

Shankar Dutt

POSTDOCTORAL FELLOW

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Profile

As a Postdoctoral Fellow at the Australian National University's Research School of Physics, I specialize in the development of advanced composite nanopore membranes using innovative track etch and controlled breakdown technologies. My expertise lies in creating nanopores in diverse materials, integrating them with 2D materials like Graphene for applications in medical and biological sensors, ultrafiltration, and lab-on-chip devices. I also contribute to the development of novel coatings for space applications. Recognized for my collaborative research approach, I have also been instrumental in commercializing silicon-based membrane technologies.

Employment

Postdoctoral Fellow (Level A)

AUSTRALIAN NATIONAL UNIVERSITY

- Fabricated innovative coatings and composite materials for space applications.

Dec. 2023 - PRESENT

Canberra, Australia

Research Officer 5/6 (0.4 FTE)

AUSTRALIAN NATIONAL UNIVERSITY

- Led commercialisation of silicon-based membrane technologies.
- Developed and analyzed diverse membranes, including silicon dioxide and silicon nitride, enhancing the technology's industrial applicability.

Nov. 2022 - Aug. 2023 &

Oct. 2023 - Nov. 2023

Canberra, Australia

Education

Doctor of Philosophy

AUSTRALIAN NATIONAL UNIVERSITY

Development and investigation of functional solid-state nanopore membranes

Sept. 2018 - PRESENT

Canberra, Australia

M.Sc. Physics Honours

GURU NANAK DEV UNIVERSITY

- University Gold Medallist (Rank - 1)
- GPA - 9.75/10

July 2016 - June 2018

Amritsar, India

B.Sc. Physics Honours

GURU NANAK DEV UNIVERSITY

- University Gold Medallist (Rank - 1)
- GPA - 9.92/10

July 2013 - June 2016

Amritsar, India

Research Projects

Postdoctoral Research

AUSTRALIAN NATIONAL UNIVERSITY

Carbon fibre additive manufacturing for products for space: Protective nanomaterial coating

- Fabricated innovative coatings and composite materials for space applications.

Canberra, Australia

December 2023 - Present

PhD Research

AUSTRALIAN NATIONAL UNIVERSITY

Development and investigation of functional solid-state nanopore membranes

- Developed highly tunable nanopores in various materials, resulting in two IP applications.
- Investigated chemical and bio-sensing of different molecules using solid-state nanopore membranes.
- Developed first Australian nanopore based bio-sensing platform.
- Co-supervised six Undergraduate students on nanopore fabrication and characterisation.
- As a part of grand challenge project, "Our Health in Our Hands", worked closely with scientists from Immunology and Infectious Disease Lab and Nanotechnology Research Lab at the Australian National University.
- Collaborated with researchers from Australian Synchrotron (Australia), Peking University (China), GSI Helmholtzzentrum für Schwerionenforschung (Germany), Joint Institute for Nuclear Research (Russia), Institute of Nuclear Physics (Kazakhstan), University of California, Riverside (U.S.A.), and Southern Methodist University (U.S.A.).
- Wrote and assisted many research proposals for Synchrotron beamtime, Ion-beam irradiation beamtime at GSI, and DAAD research funding.

Canberra, Australia

September 2018 - Present

Master's Thesis

GURU NANAK DEV UNIVERSITY

Amritsar, India

Synthesis and Characterization of Copper Tellurite Glasses

November 2017 - May 2018

- Studied structural, thermal and electrical characterisation of semiconducting copper tellurite glasses.
- Semiconducting glasses with different compositions were fabricated using melt-quench technique.
- Characterisation was done by neutron diffraction, Raman spectroscopy, thermal analysis and two probe electrical conductivity measurements.

Research Internship

ÉCOLE POLYTECHNIQUE

Paris, France

Study of the acceleration of electrons through laser plasma interaction

May 2017 - July 2017

- Assisted with the study on electron wakefield acceleration in the resonant bubble regime with few-millijoule near single-cycle laser pulses at a kilohertz repetition rate.

