

Curriculum Vitae – Dr. Sudarshan Narayanan, Ph.D.,

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CAREER SUMMARY

A materials scientist with 10+ years of combined academic and industry research experience in thin film coatings, transparent conductors, and battery materials for applications ranging from architectural glazings, automotive windshields, to optoelectronic devices and solid-state batteries. I am passionate about synergizing complementary advances in renewable energy generation and energy storage solutions for a sustainable energy future.

EDUCATION

Aug 2009 – M.S., Ph.D. Materials Science, Carnegie Mellon University, Pittsburgh PA, USA
Aug 2014 GPA: 3.93/4.0
Aug 2005 – B.Tech. Engineering Physics, Indian Institute of Technology (IIT) – Madras, Chennai India
Jul 2009 CGPA: 8.82/10.0

PROFESSIONAL/RESEARCH EXPERIENCE

Nov 2022 – **Assistant Professor**, Dept. of Sustainable Energy Engineering, IIT Kanpur, Kanpur, U.P., India
Current **Research Areas and interest:**

- **Energy Storage:** Engineering of electrode-electrolyte interfaces in Li- and Na-ion solid-state batteries; Li-S and Na-S chemistries, post Li-ion battery technologies
- **Large area thin films:** Low-cost, chemically durable transparent conducting coatings for glazing, optoelectronic applications
- **Building-Integrated Photovoltaics (BIPV):** Large-area transparent PV coatings, transparent luminescent solar concentrators (TLSCs)

Apr 2020 – **Postdoctoral Research Assistant**, Dept. of Materials, University of Oxford, Oxford UK
Oct 2022

- Characterisation of Li metal – solid electrolyte interfaces in solid-state batteries in collaboration with Nissan Motors Ltd. and SOLBAT consortium (Faraday Institution UK), for EV applications
- Co-investigator in InnovateUK Faraday Battery Challenge £670,000 Research Grant with consortium consisting of Nissan Motors Ltd., Warwick Manufacturing Group (WMG), Emerson and Renwick Ltd. (E&R), and Univ. of Oxford – LiMHIT: Lithium Metal electrode High Throughput screening

Sep 2014 – **R&D Engineer**, Vitro Architectural Glass (Formerly PPG Industries Inc.), Pittsburgh PA, USA
Nov 2019

- Lead Scientist for Sungate® 700 passive low-e coated glass product
- Large area sputter-deposited functional coatings including TCOs (low-e, transparent, durable) for architectural façades and automotive windshields

Jan 2010 – **Graduate Research Assistant**, Dept. of Materials Science and Engineering
Aug 2014 Carnegie Mellon University, Pittsburgh PA, USA

- Investigated transparent conducting materials for flexible and printable electronics using (a) Polymer-based flexible metal-dielectric laminate photonic crystals – for smart windows, optical power limiting applications (b) Ag nanowire thin films and polymer composites – for OPV/OLED device applications

Aug 2008 – **Undergraduate Research**, Dept. of Physics, IIT Madras, India
June 2009

- Low-T sintered piezoelectric PMN-PT ceramics, for energy harvesting & sensor applications

May 2008 – **Summer Research Fellow**, Materials Research Center, IISc Bengaluru, India
July 2008

- Carbon nanotubes synthesis through pyrolysis techniques using various precursors

TEACHING AND MENTORING EXPERIENCE

Indian Institute of Technology Kanpur (IIT Kanpur), India

- *Co-Instructor:* Course: SEE605A Introduction to Sustainable Energy Technologies (PG, Sem-II 2022-23)

University of Oxford, UK

- *Senior Demonstrator:* Electrode Potentials Laboratory, Department of Materials (HT 2022)
- *Co-supervisor:* Part II/Master's students; mentoring D.Phil students (Pasta Group) (MT 2021 – TT 2022)

Carnegie Mellon University, USA

- *Invited Lecturer:* Course: 27-729 Solid State Devices for Energy Conversion (PG, Fall 2018)
Course: 27-100 Intro. to Materials Science and Engineering (UG, Fall 2017)
- *Teaching Assistant:* Graduate and undergraduate level courses on Solid State Devices, Semiconductor Nanostructures, Elect.-Mag.-Opt. Materials, Polymer Physics (Fall 2010 – Spring 2013)
- *Student Mentor:* UG, Summer REU and Senior year Capstone students within CMU, WVU and Rice universities (Spring 2010 – Spring 2013)
Student research showcased at various scientific forums

Sanskrita Bharati USA and UK

- *Course Teacher:* ACS-WASC accredited "SAFL" (Sanskritam As Foreign Language) program, a 3-year online distance education program for students of grades 8-12 in USA
- *Teacher:* Spoken Sanskritam at introductory and advanced levels for adults, children in USA, UK

SELECTED PEER-REVIEWED PUBLICATIONS (Full list: [Google Scholar Page](#))

