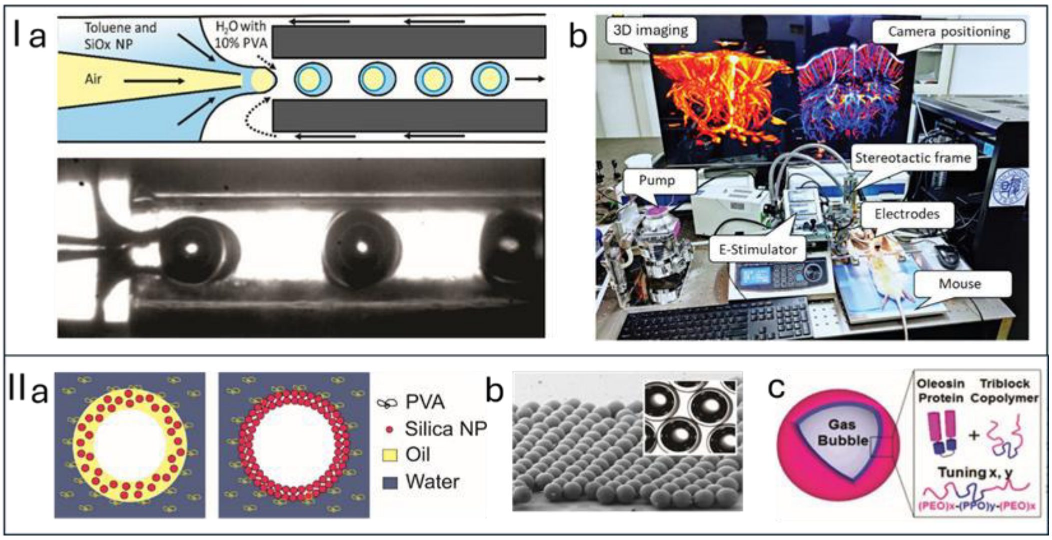

Figure 4. Microfluidic soft matter for biomedical functional materials. The composite shows flow-focused microbubble generation, multimodal imaging instrumentation, particle-stabilised interfaces, monodisperse capsule arrays and molecular shell engineering. Composite figure summarising the author's published and collaborative research cited in the text.

FLAGSHIP PROGRAMME 5. ENVIRONMENTAL REMEDIATION AND CATALYTIC MICRO-REACTORS

Established contribution. Microfluidic compartment engineering was extended through collaborative research to catalyst immobilisation, pollutant transformation and responsive chemical processing. Photocatalytic nanoparticles were confined within permeable hydrogel microcapsules, allowing molecular exchange while reducing catalyst loss and enabling recovery and reuse [Liu et al., *Environ. Sci.: Nano*, 7, 656–664, 2020]. Dynamic pH-responsive hydrogel networks were established as a means of regulating swelling, permeability and molecular release [Werner et al., *Macromolecules*, 51, 5798–5805, 2018]. The available catalytic materials space was broadened through TiO_2 nanosheets, metal-decorated CeO_2 nanomaterials, metal–organic frameworks and hydrogen-bonded organic frameworks for photocatalysis, molecular capture and analytical monitoring [Edy et al., *Prog. Nat. Sci.: Mater. Int.*, 26, 493–497, 2016; Madaan et al., *Inorg. Chem. Commun.*, 146, 110099, 2022; Mohan et al., *TrAC Trends Anal. Chem.*, 170, 117436, 2024; Virender et al., *Top. Curr. Chem.*, 383, 3, 2024]. These studies established a modular basis for combining adsorption, diffusion, photolysis, catalytic conversion and sensing within recoverable microscale reactor architectures.

Fundamental question. The central question is how reaction–diffusion behaviour is altered when photocatalysts, porous frameworks or enzyme-like catalytic centres are confined within a permeable and deformable matrix. Capsule diameter, shell thickness, porosity, crosslink density, surface charge, swelling, light penetration and catalyst distribution may improve retention and create favourable local reaction environments, but may also restrict molecular transport, attenuate illumination and generate internal concentration, oxygen or pH gradients. Apparent pollutant removal may additionally arise from adsorption or photolysis rather than catalytic conversion. The programme will therefore determine how soft-compartment architecture governs the balance among mass transfer, catalyst accessibility, reaction kinetics, leaching and long-term structural stability [Liu et al., *Environ. Sci.: Nano*, 7, 656–664, 2020; Madaan et al., *Inorg. Chem. Commun.*, 146, 110099, 2022; Virender et al., *Top. Curr. Chem.*, 383, 3, 2024].

Next-stage programme. Encapsulated and freely dispersed catalysts will be compared using catalyst-free, dark, adsorption-only, polymer-only and matched bulk-reactor controls. Capsule size, shell thickness, catalyst loading, porosity, illumination intensity, residence time and reactor packing density will be varied systematically. Quantitative mass balances, reaction-intermediate analysis, mineralisation measurements, catalyst-leaching assays and repeated-use cycles will be combined with calibrated optical or electrochemical readout. Post-operation structural characterisation will be used to distinguish activity loss caused by catalyst deactivation, fouling, diffusion limitation, shell degradation or catalyst release. Responsive shells will be engineered so that permeability or catalytic accessibility can be altered by pH, ionic strength or target-molecule binding, while MOF-, HOF- and metal-oxide-based catalysts will be compared under common reaction and transport conditions [Werner et al., *Macromolecules*, 51, 5798–5805, 2018; Liu et al., *Environ. Sci.: Nano*, 7, 656–664, 2020; Edy et al., *Prog. Nat. Sci.: Mater. Int.*, 26, 493–497, 2016; Madaan et al., *Inorg. Chem. Commun.*, 146, 110099, 2022; Mohan et al., *TrAC Trends Anal. Chem.*, 170, 117436, 2024].

Expected scientific outcome and enabling technologies. Quantitative relationships among compartment architecture, reaction–diffusion transport, catalyst retention, pollutant conversion and dynamic permeability will be established. These relationships will distinguish adsorption from genuine catalytic degradation and define operating windows in which catalyst recovery is achieved without unacceptable transport limitation. Enabling technologies may include reusable photocatalytic capsule beds, flow-through catalytic microreactors, responsive water-treatment materials, heavy-metal and contaminant monitoring platforms, food- and water-safety analytical systems and portable optical or electrochemical devices.