Publications

Google Scholar: <https://scholar.google.com/citations?user=Zn0kP-cAAAAJ&hl=en&oi=ao>

Patents

S.Dutt, P. Kluth, C. Notthoff. "A method of fabricating nanopores", P117449.AU (International Phase) 2021

S.Dutt, P. Kluth, C. Notthoff. "A method of fabricating membranes", P116401.AU (PCT Phase) 2021

Journal Articles

S. Dutt, L. Lai, Y.M. Bandara, B.I. Karawdeniya, V. Gopalan, P. Kluth. "Time-resolved structural analysis of mutant tRNA associated with defects in neuronal homeostasis through solid-state nanopore sensing", In preparation. 2023

Y. M. Bandara, **S. Dutt**, B. Karawdeniya, J. Saharia, P. Kluth and A. Tricoli. "A Robust Parallel Computing Data Extraction Framework for Nanopore Experiments", *Small Methods*. 2024

Y. M. Bandara, B. Karawdeniya, **S. Dutt**, P. Kluth and A. Tricoli. "Nanopore Fabrication Made Easy: A Portable, Affordable Microcontroller-Assisted Approach for Tailored Pore Formation via Controlled Breakdown", *Analytical Chemistry* 96 (5), 2124-2134. 2024

S. Dutt, B. Karawdeniya, Y. M. N. D. Y. Bandara, and P. Kluth. "Nanopore sensing and machine learning: Future of biomarker analysis and disease detection," *Future Science OA*, 10 (1), 2340882. 2024

T. Alwadi, C. Notthoff, **S. Dutt**, J. Wierbik, N. Afrin, A. Kiy, and P. Kluth. "Ion track formation and porosity in InSb induced by swift heavy ion irradiation," *Journal of Vacuum Science & Technology A*, 41, no. 6, p. 063 404, 2023. 2023

S. Dutt, H. Shao, B.I. Karawdeniya, Y.M. Bandara, E. Daskalaki, H. Suominen, P. Kluth. "High Accuracy Protein Identification: Fusion of solid-state nanopore sensing and machine learning", *Small Methods* 7, 11:2300676, 2023. 2023

B. R. Pauw, G. J. Smales, A. S. Anker, ... **S. Dutt**, ... and J. Wuttke. "The human factor: results of a small-angle scattering data analysis round robin", *Journal of Applied Crystallography* 56, 6:1618-1629, 2023. 2023

S. Dutt, P. Apel, O. Polezhaeva, N. Kirby, P. Kluth. "Role of antioxidants in swift heavy ion tracks in polypropylene", *Polymer* 282 (2023): 126133. 2023

S. Dutt, C. Notthoff, X. Wang, C. Trautmann, P. Mota-Santiago, P. Kluth. "Annealing of high energy ion irradiation damage in amorphous silicon dioxide", *Applied Surface Science* 628 (2023): 157370. 2023

S. Dutt, B.I. Karawdeniya, Y.M. Bandara, N. Afrin, P. Kluth. "Ultra-Thin, High-Lifetime Silicon Nitride Membranes for Nanopore Sensing", *Analytical Chemistry* 95, 13 (2023): 5754-5763. 2023

A. Kiy, **S. Dutt**, C. Notthoff, M. E. Toimil-Molares, N. Kirby, P. Kluth. "Highly Rectifying Conical Nanopores in Amorphous SiO₂ Membranes for Nanofluidic Osmotic Power Generation and Electroosmotic Pumps", *ACS Applied Nano Materials* 6, 10 (2023): 8564-8573. 2021

X. Wang, **S. Dutt**, C. Notthoff, A. Kiy, P. Mota-Santiago, S. T. Mudie, M.E. Toimil-Molares, F. Liu, Y. Wang, P. Kluth. "SAXS data modelling for the characterisation of ion tracks in polymers", *Physical Chemistry Chemical Physics* (2022). 2022