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- P. Vadhva, T. E. Gill, J. H. Cruddos, S. Said, M. Siniscalchi, **S. Narayanan**, M. Pasta, T. S. Miller, and A. J. E. Rettie, "Engineering Solution-Processed Non-Crystalline Solid Electrolytes for Li Metal Batteries", *Chemistry of Materials* (2023) **Article ASAP**, DOI: 10.1021/acs.chemmater.2c03071
 - S. Kim, Y. A. Chart, **S. Narayanan**, M. Pasta, "Thin Solid Electrolyte Separators for Solid-State Lithium–Sulfur Batteries", *Nano Letters* (2022), **22**, 24, 10176–10183
 - **S. Narayanan**, U. Ulissi, J. S. Gibson, R. S. Weatherup, M. Pasta, "Effect of current density on the solid electrolyte interphase formation at the lithium|Li₆PS₅Cl interface", *Nature Communications* (2022) **13**, 7237
 - H. J. Lee, X. Liu, Y. Chart, P. Tang, J-G Bae, S. Narayanan, J. H. Lee, R. J. Potter, Y. Sun, and M. Pasta, "LiNi_{0.5}Mn_{1.5}O₄ Cathode Microstructure for All-Solid-State Batteries" *Nano Letters* (2022) **22** (18), 7477-7483
 - **S. Narayanan**, J. S. Gibson, J. Aspinall, R. S. Weatherup, M. Pasta, "In situ and Operando characterisation of Li metal – solid electrolyte interfaces", *Current Opinion in Solid State and Materials Science*, (2022) **26**, 100978
 - J. S. Gibson, **S. Narayanan**, J. Swallow, P. K. Thakur, M. Pasta, T-L. Lee and R. S. Weatherup, "Gently Does It!: In Situ Preparation of Alkali Metal - Solid Electrolyte Interfaces for Photoelectron Spectroscopy", *Faraday Discussions*, (2022) **236**, 267-287
 - H. J. Lee, B. Darminto, **S. Narayanan**, M. Diaz-Lopez, A. Xiao, Y. Chart, J. H. Lee, J. Dawson, M. Pasta, "Li-ion conductivity in Li₂OHCl_{1-x}Br_x solid electrolytes: grains, grain boundaries and interfaces", *Journal of Materials Chemistry A* **10**, (2022), **21**, 11574-11586
 - P. Tang, H. J. Lee, K. Hurlbutt, P-Y. Huang, **S. Narayanan**, C. Wang, D. Gianolio, R. Arrigo, J. Chen, J. H. Warner, M. Pasta, "Elucidating the Formation and Structural Evolution of Platinum Single-Site Catalysts for the Hydrogen Evolution Reaction", *ACS Catalysis* (2022) **12**, 5, 3173-3180
 - C. Doerrer, I. Capone, **S. Narayanan**, J. Liu, C. R. M. Grovenor, M. Pasta, P. S. Grant, "High Energy Density Single-Crystal NMC/Li₆PS₅Cl Cathodes for All-Solid-State Lithium-Metal Batteries", *ACS Appl. Mater. Interfaces* (2021), **13**, 31, 37809–37815
 - **S. Narayanan**, J. Hajzus, C. Treacy, M.R. Bockstaller, L.M. Porter, "Polymer Embedded Metal-Nanowire Network Structures as Platform For Highly Reproducible And Flexible Transparent Conductors", *ECS J. Solid State Sci. Technol.* (2014) **3**, 11, P363-P369
 - **S. Narayanan**, J. Choi, L.M. Porter, M.R. Bockstaller, "Flexible Transparent Metal/Polymer Composite Materials Based on Optical Resonant Laminate Structures", *ACS Appl. Mater. Interfaces*, (2013), **5**, 4093-4099
 - B. Ramachandran, **N. Sudarshan**, and M. S. Ramachandra Rao, "Magnetoeimpedance and magnetodielectric properties of single phase 45PMN-20PFW-35PT ceramics", *J. Appl. Phys.* **107**, 09C503 (2010)

PATENTS (*as lead inventor or inventor with major contribution*)

- A. P. Ganjoo, **S. Narayanan**; D. J. O'Shaughnessy; "Transparent conductive oxide having an embedded film" – U.S. Patent No. 10,650,935 B2 (2020) – Issued
- A. P. Ganjoo, **S. Narayanan**, J. J. Finley, P. A. Medwick; "Coated Article Having a Silicon Oxynitride and Silicon Oxide Topcoat" – U.S. Patent No. 10,479,724 B2 (2019) – Issued
- M. R. Bockstaller, L. M. Porter, **S. Narayanan**, J. Choi; "Photonic Bandgap Structure with Tunable Optical and Electronic Properties" – U.S. Patent No. 9,182,616 B1 (2015) – Issued
- **S. Narayanan**, A. P. Ganjoo, A. D. Polcyn; "Heat-Treatable Coating with Blocking Layer Having Reduced Color Shift" – U.S. Patent Appl. No. US20220119934A1, Oct. 2021 – Pending
- Z. Ma, M. Griffin, A.P. Ganjoo, P.A. Medwick, **S. Narayanan**, A.D. Polcyn; "Low Sheet Resistance Coating" – U.S. Patent Appl. No. US20210274657A1, Feb. 2021 – Pending
- A. P. Ganjoo, **S. Narayanan**; J. J. Finley; "Protective Layer Over a Functional Coating" – U.S. Patent Appl. No. US 20190043640A1, Aug. 2017 – Pending
- A. P. Ganjoo, **S. Narayanan**; "Method of Decreasing Sheet Resistance in an Article Coated with a Transparent Conductive Oxide" – U.S. Patent Appl. No. US 20190040523A1, Aug. 2017 – Pending
- A. P. Ganjoo, P. J. Fisher, **S. Narayanan**; "Flash Annealing of Transparent Conductive Oxide and Semiconductor Coatings" – U.S. Patent Appl. No. US 20190041550A1, Aug. 2017 – Pending