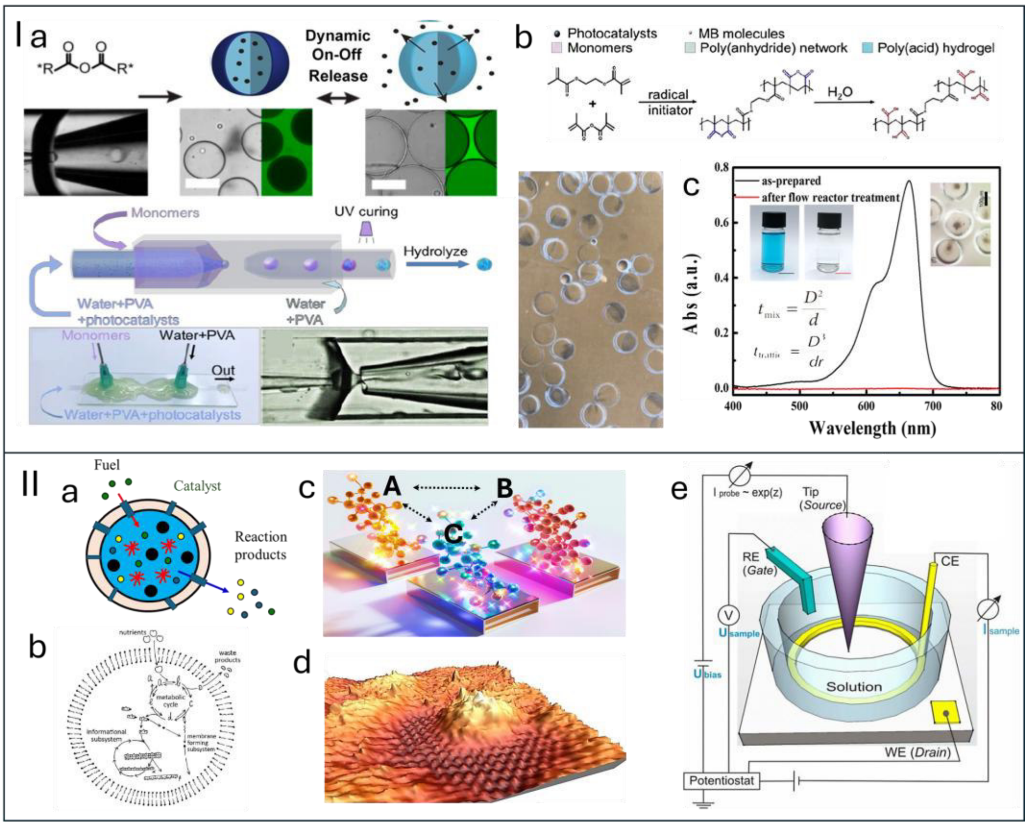

Figure 5. Adaptive environmental materials and soft catalytic microreactors. The figure integrates microfluidic capsule synthesis, pH-responsive switching, characteristic mixing and diffusion times, artificial cell-like catalytic compartments, advanced catalyst surfaces and electrochemical monitoring. Composite figure summarising the author's published and collaborative research cited in the text.

FLAGSHIP PROGRAMME 6. THIN-FILM NANO-TRANSISTOR FOR DETECTION OF BIOMOLECULAR INTERACTIONS

Established contribution. Silicon-on-insulator thin-film transistor biosensors were established through collaborative work as integrated liquid-interface platforms combining semiconductor device physics, organophosphonate surface functionalisation, electrolyte gating, electrical shielding and microfluidic packaging [Mohan et al., *Adv. Funct. Mater.*, 34, 2405231, 2024]. This platform was complemented by broader work on electrochemical and nanocomposite biomarker detection, molecular-ligand sensing, porous framework-based analytical materials and food-safety monitoring [Kumar et al., *Microchem. J.*, 180, 107561, 2022; Mohan et al., *TrAC Trends Anal. Chem.*, 159, 116921, 2023; Mohan et al., *TrAC Trends Anal. Chem.*, 170, 117436, 2024; Mohan et al., *Vietnam J. Chem.*, 63, 1–22, 2025; Mohan et al., *Vietnam J. Chem.*, 63, 175–194, 2025]. A distinct thin-film sensing programme is therefore defined in which molecular recognition, liquid-interface chemistry, transistor geometry and microfluidic delivery are treated as a coupled transduction system rather than as independent device components.

Fundamental question. The central question is how reliable biomolecular transduction is governed by the combined effects of semiconductor channel geometry, buried-oxide capacitance, interfacial charge density, electrolyte ionic strength, Debye screening, receptor packing, surface ageing, reference-electrode configuration and liquid delivery. Apparent sensitivity alone is insufficient because baseline drift, hysteresis, nonspecific adsorption, trapped gas bubbles, leakage current, pH variation and degradation of the recognition layer may generate signals comparable to those produced by specific molecular binding. The programme will therefore determine the conditions under which conductance or threshold-voltage changes can be attributed quantitatively to biomolecular interactions rather than to electrochemical, fluidic or packaging artefacts [Mohan et al., *Adv. Funct. Mater.*, 34, 2405231, 2024; Kumar et al., *Microchem. J.*, 180, 107561, 2022; Mohan et al., *Vietnam J. Chem.*, 63, 175–194, 2025].

Next-stage programme. Self-referenced and multiplexed transistor arrays will be developed in which target-specific, nonspecific-control and calibration channels are exposed to the same microfluidic environment. Field-effect measurements will be compared with orthogonal electrochemical, impedance, optical or fluorescence readouts so that true binding events can be distinguished from changes in ionic strength, pH, flow or surface state. Performance will be quantified through conductance and threshold-voltage shifts together with baseline drift, hysteresis, low-frequency noise, response and recovery kinetics, selectivity, inter-device variability and operational lifetime. Organophosphonate monolayers and alternative molecular attachment chemistries will be compared under controlled aqueous ageing, while receptor density, electrolyte composition, flow rate and reference-electrode position will be varied independently [Mohan et al., *Adv. Funct. Mater.*, 34, 2405231, 2024; Mohan et al., *TrAC Trends Anal. Chem.*, 170, 117436, 2024; Mohan et al., *Vietnam J. Chem.*, 63, 1–22, 2025].

Expected scientific outcome and enabling technologies. A predictive interface–screening–packaging–drift model will be established for stable liquid-gated transistor operation. Quantitative operating windows will be defined in which molecular binding can be resolved above electrochemical drift, nonspecific adsorption and device noise. The resulting design rules are expected to enable multiplexed microfluidic diagnostics, cancer-biomarker detection, environmental and food-safety sensing, continuous molecular monitoring and portable point-of-care devices.

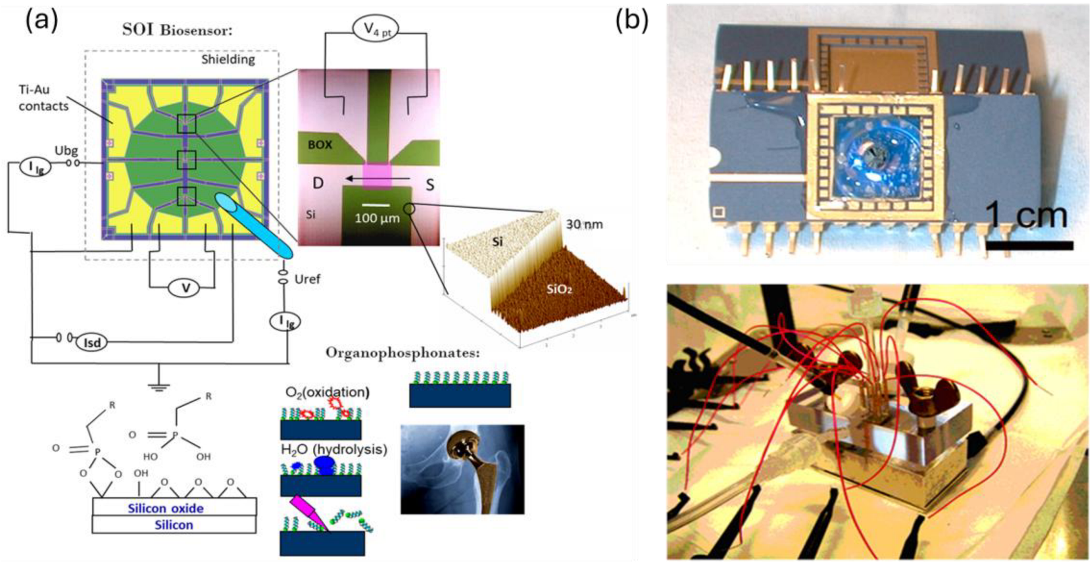

Figure 6. Thin-film bioelectronics and liquid-interface sensing. The composite shows an SOI field-effect transistor architecture, channel and buried-oxide structure, organophosphonate surface chemistry, packaged sensor chips and the complete microfluidic/electrical test platform. Composite figure summarising the author's published and collaborative research cited in the text.