S. Dutt, P. Apel, N. Lizunov, C. Notthoff, Q. Wen, C. Trautmann, P. Mota-Santiago, N. Kirby, P. Kluth. "Shape of nanopores in track-etched polycarbonate membranes", *Journal of Membrane Science* 638 (2021): 119681. 2021

- A. Kiy, C. Notthoff, **S. Dutt**, M. Grigg, A. Hadley, P. Mota-Santiago, N. Kirby, C. Trautmann, M.E. Toimil-Molares, P. Kluth “Ion track etching of polycarbonate membranes monitored by in situ small angle X-ray scattering.”, *Physical Chemistry Chemical Physics* 23 (2021): 14231-14241. 2021
- S. Dutt**, S. Singh, A. Mahajan, B. Arora, B.K. Sahoo. “van der Waals coefficients of the multi-layered MoS₂ with alkali metals”, *Physica Scripta* 95.9 (2020): 095506. 2020
- A. Hadley, C. Notthoff, P. Mota-Santiago, **S. Dutt**, S. Mudie, MA Carrillo-Solano, ME Toimil-Molares, C Trautmann, P Kluth. “Analysis of nanometer-sized aligned conical pores using small-angle X-ray scattering”, *Physical Review Materials* 4.5 (2020): 056003. 2020
- N. Kaur, A. Khanna, M. Fabian, **S. Dutt**. “Structural and electrical characterization of semiconducting xCuO-(100-x)TeO₂ glasses”, *Journal of Non-Crystalline Solids* (2020): 119884. 2020
- D. Gustas, D. Guenot, A. Vernier, **S. Dutt**, F. Bohle, R. Lopez-Martens, A. Lifschitz, J. Faure. “High-Charge relativistic electron bunches from a kHz laser-plasma accelerator”, *Physical Review Accelerators and Beams* 21.1 (2018): 013401. 2018

Other Articles

- S. Dutt**, C. Notthoff, A. Kiy, Q. Wen, M.E. Toimil-Molares, C. Trautmann, N. Kirby, P. Kluth. “Highly tunable nanopores in silicon dioxide and silicon oxynitride membranes”, *AINSE Annual Report* (2022): 37-40. 2023
- S. Dutt**, C. Notthoff, A. Hadley, N. Lizunov, M.E. Toimil-Molares, C. Trautmann, P. Mota-Santiago, P. Apel, N. Kirby, P. Kluth. “Investigating track-etched nanopore membranes”, *AINSE Annual Report* (2021): 51-54. 2022

Experimental Expertise

Solid state nanopore sensing

AUSTRALIAN NATIONAL UNIVERSITY

- Proficient in resistive pulse single molecule sensing. Designed and performed numerous experiments.
- Developed software applications for analysis of the nanopore data.

Synchrotron based small-angle X-ray scattering

AUSTRALIAN SYNCHROTRON

- Performed numerous experiments at the SAXS/WAXS beamline.
- Developed new form factor models for the analysis of 1D-SAXS data and different data analysis softwares.

Ion beam irradiation

¹⁴UD ACCELERATOR AND HIGH ENERGY IMPLANTER

- Hands on experience on using and doing irradiation at the biggest swift heavy ion accelerator in the Southern Hemisphere.
- Irradiated different materials with number of ions/atoms from energy ranging from 1MeV to 185MeV and fluence ranging from 1×10^7 ions cm⁻² to 1×10^{15} ions cm⁻².

Thin-film depositions

AUSTRALIAN NATIONAL FABRICATION FACILITY

- Performed and developed protocols for thin film depositions using plasma-enhanced chemical vapor deposition, low pressure chemical vapor deposition, atomic layer deposition, sputter deposition and e-beam deposition.
- Deposited a range of materials including dielectrics (silicon dioxide, silicon nitride, silicon oxynitride, titanium dioxide, hafnium oxide, tin oxide, aluminium oxide), metals(gold, platinum, aluminium, silver), a-silicon and many more.

Microscopy Techniques

AUSTRALIAN NATIONAL FABRICATION FACILITY AND RESEARCH SCHOOL OF PHYSICS, ANU

- Practical experience on using scanning electron microscope and atomic force microscope.