SELECTED CONFERENCE PRESENTATIONS

- *Talk* – "Current density mediated evolution of Li metal – solid electrolyte interfaces" – Faraday Institution Conference; Nov 2021
- *Talk* – "Interfacial Characterization, Electrochemical Evolution and Kinetics in Argyrodite Solid Electrolytes with Li Metal Anode for High Energy Density Solid-State Batteries" – 239th ECS Meeting; Jun 2021
- *Guest Speaker*; "Large Area Thin Film Coatings and Processes for Architectural Glazings and Other Applications" – AVS Western PA Chapter Annual Meeting Pittsburgh, PA; Feb 2018
- *Invited Talk*; "Novel Metal-Polymer Hybrid Composite Materials for use as Flexible Transparent Electrodes" – EMN Meeting on Transparent Electrodes Orlando, FL; Dec 2016
- *Talk* – "Polymer Embedded Metal-Nanowire Network Structures for Highly Reproducible and Flexible Transparent Conductors" – 56th EMC in Santa Barbara CA; Jun 2014
- *Talk* – "Modeling and Characterization of Ag Nanowire-Based Transparent Conductors: Towards Optimization of Electrical and Optical Properties" – 60th AVS Intl. Symposium and Exhibition in Long Beach CA; Oct 2013
- *Talk* – "Electrical and Optical Characterization of Metal Nanowire Networked Composites for Transparent Contacts" – 55th EMC in Notre Dame IN; Jun 2013
- *Talk* – "Flexible Transparent Metal/Polymer Composite Materials Based on Optical Resonant Laminate Structures" – MRS Spring Meeting in San Francisco CA; Apr 2013
- *Talk* – "Percolation-threshold Lowering in Networked Metal Nanowire-Polymer Composites for Flexible, Transparent and Conductive Devices" – MRS Spring Meeting in San Francisco CA; Apr 2013
- *Poster* – "Laminated metallodielectric and networked metal nanowire-polymer composites for flexible, transparent and conducting devices" – 6th Solvay-COPE Symposium on Organic Electronics in Pittsburgh PA; May 2012

HONORS AND AWARDS

- 2022 Nominated as representative of University of Oxford for participation at Global Young Scientists Summit GYSS-2022 (Online)
- 2018 Glass R&D Director's Award – Recognition of Exceptional Performance, Vitro Architectural Glass, presented to the team (of 3) developing Sungate® 700 for 2018

- 2018 Achievement Award for R&D Innovation, Vitro Architectural Glass
2013 3rd Best Poster award at the Young Members' Night – ASM Pittsburgh Chapter
2009 Carnegie Institute of Technology Dean's Fellowship
2009 Institute prize for Best student in Humanities and Social Sciences, IIT Madras, India
2008 Summer Research Fellow of the Indian Academy of Sciences, Bengalooru, India
2007 Selected for and participated in IIT-NUS Student Exchange Program

PROFESSIONAL MEMBERSHIPS, SERVICE AND ACTIVITIES

- Reviewed 10+ scholarly articles submitted to Springer Nature (Nature Communications), Wiley (Advanced Functional Materials), Springer (Journal of Electronic Materials) and Elsevier (Scripta Materialia) journals
- Member of Materials Research Society (MRS), Electrochemical Society (ECS), American Vacuum Society (AVS), and Society of Vacuum Coaters (SVC)
- Trained First-Aider for Dept. of Materials at University of Oxford;
Member of Emergency Medical Response and Ergonomics teams, Vitro Glass Tech. Centre (Pittsburgh)
- Chair of Vitro R&D Recognition Committee, 2018 – 2019
- Invited speaker at Café Scientifique, Carnegie Science Center, Pittsburgh PA, USA – June 2015
- President, MRS Student Chapter at CMU, 2012-2013
- Head, Internal Communications, CrossLink-CMU – student-run networking organization, 2013-2014
- Teach Spoken Sanskrit language classes for adults and high school students as a volunteer for Samskrita Bharati USA and UK, both non-profit organizations

LANGUAGES

Fluent in English, Tamil, Sanskrit, Hindi, Bengali (Written and Spoken). Learning Spanish, French