Leadership and Three- to Five-Year Implementation Plan

Immediate-start capability. Active-matter control, microfluidic soft materials, electrochemical benchmarking and computational modelling can be initiated using standard optical microscopy, microfluidic fabrication, electrochemical instrumentation and GPU-enabled analysis. Strain-engineered nanomembrane fabrication and advanced silicon-on-insulator processing will initially be conducted through shared cleanroom facilities and targeted institutional collaborations while local capability is progressively developed.

Initial research platform. The core experimental platform will comprise high-speed optical microscopy, programmable magnetic-field control, syringe- and pressure-driven microfluidics, electrochemical workstations, flow and bubble characterisation, particle-tracking systems, wet-chemistry and soft-material preparation, and computational resources for finite-element, CFD, trajectory and uncertainty analysis. Specialist quantum-optical, micromagnetic, acoustic, semiconductor and biomedical measurements will be accessed through shared facilities and collaboration rather than duplicated during the establishment phase.

Funding and partnership strategy. National competitive funding will be pursued in fundamental materials science, active matter, biomedical engineering, clean energy and environmental technologies, followed by industry-linked projects in sensing, diagnostics, water treatment and compact analytical systems. Early proposals will be modular, with each project testing a clearly defined flagship hypothesis while sharing instrumentation, control experiments, modelling tools and datasets across the broader programme. Collaborative proposals will be developed where specialist fabrication or measurement capabilities are scientifically required, while responsibility for the central hypotheses, experimental design and interpretation will remain within the programme.

Programme sequencing and measurable outputs. Programmes 2, 3 and 4 can commence rapidly because the required microscopy, magnetic control, microfluidic, electrochemical and computational capabilities can be established using broadly available infrastructure. Programme 5 will be developed from the same microfluidic, catalytic and analytical platform. For Programmes 1 and 6, modelling, device design, materials selection and measurement protocols will proceed while fabrication is accessed through shared cleanroom and semiconductor facilities. By the end of Year 2, calibrated baseline platforms, reference datasets and mechanism-resolved control experiments will have been established. Year 3 will prioritise cross-platform experiments testing defined coupling mechanisms, competitive grant submissions and externally collaborative projects. By Year 5, prospective model tests, validated operating maps and a focused portfolio of application-relevant prototypes will be delivered, with reproducibility, uncertainty and failure boundaries documented.

Leadership, supervision and research culture. The programme will be managed as an integrated research environment rather than as six isolated projects. Shared protocols will govern calibration, sample traceability, image and trajectory analysis, uncertainty reporting, data management and responsible use of AI-assisted tools. Researchers and students participating in the programme will be encouraged to develop competence in complementary methods so that common principles of materials structure, interfaces, transport and nonequilibrium behaviour can be understood across nanomembranes, active matter, microfluidics, electrochemistry and bioelectronics. Regular mechanism reviews will distinguish exploratory observations from validated results, while negative or null findings will be retained when they constrain the design space. This structure will support rigorous supervision, efficient use of shared facilities and productive specialist collaboration without transferring responsibility for the programme’s central scientific questions.

Milestones and decision criteria

Phase	Strategic objective	Programme-level objectives	Representative outputs	Progression criteria
Years 1–2	Establish reproducible experimental and computational foundations	Establish shared metrology, control experiments and uncertainty protocols across all six programmes; initiate immediately accessible work in active matter, microfluidics and electrochemistry; develop fabrication pathways for nanomembranes and thin-film transistor devices through host facilities and collaboration.	Stress–thickness–curvature maps; calibrated magnetic-control and trajectory-analysis platforms; catalyst–surfactant electrochemical baselines; multi-batch soft-compartment datasets; photocatalytic reaction–diffusion controls; drift-resolved liquid-gated transistor benchmarks; shared data and reproducibility protocols.	Independent repetition is achieved; batch variation and measurement uncertainty are quantified; baseline models reproduce limiting cases; competing mechanisms can be distinguished experimentally.
Years 2–3	Resolve fundamental mechanisms within each flagship programme	Determine how curvature modifies physical properties; establish when active trajectories contain measurable environmental information; resolve catalyst–surfactant–interface effects in peroxide fuel cells; quantify process–structure–function relations in soft compartments; isolate confinement effects in catalytic microreactors; identify the origins of drift and signal formation in liquid-gated transistors.	Curvature-dependent magnetic or optical measurements; active particles operated in defined chemical and hydrodynamic landscapes; catalyst–structure–selectivity maps; shell mechanics and permeability maps; compartment-versus-bulk reaction–diffusion comparisons; self-referenced transistor measurements.	Observed effects remain reproducible across batches and operating conditions; artefacts and alternative explanations are excluded; measured behaviour is attributable to a defined physical or chemical mechanism.
Years 3–4	Integrate mechanisms across programmes and institutional capabilities	Test common principles linking geometry, interfaces, transport, nonequilibrium dynamics and signal generation; undertake experiments requiring combined cleanroom, microscopy, electrochemical, acoustic, semiconductor, modelling or biomedical capabilities; develop major collaborative funding proposals around clearly defined scientific questions.	Curved active or sensing structures; integrated active-matter and microfluidic experiments; coupled electrochemical–transport models; responsive catalytic compartments with calibrated readout; multiplexed sensing platforms; jointly validated datasets and cross-disciplinary publications.	Integrated behaviour exceeds what can be explained by uncoupled components and remains attributable to a specified coupling mechanism; collaborative measurements independently confirm the principal conclusions.
Years 4–5	Achieve prospective prediction, external validation and bounded translation	Test models on previously unseen geometries, materials and operating conditions; establish validated operating maps and failure boundaries; select only those application pathways supported by reproducible mechanism-based evidence; evaluate performance under relevant environmental, biomedical or device conditions.	Prospective model tests; externally validated datasets; predictive design laws; documented operating envelopes; reproducible demonstrators in active sensing, membrane-free energy conversion, water remediation, functional microfluidic materials or molecular detection; competitive follow-on funding and targeted partnerships.	Independent data are predicted within predefined uncertainty; performance is reproduced under relevant conditions; failure modes and operating boundaries are documented; prototype development is justified by validated mechanism rather than incremental optimisation.

Experimental rigor, institutional fit and expected impact

Experimental rigour. Each project will be framed around a fundamental scientific challenge rather than an incremental device modification. The system boundary, mechanistic hypothesis, critical variables, primary readouts, control conditions and failure criteria will be defined before experimentation. Measurement uncertainty, batch variation, instrumental drift, negative results and competing explanations will be retained in the analysis. Models will be required to reproduce limiting cases, remain consistent with physical constraints and predict independent datasets not used for parameter fitting. This approach is intended to distinguish genuine mechanism from empirical optimisation and to identify transferable principles rather than isolated performance improvements.

Institutional complementarity and collaboration. The programme is designed to use the host institution's capabilities to address problems that cannot be solved within a single laboratory or discipline. Shared cleanroom, microscopy, microfluidic, electrochemical, semiconductor and computational facilities will be integrated with expertise in materials science, chemical engineering, physics, biomedical engineering, environmental technology and electrical engineering. Collaborations will be structured around defined scientific dependencies, including advanced fabrication, micromagnetic and multiphysics modelling, optical and acoustic characterisation, biological validation and device integration. These partnerships will not be used merely to extend the number of applications, but to test questions whose resolution requires combined experimental, theoretical and technological capability.