Spectroscopy Techniques

RESEARCH SCHOOL OF PHYSICS, ANU

- Hands on experience on UV-VIS-NIR spectroscopy and FTIR spectroscopy.

Microelectromechanical systems

AUSTRALIAN NATIONAL FABRICATION FACILITY AND RESEARCH SCHOOL OF PHYSICS, ANU

- Formulated protocols and experiments for fabrication of versatile membranes using lithography and MEMS techniques.
- Fabricated silicon nitride, silicon dioxide, silicon oxynitride membranes as thin as 4nm.
- Developed protocols for chemical etching and dry etching (using inductively coupled plasma etching technique) for different materials.

Grants

Seed Grant

AUD \$192,872

AUSTRALIA'S ECONOMIC ACCELERATOR

Collaborating Entrepreneur : “MiniGrav: a drone-deployable miniaturised absolute gravimeter for subsurface mapping”

2024

Research Translation and Engagement Primer

AUD \$24,200

AUSTRALIAN NATIONAL UNIVERSITY

Co-Investigator : Grant for providing researchers with opportunities to develop research translation and engagement activities (e.g. with industry and government)

2022

Discovery Translation Fund

AUD \$75,000

ANU CONNECT VENTURES

Co-Investigator : Grant for prototyping, equipment, testing and external verification to enable crucial ‘proof of concept’ development of new technologies or the establishment of new ventures.

2022

SAXS Beamtime Grants

ANSTO-AUSTRALIAN SYNCHROTRON

Co-proposer of eight successful SAXS/WAXS beamtime proposals

Sept 2018 - Sept 2023

GPU Grant

AUD \$16,000

NVIDIA

LEAD : Two Nvidia A6000 GPUs were awarded for the development of machine learning-based biomarker identification in solid-state nanopore platform.

2022

Cloud Computation Time

AUD \$8,564

GOOGLE

LEAD : Google Cloud Research Credits were given to advance the nanopore sensing research.

2022

AINSE Travel Grant

AUD \$1,000

AUSTRALIAN INSTITUTE OF NUCLEAR SCIENCE AND ENGINEERING

LEAD : Travel Grant was awarded for attending SHIM 2022 conference in Finland.

2022

Vice-Chancellor's HDR Travel Grant

AUD \$1,500

AUSTRALIAN NATIONAL UNIVERSITY

LEAD : Travel Grant was awarded for attending SHIM 2022 conference in Finland.

2022

Short Term Research Grant

€7,000

DEUTSCHER AKADEMISCHER AUSTAUSCHDIENST (DAAD)

LEAD : Short term research grant to visit and do research in Germany for three months

2021

Academic Awards & Honors

2024	Neville Fletcher Early Career Research Award (RSPHys DMP/EME Award, Australian National University)	Australia
2023	Elsevier NIMB Young Researcher Award at the 21st International Conference on Radiation Effects in Insulators	Japan
2022	The Jak Kelly Award by the Royal Society of New South Wales	Australia
2022	Award for Postgraduate Excellence in Physics by the Australian Institute of Physics	Australia
2022	John Carver Prize by Research School of Physics, Australian National University	Australia
2019	AINSE Postgraduate Research Scholarship	Australia
2019	Australian Government Research Training Program International Scholarship	Australia
2019	Australian Government Research Training Program International Fee-Offset Scholarship	Australia
2018	ANU PhD Scholarship(International)	Australia
2018	ANU HDR Fee Remission Merit Scholarship	Australia
2018	Student of the Year by Department of Physics, Guru Nanak Dev University	India

2018	University Gold Medallist(Rank-1) in M.Sc. (Physics Hons.)	India
2017	Charpak Master's Scholarship by Embassy of France in India	France
2017	International Scholarship by École Polytechnique	France
2016	Summer Research Fellow of Indian Academy of Science	India
2016	University Gold Medallist(Rank-1) in B.Sc. (Physics Hons.)	India
2014	University Merit Scholarship by Guru Nanak Dev University	India
2014	SHE INSPIRE Scholarship by Department of Science and Technology, Govt. of India	India

