

Shankar Dutt

DOCTORAL STUDENT

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Profile

A doctoral student currently with the Research School of Physics of the Australian National University, investigating novel composite nanopore membranes. Using track etch technology and controlled breakdown technique, I work on an industrially compatible technology for the fabrication of extremely small nanopores of controllable shape and size in a variety of materials. Combining this technology with 2D materials such as Graphene or ultra-thin film deposition enables the fabrication of nanopore membranes with desired functionalities that can be used in medical and biological sensors, ultrafiltration, and lab-on-the-chip applications.

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

PhD Research

AUSTRALIAN NATIONAL UNIVERSITY

Development and Investigation of functional solid-state nanopore membranes

Canberra, Australia

September 2018 - Present

- Investigated the fabrication of highly tunable nanopores in different materials and applied for two IP applications based on this research.
- Investigated chemical and bio-sensing of different molecules using solid-state nanopore membranes.
- Developed first Australian nanopore based bio-sensing platform.
- Co-supervised three Undergraduate students on nanopore fabrication and characterisation.
- As a part of grand challenge project, "Our Health in Our Hands", worked closely with scientists from Innunology 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), and Institute of Nuclear Physics(Kazakhstan).
- Wrote and assisted on many research proposals for Synchrotron beamtime, Ion-beam irradiation beamtime at GSI, and DAAD research funding.

Master's Thesis

GURU NANAK DEV UNIVERSITY

Synthesis and Characterization of Copper Tellurite Glasses

Amritsar, India

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

Study of the acceleration of electrons through laser plasma interaction

Paris, France

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.

Research Project

GURU NANAK DEV UNIVERSITY

Determination of C_3 coefficients for interaction of alkali atoms with thin films of MoS₂

Amritsar, India
August 2016 - May 2017

- Investigated van der Waals coefficients and the separation dependent retardation functions of the interactions between the atomically thin films of the multi-layered transition metal molybdenum disulfide dichalcogenides with the alkali atoms.
- Frequency-dependent dielectric permittivity and intrinsic carrier density values for different layers of MoS₂ were determined.

Research Internship

INSTITUTE OF NANO-SCIENCE AND TECHNOLOGY

Change in surface plasmon resonance of gold nanoparticles incorporated in silica aerogel

Mohali, India
May 2016 - July 2016

- Worked on the fabrication and characterisation of silica aerogel and gold nanoparticles incorporated in silica aerogel.

Publications

Patents

S.Dutt, C. Notthoff, P. Kluth. "A method of fabricating nanopores", A Patent Application (No. 2021903959) has been submitted **2021**

S.Dutt, C. Notthoff, P. Kluth. "A method of fabricating membranes", A Patent Application (No. 2021903960) has been submitted **2021**

Journal Articles

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**

Experimental Expertise

Synchrotron based small-angle X-ray scattering

AUSTRALIAN SYNCHROTRON

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

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 Raman spectroscopy, 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.
- Developed protocols for chemical etching and dry etching (using inductively coupled plasma etching technique) for different materials.

Academic Awards & Honors

2021	DAAD short term research grant to visit and do research in Germany for three months	Germany
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

Conference Presentations

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

Oral Presentation Canberra, Australia	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>	2020
Poster Presentation Melbourne, Australia	S.Dutt , C. Notthoff, A. Hadley, A. Kiy, N. Kirby, M.E. Toimil-Molares, C. Trautmann, P. Kluth. "Investigation of etched ion-tracks in SiO ₂ membranes ", <i>Australian Synchrotron User Meeting 2020</i>	2020
Oral Presentation Brisbane, Australia	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>	2020
Poster Presentation Nur-Sultan, Kazakhstan	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>	2019
Oral Presentation Amritsar, India	S.Dutt , S. Singh, A. Mahajan, B. Arora, B.K. Sahoo. "van der Waals coefficients of the multi-layered MoS ₂ with alkali metals", <i>Recent research trends in material sciences</i>	2017

Skills

Modeling and Analysis	Mathematica, Matlab, Maple, Python, Labview, Origin, AutoCad, \LaTeX , MS-Office, Corel-Draw, 3Ds Max, SolidWorks, 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) Nanopore overlap Calculator (c) Nanopore size calculator from IV measurements Python and C based (command line interface) 1D SAXS data fitting software from nanopores and ion tracks
Languages	English, Punjabi and Hindi

Additional Activities

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
2015-2017	President , Physics Club at Department of Physics, Guru Nanak Dev University	India
2014-2016	Editor , Departmental Newsletter "The Horizon"	India