Expected impact and closing scientific position. The programme will address fundamental challenges in controlling function at small scales: how geometry and strain reorganise material properties; how active systems acquire and use information; how interfacial chemistry governs energy conversion; how confinement alters reaction–diffusion behaviour; and how molecular interactions can be transduced reliably in complex liquids. The intended outcome is not a sequence of incremental prototypes, but a set of predictive frameworks, validated operating maps and experimentally testable design laws. By combining the programme's core hypotheses with the infrastructure and specialist strengths of the host institution, important problems in active matter, clean energy, water remediation, biomedical materials and molecular sensing can be addressed at a level that is both fundamentally significant and technologically enabling.

Service, Governance and External Engagement Statement

NanoTRIZ Junior Research Scholar / Research Scholar Program

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EXECUTIVE SUMMARY

I understand service not as a secondary list of visible roles, but as the dependable work that makes a research and education program credible: transparent governance, participant protection, accurate records, fair decisions, research integrity, safe practice, timely communication and responsible external representation. Within the NanoTRIZ Innovation Institute, this service obligation is particularly important because the Junior Research Scholar and Research Scholar pathways operate internationally, remotely and, in many cases, with participants under eighteen.

My documented service record spans sustained course and curriculum leadership at Fudan University, student advising and laboratory coordination, supervision from undergraduate to postdoctoral level, institutional partnership work, editorial leadership, peer and grant review, conference and workshop service, industry-facing translation, public science communication and international academic engagement. These activities provide the operational foundation for NanoTRIZ; they do not justify presenting the institute as a university, an accredited provider or a substitute for local laboratory, school, medical or safeguarding responsibilities.

This statement distinguishes completed evidence from prospective program priorities. Formal invitations, meetings, acknowledgments and referrals are described as such and are not converted into claims of government advisory authority, funding, endorsement or partnership. Proposed conferences, external experts, publications and industry activities are treated as future possibilities until a specific agreement exists. The central service objective is measurable value for participants and families: well-governed projects, defensible outputs, fair attribution, safe boundaries and an accurate account of what was achieved.

SERVICE PROPOSITION

Service domain	Documented foundation	Application within NanoTRIZ
Program governance	Seven academic years of course leadership; curriculum development; digital-teaching continuity; student advising; research-team and laboratory coordination.	Transparent admission, participant agreements, project registers, milestone records, quality review and dependable program operations.
Participant development	Six completed PhD students or co-supervisees; undergraduate, master's and postdoctoral mentoring; award-recognised supervision and trainee progression.	Structured onboarding, inclusive participation, safeguarding, feedback, progression review, recommendations based on documented performance and appropriate referral.
Research integrity	Founder and Editor-in-Chief of SciViD; guest-editing roles; review for more than 50 journals; international proposal assessment.	Source verification, authorship and affiliation rules, AI-use records, reproducibility, data provenance, venue screening and proportionate claims.
External engagement	Fudan-Skoltech institutional coordination; MARSS 2023 and workshop service; more than 30 invited presentations; international research networks.	Carefully scoped expert input, seminars, conference preparation and partnerships with explicit roles, consent, confidentiality and no implied commitment.
Translation and public service	Two patent-related outputs; C4X advising; BMBF iC4 participation; Suzhou commercialisation engagement; public science communication.	Patent-aware project guidance, realistic translation briefs, public communication, societal relevance and clear separation of education from commercial promises.

1. SERVICE PHILOSOPHY: RELIABLE INSTITUTION-BUILDING

NanoTRIZ service begins with operational reliability. A remote research-enrichment program depends on work that may be less visible than publications or public events: reviewing applications, defining feasible scope, recording decisions, maintaining templates, checking consent, protecting confidential information, scheduling meetings, documenting contributions, resolving misunderstandings and ensuring that external claims match the evidence. I therefore treat service as an auditable responsibility rather than a collection of honorary titles.

This approach reflects experience gained through course ownership, laboratory leadership and institutional coordination. At Fudan University, I was responsible for the sequence, materials, projects, assessment and continuing revision of Microfluidics and Lab-on-a-Chip across seven academic years. I supported digital-teaching continuity during the COVID-19 transition, advised students and research teams, and coordinated academic work contributing to the Fudan-Skoltech Memorandum of

Understanding. These activities required preparation, documentation, communication across different systems and attention to shared responsibilities rather than individual visibility.

The institute is an independent, non-accredited Australian initiative. Service therefore includes accurate description of its status, limits and outputs. NanoTRIZ may provide a structured remote Scholar title, supervision records, project documentation and recommendations where earned; it does not award a university degree, academic credit, regulated Australian qualification, employment status, visa pathway or guaranteed admission outcome. Program terms, fees, cancellation arrangements and the conditions for completion, affiliation and recommendation should be disclosed before a family makes a participation decision.

- Completed activity, proposed activity and external recognition are labelled separately.
- An acknowledgment, invitation or referral is not described as funding, endorsement or a formal partnership.
- International reputation is used to support access to expertise, not to imply that an institution or named scientist has joined a project without agreement.
- Service commitments are limited to what can be delivered reliably within available supervision capacity.

2. PROGRAM GOVERNANCE, ADMISSION AND OPERATIONAL SERVICE

Admission is a service decision because accepting an unsuitable project can waste a participant's time, create unrealistic expectations or introduce safety and supervision risks. The process should therefore include an online application and short interview, followed by an assessment of motivation, educational stage, language, weekly availability, topic fit, access to tools, safeguarding requirements and the feasibility of producing a meaningful result. Selection is not based solely on ability to pay, and an attractive topic is not accepted unless an evidence and supervision plan can be defined.

Once admitted, each participant should have a documented project record containing the approved research question, intended output, milestones, meeting schedule, primary responsibilities, file structure, reference-management approach, AI-use requirements, safety boundaries and any relevant confidentiality or intellectual-property conditions. Version history, meeting notes and contribution logs are service mechanisms as well as research tools: they protect the participant, supervisor and collaborators by showing how decisions and outputs developed.

- Maintain a current register of participants, project stage, guardian consent where applicable, meetings, milestones and completion status.
- Use standardised onboarding, project-plan, meeting-note, contribution, AI-use and completion templates, while allowing justified project-specific variation.
- Record external expert roles, conflicts of interest, confidentiality conditions and the limits of any advice provided.
- Separate program administration from authorship decisions, publication decisions and recommendation decisions.
- Use clear procedures for questions, concerns, complaints and correction of records, with escalation proportionate to the issue.
- Review supervision load and pause admission when capacity is insufficient for dependable feedback.

Where scholarships or reduced-fee arrangements are offered, the criteria, duration and obligations should be stated in writing. Financial support must not alter academic standards or purchase authorship, affiliation, publication, favourable assessment or a recommendation. Likewise, cancellation of participation does not erase completed work, but an unfinished project may not support a completion record or substantive recommendation.

3. PARTICIPANT, FAMILY, SAFEGUARDING AND INCLUSION SERVICE

Service to participants extends beyond technical feedback. Junior Research Scholars may be school students encountering research, peer review and professional communication for the first time. They need explicit expectations, predictable communication and a developmental process in which uncertainty and mistakes can be reported without humiliation. My supervision experience, including six completed PhD researchers or co-supervisees and mentoring across undergraduate, master's and postdoctoral levels, supports a structured-independence model: guidance is strong at entry and responsibility is transferred as capability is demonstrated.

For participants under eighteen, informed parental or guardian consent is required before participation. Communication, video meetings, file exchange and any involvement of external researchers should follow appropriate safeguarding and professional-boundary practices. A remote mentor cannot replace local school supervision, laboratory induction, medical care, emergency support or legal responsibility. Parents and participants should know whom to contact, what communication channels are used, what information is retained and how concerns can be raised.