Talks and Presentations

Invited Talks

Invited Talk Fukuoka, Japan	S. Dutt , C. Notthoff, X. Wang, C. Trautmann, P. Mota-Santiago, P. Kluth. "Annealing of swift heavy ion tracks in amorphous silicon dioxide", 21st International Conference on Radiation Effects in Insulators	2023
Invited Talk Virtual Presentation (Yaroslavl, Russia)	S. Dutt , C. Notthoff, A. Kiy, X. Wang, C. Trautmann, P. Mota-Santiago, N. Kirby, P. Kluth. "Swift heavy ion tracks in amorphous silicon dioxide", The XXVI International Conference on Ion-Surface Interactions	2023
Invited Talk Helsinki, Finland	S. Dutt , C. Notthoff, A. Kiy, P. Apel, N. Lizunov, P. Mota-Santiago, N. Kirby, M.E. Toimil-Molares, C. Trautmann, I. Korolkov, M. Zdorovets, P. Kluth. "Exploring ion tracks and nanopores using small-angle X-ray scattering", 29th international conference on atomic collisions in solids & 11th international symposium on swift heavy ions in matter	2022
Invited Talk Darmstadt, Germany	S. Dutt , C. Notthoff, X. Wang, A. Kiy, P. Apel, N. Lizunov, P. Mota-Santiago, N. Kirby, M.E. Toimil-Molares, C. Trautmann, I. Korolkov, M. Zdorovets, P. Kluth. "Versatile solid-state nanopore membranes", GSI MAT Seminar	2022

Conference Presentations

Oral Presentation Canberra, Australia	S. Dutt , H. Shao, B.I. Karawdeniya, Y.M. Bandara, E. Daskalaki, H. Suominen, P. Kluth. "High Accuracy Protein Identification: Fusion of solid-state nanopore sensing and machine learning", ANZCOP-AIP Summer Meeting 2023	2023
Oral Presentation Dehradun, India	S. Dutt , C. Notthoff, X. Wang, C. Trautmann, P. Mota-Santiago, P. Kluth. "Annealing of swift heavy ion tracks in amorphous silicon dioxide", 7th International Conference on Nanostructuring by Ion Beams	2023
Oral Presentation San Diego, USA	S. Dutt , B.I. Karawdeniya, Y.M. Bandara, N. Afrin, P. Kluth. "Ultra-thin, high-lifetime silicon nitride nanopore membranes for biosensing", 67th Biophysical Society Annual Meeting	2023
Oral Presentation Taipei, Taiwan	S. Dutt , C. Notthoff, Q. Wen, A. Kiy, M.E. Toimil-Molares, I. Korolkov, M. Zdorovets, N. Kirby, P. Kluth. "Fabrication of highly tunable silicon dioxide and silicon oxynitride nanopore membranes", 16th International Conference on Inorganic Membranes	2022
Oral Presentation Melbourne, Australia	S. Dutt , P. Apel, O. Polezhaeva, A. Kiy, N. Afrin, C. Notthoff, N. Kirby, P. Kluth, "Role of antioxidants in swift heavy ion tracks in polypropylene", ANSTO User Meeting 2022	2022
Oral Presentation Melbourne, Australia	S. Dutt , P. Apel, C. Notthoff, A. Kiy, N. Lizunov, Q. Wen, C. Trautmann, P. Mota-Santiago, N. Kirby, P. Kluth. "Shape of track-etched nanopores characterized by small-angle X-ray scattering", ANSTO User Meeting 2021	2021
Oral Presentation Online Symposium	S. Dutt , C. Notthoff, A. Kiy, C. Trautmann, P. Mota-Santiago, N. Kirby, P. Kluth. "Fabrication, Characterisation and Application of solid-state nanopore membrane", 8th MSA Early Career Researcher Online Membrane Symposium	2021
Poster Presentation Oxfordshire, United Kingdom	S. Dutt , P. Apel, N. Lizunov, C. Notthoff, Q. Wen, C. Trautmann, P. Mota-Santiago, N. Kirby, P. Kluth. "Shape of nanopores in track-etched polycarbonate membranes", S4SAS Conference 2021	2021