- Use age-appropriate explanations of research expectations, authorship, publication uncertainty, AI use and program status.
- Provide timely feedback and identify prolonged inactivity, repeated missed milestones or communication difficulties early.
- Allow reasoned disagreement and ensure that group participation is not dominated by the most confident speaker.
- Consider language confidence, disability, time-zone constraints, school examinations and different educational backgrounds without lowering essential research standards.
- Refer safeguarding, health, wellbeing or serious conduct matters to appropriate local adults or services rather than attempting to manage them solely through academic mentoring.

Recommendations and completion documentation are service outputs that require restraint. They should describe the participant's actual work, reliability, independence, response to feedback and demonstrated skills. Attendance, payment or an internal title alone is not a sufficient basis for a strong recommendation. Accurate documentation protects both the participant and the credibility of the program.

4. RESEARCH INTEGRITY, SAFETY AND QUALITY ASSURANCE

My editorial, peer-review and proposal-evaluation service informs the standards applied within NanoTRIZ. As Founder and Editor-in-Chief of SciViD, an invited guest editor and a reviewer for more than 50 international journals, I have worked with questions of scope, novelty, methodological adequacy, evidence, authorship, conflicts and proportionate claims. I have also assessed proposals for international funding schemes. These roles do not make every student project publishable; they provide a basis for explaining why evidence must be traceable and why attractive presentation cannot compensate for weak methods.

Every project should distinguish source material, participant analysis, supervisor input and AI-assisted work. Primary sources should be checked; quotations, paraphrases, figures and data should be attributed; raw and processed material should be separated where applicable; and uncertainty, negative results and limitations should remain visible. For each material use of generative AI, the participant should record the tool, version or access date, purpose, affected section or file, verification performed and corrections made. The participant and supervisor remain accountable for the final scientific argument.

- Payment, enrolment or an internal Scholar title does not purchase authorship or the right to use NanoTRIZ affiliation in a publication.
- Authorship follows actual, substantial and documented intellectual contribution and the policy of the relevant venue.
- External submission occurs only after scientific, ethical, authorship, rights and practical review.
- Low-quality or misleading publication venues are not used merely to create an appearance of achievement.
- Confidential data, unpublished collaborator material and personal information are not entered into external AI systems without permission.
- Corrections are documented; fabricated, selectively altered or misrepresented evidence is incompatible with participation.

Safety takes priority over ambition. Remote participants must not conduct hazardous chemistry or biological work, high-voltage experiments, pressure systems, work with toxic, flammable or reactive substances, or other unsafe procedures without authorised facilities, local induction and competent supervision. NanoTRIZ may support literature synthesis, modelling, image analysis, public datasets, conceptual design and low-risk observations, but remote supervision is not a laboratory permit.

Quality assurance should be based on evidence rather than promotional indicators. Useful measures include milestone completion, traceability of sources and decisions, quality of feedback and revision, participant and guardian feedback, safety compliance, timeliness of records, authorship clarity, appropriate handling of concerns and the defensibility of completed outputs. Templates and policies should be revised when repeated problems reveal a design weakness.

5. PROFESSIONAL, EDITORIAL AND ACADEMIC COMMUNITY SERVICE

Professional service connects NanoTRIZ to broader scholarly standards. My record includes editorial leadership through SciViD, guest-editing in interdisciplinary areas, peer review across materials science, chemistry, nanotechnology, microfluidics and applied physics, and proposal assessment for European, DAAD-related, BRICS and National Natural Science Foundation of China schemes. The direct value to participants is not access to privileged decisions; it is exposure to the evaluative questions used in serious research communities.

- Is the question genuinely defined, or only fashionable?
- Does the evidence support the claim, and are plausible alternative explanations considered?
- Are methods, controls, conditions and limitations sufficiently clear for another person to evaluate the work?
- Are novelty, authorship, conflicts, rights and venue suitability assessed before submission?
- Has criticism been answered through evidence and revision rather than rhetoric?

Within NanoTRIZ, these standards support structured internal review of proposals, figures, reports, posters and manuscripts. Participants may practise responding to reviewer-style comments and comparing venues, but no editor, journal, conference or external reviewer is represented as committed unless a formal invitation or submission process exists. Editorial roles are kept separate from program recruitment and payment.

6. INTERNATIONAL PARTNERSHIPS, EVENTS AND EXTERNAL EXPERTISE

My service includes cross-institutional coordination and academic event activity across Europe, Asia, North America and Australia. I coordinated academic work supporting the Fudan-Skoltech Memorandum of Understanding and participated in MIT-linked discussions; served in a chair role at MARSS 2023 in Abu Dhabi; co-organised a Fudan workshop marking ten years of nanorocket research; and delivered more than 30 invited presentations. These activities demonstrate experience in aligning contributors, preparing programs, communicating across disciplines and representing scientific work to different audiences.

Policy-facing activity is described carefully. I participated in official briefings, foreign-expert activities, science-diplomacy forums and an invited scientific delegation to the Great Hall of the People. These are evidence of experience communicating science in formal stakeholder settings; they are not presented as continuing government advisory appointments unless separately documented. The same principle applies to all NanoTRIZ external communication.

External researchers may strengthen a project when their expertise is relevant and their role is explicit. Before involvement, NanoTRIZ should define the question to be addressed, expected time commitment, access to participant data, safeguarding requirements, confidentiality, intellectual property, authorship implications and whether the contribution is advisory, supervisory or collaborative. For minors, guardian awareness and appropriate meeting arrangements are required. A general professional contact or historical affiliation does not imply participation in the program.

- Prefer a small number of credible, mutually beneficial relationships over a large number of nominal affiliations.
- Use external seminars and expert reviews for clear educational purposes, with documented participant preparation and follow-up.
- Describe proposed conferences, competitions and collaborations as possibilities until dates, roles and participation are confirmed.
- Protect the independence of participant assessment from prestige, seniority or external pressure.

7. INDUSTRY, TRANSLATION, PUBLIC ENGAGEMENT AND AUSTRALIAN CONTRIBUTION

My translational service includes a granted patent related to real-time imaging, tracking and control of micromotors, a published patent application on membraneless hydrogen-peroxide fuel cells, academic advising to C4X on carbon-capture and conversion concepts, participation in the German BMBF iC4 cluster and engagement with the Suzhou nanotechnology commercialisation ecosystem. These activities inform teaching about intellectual property, technical risk, scale, manufacturability, safety and stakeholder requirements. They do not convert an early student concept into a patentable or commercial technology without professional assessment.

Within NanoTRIZ, industry and translation service should therefore focus on realistic problem briefs, validation plans, patent-awareness and communication with potential users. External organisations should be engaged only where the educational purpose, confidentiality, ownership, deliverables and participant protection are clear. Commercial interest must not distort academic conclusions or create pressure to overstate novelty.

Public science communication has included popular writing, media participation, documentaries, demonstrations and events reaching large live audiences. This experience supports participant training in explaining complex research accurately to non-specialists. Public-facing material should distinguish schematics from data, possibility from demonstrated result and personal interpretation from institutional position.

Since relocating to Brisbane, I have developed NanoTRIZ as an Australian-based initiative and proposed a microfluidics and droplet-technology innovation hub. The proposal received formal acknowledgment from the Lord Mayor of Brisbane and referral to Brisbane Economic Development Agency; this is presented as stakeholder engagement, not secured funding or endorsement. Local service should grow through similarly accurate, staged engagement with schools, colleges, researchers, industry and community organisations.

8. IMPLEMENTATION, EVALUATION AND ACCOUNTABILITY

The next stage of NanoTRIZ service development should prioritise governance before expansion. Growth in applications, topics or external visibility is useful only when participant records, feedback capacity, safeguarding, quality review and financial transparency remain dependable. Service initiatives should be retained, revised or discontinued according to evidence of value and risk.

- Maintain a concise governance manual covering admission, fees, cancellation, safeguarding, communication, data, AI use, authorship, affiliation, safety, complaints and completion.
- Review every active project against scope, milestone, supervision capacity, safety and documentation requirements.
- Introduce periodic internal audits of consent records, AI-use logs, contribution statements, recommendations and external claims.
- Seek selected external review of program templates and policies without presenting reviewers as institutional partners.
- Collect participant and guardian feedback and document corrective actions rather than using testimonials as the sole quality measure.
- Disclose conflicts of interest and separate educational, editorial, publication, commercial and personal decisions.
- Protect workload discipline: external events and new partnerships must not reduce the quality or timeliness of participant supervision.

SERVICE IMPACT INDICATORS

Domain	Representative indicator	Evidence retained	Review question
Governance	Decisions and terms are timely, consistent and transparent.	Application, interview, agreement, fee and project records.	Could an independent reviewer understand why the decision was made?
Participant support	Milestones, feedback and concerns are addressed appropriately.	Meeting notes, progress reviews, guardian communication and referrals.	Is the participant receiving support proportionate to age, level and risk?
Integrity and safety	Claims, authorship, AI use and experimental boundaries are defensible.	Source checks, AI logs, contribution statements, safety records and submission reviews.	Would the project withstand ethical and methodological scrutiny?
Quality of outputs	Completed work is traceable, revised and proportionate to evidence.	Version history, rubrics, reviewer responses and final artefacts.	Does the output show genuine participant contribution and development?
External engagement	Partnerships and events create specific educational or scientific value.	Written roles, consent, agendas, deliverables, feedback and conflict disclosures.	Is the relationship substantive, accurate and sustainable?
Continuous improvement	Repeated problems lead to policy or workflow changes.	Audit notes, feedback summaries, revised templates and action records.	What changed because the evidence showed a weakness?

CONCLUSION

The service case for NanoTRIZ is grounded in documented experience in course and curriculum leadership, student and researcher development, laboratory and institutional coordination, editorial and peer-review standards, international partnerships, academic events, translation and public communication. The most important application of this record is not the accumulation of additional titles. It is the construction of a reliable research-enrichment environment in which participants and families understand the terms, risks, responsibilities and limits of the program.

My objective is to build service systems that protect academic credibility while expanding access to serious research experience: transparent admission, safeguarding, accurate records, ethical authorship, responsible AI use, safe project boundaries, proportionate external claims and measurable continuous improvement. International networks and professional recognition can strengthen this work only when they are converted into specific, documented value for participants and do not substitute for governance, evidence or accountability.

Teaching, Mentorship and Research Training Statement

NanoTRIZ Junior Research Scholar / Research Scholar Program

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EXECUTIVE SUMMARY

My teaching, mentorship and research-training philosophy is grounded in a central proposition: students should not merely learn about science; they should acquire documented capacity to formulate questions, evaluate evidence, reason quantitatively, design methods, communicate limitations and assume responsibility for scholarly work. The NanoTRIZ Junior Research Scholar / Research Scholar Program translates my university teaching, international laboratory experience and supervision record into a structured, remote and milestone-based pathway for senior secondary students, university students and early-career participants.

The program is designed to bridge a persistent gap between classroom knowledge and authentic research practice. Participants work on open scientific or engineering questions rather than exercises with predetermined answers. They learn to map evidence, distinguish observation from interpretation, identify research gaps and technical contradictions, use TRIZ-based problem reframing, develop a defensible contribution and communicate the result through a report, presentation, poster, review, simulation, preprint or manuscript-level output when the quality of the work permits. The internal titles Junior Research Scholar - Remote and Research Scholar - Remote indicate participation in this structured process; they do not constitute university enrolment, employment, academic credit or an accredited qualification.

My approach has been shaped by sustained course ownership at Fudan University, supervision of researchers from undergraduate to postdoctoral level, and work in leading research environments including Professor David Weitz's group at Harvard SEAS, Professor Geoffrey Ozin's Solar Fuels and nanochemistry environment at the University of Toronto, the Technical University of Munich and Walter Schottky Institute, IFW Dresden, the Max Planck Institute for Intelligent Systems, Columbia University, Leibniz research institutes and The University of Queensland. These settings reinforced complementary principles: intellectual independence must be matched by experimental discipline; creativity must remain accountable to evidence; and scientific work should be connected, where appropriate, to societal purpose, translation and responsible communication.

PROGRAM-SPECIFIC EDUCATIONAL PROPOSITION

Domain	Documented foundation	Application within NanoTRIZ
Course leadership	Seven academic years of end-to-end responsibility for Microfluidics and Lab-on-a-Chip at Fudan University, together with Materials in Life, seminars and laboratory instruction.	A coherent sequence of research literacy, evidence mapping, problem definition, method selection, analysis, revision and communication.
Research supervision	Six completed PhD researchers as principal or co-supervisor, plus master's, undergraduate and postdoctoral mentoring; award-recognised postgraduate supervision.	Staged transfer of responsibility, explicit milestones, traceable feedback, contribution records and development of independent judgement.
International research culture	Harvard, University of Toronto, TUM, Max Planck, IFW Dresden, Columbia, Leibniz, Fudan and UQ research environments.	A balance of intellectual ownership, experimental rigour, collaboration, creativity, reproducibility and translation.
Research and innovation record	More than 80 peer-reviewed publications, over 6,700 citations, h-index 36, two patents, competitive funding and international consortia.	Research questions and examples grounded in actual scientific practice rather than generic mentoring advice.
Educational innovation	Project-based learning, flipped teaching, authentic data, peer review, video-supported reproducibility and responsible AI guidance.	Remote research sprints and Scholar projects producing verifiable artefacts rather than attendance-only certificates.

1. TEACHING PHILOSOPHY: FROM KNOWLEDGE ACQUISITION TO RESEARCH JUDGEMENT

Students may reproduce formulas, definitions or standard procedures while remaining unable to explain why a method applies, which assumptions determine its validity or how uncertainty affects the conclusion. This gap is especially serious in nanotechnology, materials science, microfluidics, active matter, biosensing and energy systems, where interfaces, geometry, transport, fabrication history and measurement conditions may dominate behaviour. I therefore organise teaching and mentorship around a disciplined progression from conceptual understanding to application, critique and independent judgement.

- **Concept before procedure.** The governing mechanism, relevant scales, units, assumptions and limiting cases are clarified before equations, software or AI tools are applied.
- **Evidence before assertion.** Participants distinguish primary data, interpretation, uncertainty and claim; prestigious publication or high citation count does not remove the need to inspect methods and controls.
- **Structure-processing-properties-performance.** Materials and devices are considered as systems in which composition, fabrication, interfaces, geometry, environment and measurement jointly determine function.
- **Anomalies as evidence.** Negative results, disagreement between model and experiment, unstable behaviour and failed prototypes are analysed rather than hidden.
- **Progressive independence.** Support is strongest at entry and is deliberately reduced as the participant demonstrates capability, ownership and reliable judgement.
- **Communication as part of research.** Figures, captions, presentations, meeting updates, literature matrices and written argument are treated as analytical tools, not cosmetic final products.