<p>Oral Presentation Canberra, Australia</p>	<p>S. Dutt, A. Kiy, B.I. Karawdeniya, K. Murugappan, C. Notthoff, N. Kirby, M.E. Toimil-Molares, C. Trautmann, A. Tricoli, P. Kluth. "Versatile nanoporous silicon dioxide membranes: fabrication, characterisation and applicaton ", <i>Our health in our hands symposium</i></p>	<p>2020</p>
<p>Poster Presentation Melbourne, Australia</p>	<p>S. Dutt, C. Notthoff,A. Hadley, A. Kiy, N. Kirby, M.E. Toimil-Molares, C. Trautmann, P. Kluth. "Investigation of etched ion-tracks in SiO₂ membranes ", <i>Australian Synchrotron User Meeting 2020</i></p>	<p>2020</p>
<p>Oral Presentation Brisbane, Australia</p>	<p>S. Dutt, C. Notthoff,A. Hadley, A. Kiy, N. Kirby, M.E. Toimil-Molares, C. Trautmann, P. Kluth. "Fabrication of solid-state nano-pore graphene composite membranes ", <i>International conference on nanoscience and nanotechnology (ICONN-2020)</i></p>	<p>2020</p>
<p>Poster Presentation Nur-Sultan, Kazakhstan</p>	<p>S. Dutt, A. Hadley, C. Notthoff, N. Kirby, M.E. Toimil-Molares, C. Trautmann, P. Kluth. "Fabrication of solid-state nano-pore membranes ", <i>20th International conference on radiation effects in insulators</i></p>	<p>2019</p>
<p>Oral Presentation Amritsar, India</p>	<p>S. Dutt, S. Singh, A. Mahajan, B. Arora, B.K. Sahoo. "van der Waals coefficients of the multi-layered MoS₂ with alkali metals", <i>Recent research trends in material sciences</i></p>	<p>2017</p>

Skills

Modeling and Analysis	Mathematica, Matlab, Python, Origin, AutoCad, L ^A T _E X, MS-Office, Corel-Draw, Inventor, C/C++, IgorPro
Software Developments	<ul style="list-style-type: none"> • IgorPro Macro (graphical user interface) for fitting 1D SAXS data fitting from nanopores and ion tracks • Web applications: <ul style="list-style-type: none"> (a) Simulation of conical nanopore shape (b) SAXS 1D Data fitting (c) Nanopore size calculator • Python and C based (command line interface) 1D SAXS data fitting software from nanopores and ion tracks • Python and C based (graphical user interface) nanopore biosensing data analysis
Languages	English, Punjabi and Hindi

Additional Activities

2024-2025	Guest Editor of Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms (Elsevier)	
2024	Co-organizer and Secretary of 30th International Conference on Atomic Collisions in Solids & 12th International Symposium on Swift Heavy Ions in Matter	Australia
2024	Co-organizer of Workshop on "Advances in Ion Track Physics and Related Applications"	Australia
2023	Honorary Secretary of the ANZCOP-AIP Summer Meeting, orchestrating one of the largest physics conferences in Australia/New Zealand, showcasing exceptional organizational and leadership skills	Australia
2023	Reviewed papers for Physical Review B, ACS Applied Nano Materials, Biotechnology Progress, Vacuum, STAR Protocols, RSC Advances and the Journal of Applied Crystallography	
2021	Technical Organisation Committee , 7th IUPAP International Conference on Women in Physics	Australia
2020	Organisation Committee , Fundamental Sciences & Quantum Technologies using Atomic Systems	India
2019	Marker , 20th Asian Physics Olympiad	Australia
2016-2018	Gender Champion: Leadership role working towards breaking gender barriers and making gender equality a reality , Government of India	India