TRIZ-based reasoning is introduced only after the problem and evidence base are sufficiently defined. It is not used as a substitute for scientific knowledge or as a formula for producing novelty. Participants learn to express a contradiction precisely - for example, a system must become more sensitive without becoming less stable, or a device must increase reaction rate without increasing hazardous reagent demand - and then examine resources, separation principles, alternative system boundaries and transformation mechanisms. The purpose is to make inventive reasoning explicit, testable and connected to physical constraints.

2. INTERNATIONAL RESEARCH ENVIRONMENTS SHAPING MY MENTORSHIP

My mentorship model is not derived from one institution or one pedagogical school. It reflects observation and participation across research cultures in Europe, North America, Asia and Australia. The lessons below are incorporated selectively into NanoTRIZ rather than copied as institutional branding.

Professor David Weitz's group, Harvard SEAS

As a Visiting Scholar in Professor David Weitz's laboratory, I observed a high-trust research culture in which students and postdoctoral researchers were expected to own questions, experiments and interpretations while maintaining demanding standards of preparation and reproducibility. The most transferable lesson was that responsibility and opportunity should increase together. In NanoTRIZ, this principle appears as staged ownership: junior participants initially receive explicit structures for literature review, meeting preparation and documentation, but progressively become responsible for narrowing the question, defending methodological choices, leading discussion and revising the argument. The Weitz environment also demonstrated how fundamental microfluidics and soft-matter research can connect to patents, start-ups and societal applications without weakening scientific standards. Accordingly, NanoTRIZ participants are encouraged to consider translation only after mechanism, evidence and limitations have been established.

Professor Geoffrey Ozin's group and Solar Fuels environment, University of Toronto

Work in Professor Geoffrey Ozin's nanochemistry and Solar Fuels environment reinforced the importance of treating science as both a rigorous and creative enterprise. Nanomaterials can be studied as structures governed by chemistry and physics, but also as designed systems capable of addressing energy, environmental and societal problems. This experience informs NanoTRIZ projects that connect molecular or nanoscale mechanisms to broader purpose while resisting unsupported claims of impact. It also strengthened my use of analogy, visual explanation and cross-disciplinary communication: a participant should be able to explain not only what a material or device does, but why its architecture produces that behaviour and what evidence would be required to demonstrate usefulness.

European materials and micro/nanosystems environments

Research and training at the Technical University of Munich and Walter Schottky Institute, IFW Dresden, the Max Planck Institute for Intelligent Systems and Leibniz institutes reinforced precision in fabrication, mechanism-based analysis, instrument awareness, safety and reproducibility. Work on strained thin films, nanomembranes, micro/nanomotors and microsystems showed that seemingly small changes in thickness, surface condition, geometry, release procedure or fluid composition can determine the result. Within NanoTRIZ, this experience is translated into disciplined attention to provenance, units, boundary conditions, controls, uncertainty and failure modes, even when the project is literature-based or computational.

Fudan University, Columbia University and The University of Queensland

My tenured professorial work at Fudan University provided sustained experience in course ownership, supervision, international teaching and development of researchers across different levels of preparation. Research exposure and collaboration involving Columbia University and, after relocation to Australia, The University of Queensland further reinforced the value of interdisciplinary discussion and clearly defined collaborative roles. These experiences support a remote program in which participants may come from different countries and educational systems: expectations must be explicit, feedback must be documented, and academic quality cannot depend on prior familiarity with elite research culture.

3. DOCUMENTED TEACHING, SUPERVISION AND STUDENT DEVELOPMENT

From 2016 to 2023, I independently designed and delivered the semester-long Microfluidics and Lab-on-a-Chip course at Fudan University. Responsibility included curriculum structure, content sequencing, teaching materials, research examples, student projects, assessment, feedback and revision. The course connected transport phenomena, diffusion, capillarity, multiphase flow, microfabrication, diagnostics, environmental analysis and device design. I also designed and taught Materials in Life in Fudan's International Summer Session, contributed seminars at the Technical University of Munich and provided laboratory instruction in nanomachines at IFW Dresden. During the COVID-19 transition, I developed digital materials and supported adaptation to remote teaching.

My supervision record includes six PhD completions as principal or co-supervisor, together with master's students, undergraduates and postdoctoral researchers. Trainees received scholarships, Outstanding Graduate recognition and innovation awards; student teams achieved recognition in national innovation competitions; and former researchers progressed to institutions and employers including Northwestern University, Cornell University and Infineon Technologies, as well as academic appointments and technology-intensive industry. Fudan University recognised the postgraduate supervision group among its Top Ten "Three-Good" groups in 2021. These outcomes are not presented as the product of one supervisor alone; they demonstrate a structured environment in which researchers were supported to develop technical judgement, communication, initiative and career readiness.

This record is relevant to NanoTRIZ because the program is not based solely on inspirational discussion. It requires the same underlying practices that support serious research training: a feasible question, defined milestones, regular preparation, transparent records, critical feedback, progressively independent work, quality thresholds and realistic decisions about when a result is ready for external presentation.

4. NANOTRIZ RESEARCH-TRAINING PATHWAY

The NanoTRIZ pathway is structured so that the visible output is supported by an auditable process. Admission begins with an online application and a short interview assessing motivation, educational background, available time, language, interests, project feasibility and supervision capacity. A broad interest such as nanotechnology, medicine, artificial intelligence or clean energy is not yet a project; the first educational task is to convert it into a tractable question appropriate to the participant's level and available evidence.

Stage	Primary purpose	Typical activities	Documented artefact
1	**Diagnostic framing**	Clarify interests, prior knowledge, constraints, safeguarding and feasible scope.	Research brief and learning agreement
2	**Research literacy and evidence mapping**	Search systematically; distinguish source types; extract methods, findings, limitations and relevance.	Reference library, evidence table and annotated map
3	**Gap and contradiction analysis**	Compare results, identify uncontrolled variables, unresolved mechanisms, trade-offs and reproducibility problems.	Gap statement and TRIZ-informed contradiction map
4	**Contribution development**	Develop a classification, model, estimate, simulation, design, protocol, critical synthesis or data analysis.	Method record, calculations, figures and contribution log
5	**Critical evaluation and revision**	Test assumptions, compare alternatives, identify falsifying evidence, limitations and required controls.	Revision history, validation plan and limitations statement
6	**Scholarly communication**	Select a proportionate format and prepare the work for internal or external review when justified.	Report, presentation, poster, review, preprint or manuscript contribution

The level of scaffolding differs by role. Junior Research Scholars, typically senior secondary students, receive more explicit guidance in reading, source evaluation, task sequencing and academic communication. Their projects normally prioritise literature synthesis, low-risk observations, public datasets, image analysis, conceptual design, modelling or reproducibility studies. Research Scholars at university or early-career level are expected to assume greater responsibility for scope, quantitative reasoning, method design, collaboration and manuscript-level argument. Progression is based on demonstrated capability rather than age or status alone.

5. MENTORSHIP MODEL: STRUCTURE, OWNERSHIP AND ACCOUNTABILITY

My mentorship approach can be described as structured independence. Participants need sufficient scaffolding to avoid confusion, but excessive direction converts research into task execution. I therefore establish expectations early and transfer responsibility progressively.

- At entry, the participant receives a defined scope, milestone sequence, communication expectations, file structure, reference-management approach, AI-use requirements, safety limits and authorship principles.
- During guided development, meetings focus on decisions rather than passive reporting: what evidence was found, why it is credible, what changed in the argument, which uncertainty remains and what action follows.
- As capability develops, the participant leads more of the meeting, proposes alternatives, defends assumptions, evaluates criticism and owns the next-step plan.
- In group projects, each participant has a defined question, evidence set, analysis or deliverable. Meeting records, version history and contribution logs make responsibility visible.
- The mentor does not manufacture a project outcome for the participant. Feedback may require a question to be narrowed, unsupported claims to be removed, calculations to be repeated, a concept to be abandoned or an external submission to be delayed.

Regular meetings may be individual or conducted in a small group, but most progress occurs through independent reading, analysis, writing and revision between sessions. The quality of the relationship therefore depends on preparation and honest communication. Participants are expected to report difficulties early, distinguish lack of time from conceptual difficulty, and document decisions. When progress stalls, the first response is diagnostic: the project may need narrower scope, a different method, additional foundational study, local technical support or, in some cases, discontinuation because the work is not feasible within the available conditions.

Assessment and evidence of development

NanoTRIZ does not assess success through attendance, title or activity volume alone. Evaluation is based on evidence of capability and improvement. Relevant criteria include:

- clarity and feasibility of the research question;
- quality, diversity and traceability of the evidence base;
- ability to distinguish evidence, interpretation and speculation;
- quantitative and logical accuracy, including units and limiting cases;
- methodological rigour, controls, reproducibility and awareness of artefacts;
- responsiveness to feedback and quality of revision;
- independence, reliability and contribution to team work;
- academic integrity, responsible AI use and accurate attribution;
- quality of scientific figures, writing, presentation and communication of limitations.

A completion record or recommendation, when earned, should describe the participant's actual contribution and observed development. It should not imply a degree, university credit, employment relationship, guaranteed publication or admissions outcome. The educational value lies primarily in the documented body of work and the participant's ability to explain how it was produced.

6. RESPONSIBLE AI, RESEARCH INTEGRITY, SAFETY AND SAFEGUARDING

Responsible use of artificial intelligence is embedded in the research process rather than treated as a separate technology lesson. AI may assist brainstorming, language improvement, coding, comparison, workflow organisation, design-space exploration or visual drafting. It may not replace source reading, fabricate references or data, conceal third-party writing, or be presented as an author. The participant remains accountable for every claim, calculation, citation, figure and conclusion.

For each material use of AI, the participant maintains a record identifying the tool, version or access date, purpose, affected section or file, verification performed and corrections made. Generated summaries are checked against original sources; generated references are verified; code is tested on transparent examples and limiting cases; and AI-assisted figures are reviewed for scientific accuracy, rights and appropriate disclosure. This record makes the workflow teachable and auditable.

Authorship and affiliation follow accepted academic criteria. Payment, participation in the program or use of an internal Scholar title does not purchase authorship, publication, affiliation or a recommendation. Authorship requires a substantial, documented intellectual contribution to the specific output and compliance with the policies of the relevant venue. NanoTRIZ affiliation may be used only when the work was genuinely conducted through the institute and the role has been approved. Publication, conference acceptance, patentability and commercial success cannot be guaranteed in advance.

Safety and feasibility take priority over ambition. Remote participants must not undertake hazardous chemistry or biological work, high-voltage experiments, pressure systems, work with toxic, flammable or highly reactive substances, or other unsafe procedures without authorised facilities, formal induction and competent local supervision. Remote NanoTRIZ mentorship is not a laboratory permit and does not replace local responsibility. Many strong projects can be completed through literature synthesis, modelling, image analysis, public datasets, conceptual design, low-risk observations or reproducibility analysis.

For participants under eighteen, informed parental or guardian consent is required before participation. Communication, video meetings, file exchange and any involvement of external researchers must follow appropriate safeguarding practice and professional boundaries. Administrative communication with parents or guardians should support safety and informed participation while preserving the student's academic responsibility for the work.

7. INCLUSION, CROSS-CULTURAL MENTORSHIP AND SCIENTIFIC COMMUNICATION

My teaching and supervision have involved students from different countries, disciplines and educational systems. Participants vary in prior knowledge, language confidence, familiarity with critique, experience of teamwork and comfort with uncertainty. Inclusive mentorship therefore requires explicit expectations, accessible resources, timely feedback and multiple ways to demonstrate understanding without lowering scientific standards.

Students educated in examination-oriented systems may initially be reluctant to question a supervisor, present an unfinished idea or report a failed attempt. I address this through staged open-ended tasks, low-stakes critique, rotating leadership roles, structured self-reflection and explicit permission to disagree with evidence. Mistakes are treated as diagnostic information, but responsibility remains real: claims must be corrected, tasks completed and team contributions made visible. This approach develops confidence without confusing encouragement with the absence of standards.

Scientific communication is developed throughout the project. Participants practise concise meeting updates, research questions, literature matrices, technical figures, captions, tables, abstracts, posters and oral presentations. They learn to explain the same project to a specialist, an interdisciplinary collaborator, a prospective supervisor and a non-specialist audience without changing the evidence. Video-supported documentation and SciViD-related methods may be used where dynamic experimental or computational processes are better understood through visual records, but visual appeal never substitutes for methods, data or critical interpretation.

8. RESEARCH THEMES AND APPROPRIATE PROJECT SCOPE

NanoTRIZ projects are selected for scientific distinctiveness, feasibility, educational value and access to appropriate evidence or tools. My strongest direct areas include strain-engineered thin films and nanomembranes; catalytic and magnetic micro/nanosystems; microfluidics, droplets and lab-on-a-chip devices; biosensing; active matter; membraneless fuel cells and clean-energy microsystems; and responsible AI-assisted research methods. Projects may also address adjacent fields when a credible evidence plan and, where necessary, qualified co-supervision can be established.

Suitable Junior Research Scholar projects may include a critical comparison of propulsion mechanisms in catalytic micro/nanomotors; a matrix connecting energy input, transduction mechanism and mechanical output; a review of how strain modifies functional thin films; a reproducibility analysis of device performance under different geometries; a conceptual microfluidic sensing platform; or a structured analysis of contradictions limiting a clean-energy technology. More advanced participants may develop quantitative models, simulations, validation protocols, systematic reviews, manuscript sections or patent-oriented concept notes. The project format is determined by evidence and contribution, not by a promise that every participant will publish.

9. QUALITY ASSURANCE AND CONTINUOUS IMPROVEMENT

A rigorous remote program requires its own evidence of quality. I evaluate the NanoTRIZ model through milestone completion, quality of participant artefacts, traceability of feedback, revision depth, growth in independence, adherence to safety and integrity requirements, and the proportionate quality of final outputs. Participant and parent feedback may identify communication or scheduling problems, but educational decisions remain grounded in research standards rather than customer satisfaction alone.

Project templates, AI-use records, safeguarding procedures, contribution logs and assessment rubrics are reviewed as the program develops. External researchers may provide specialist critique when a project exceeds my direct expertise, but their involvement is confirmed only through a specific agreement. The purpose of continuous improvement is not to increase the appearance of outputs; it is to improve the reliability, transparency and educational value of the process.

CONCLUSION

The NanoTRIZ Junior Research Scholar / Research Scholar Program represents an extension of my teaching and supervision experience into a structured international research-enrichment model. Its purpose is not to imitate university enrolment or to sell a credential. It is to give serious participants supervised experience of how research is actually developed: a question is narrowed, evidence is tested, contradictions are made explicit, methods are justified, uncertainty is documented, feedback is incorporated and a proportionate scholarly result is communicated.

My work in the research environments of David Weitz, Geoffrey Ozin and other leading laboratories, together with sustained course leadership and supervision at Fudan University, has shaped a mentorship approach that combines independence with discipline, creativity with evidence, ambition with safety and scientific communication with responsibility. The intended outcome is a participant who can enter a university laboratory, research internship or advanced academic program with more realistic expectations, stronger research judgement and a documented record of serious intellectual work.

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