

Curriculum Vitae

Dr. Sourav Mandal

Inspire Faculty

Department of Energy Science and Technology

Indian Institute of Technology Delhi

Hauz Khas, New Delhi, India-110016

Email: 4souravmandal@gmail.com

Mobile: +91 9830725399



Orcid ID/link: <https://orcid.org/0000-0001-7859-9648>

Scopus: <https://www.scopus.com/authid/detail.uri?authorId=56086533600>

Research interested (or in progress):

- Fabricating and analysing silicon heterojunction (SHJ) solar cells.
- Fabricating and analysing silicon based carrier selective solar cells.
- Exploring different carrier selective materials like Molybdenum oxide (MoO_x) and Nickel oxide (NiO), lithium fluorided (LiF) etc.
- Development of different types of Transparent conducting oxides (TCOs) for application on solar cells.
- Analysis of the junctions of the SHJ solar cells.
- Using TLM method to find out the contact resistivity at different junctions of SHJ solar cells.
- Working on the silicon wafer surface by changing the pyramid size and shapes.

Awards & Honors:

- Best poster Award at EU-PVSEC 2016 on “New Materials and Concepts for solar cells and modules”.
- CSIR-UGC Fellowship for Doctoral research.
- DST-INSPIRE Faculty award.

Qualified National Competitive Exam:

- CSIR-UGC NET 2012 in Physical Science.
- GATE-2011 in Physics.

Experimental Skills:

- Cluster tool PECVD,
- Thermal Evaporation System,
- RF and DC magnetron Sputtering System,
- Reactive Ion Etching (RIE),
- Surface preparation of Silicon Wafer.

Characterization Expertise:

- **Surface Analysis:** Field Emission Scanning Electron Microscope, Transmission Electron Microscope, Atomic Force Microscope, XRD.
- **Thin film Metrology:** Four point probe, Cryostat, Minority carrier lifetime, Thickness Profilometer.
- **Chemical Analysis:** Fourier-transform infrared spectroscopy (FTIR), UV/Vis Spectroscopy, Raman Spectroscopy, Photo Luminescence.
- **Solar cell Analysis:** I-V measurement, EQE measurement, carrier transport analysis, photovoltaic parameter analysis, Sun Voc,

Attained International Conferences:

- 12th SiliconPV conference, 28-02 April 2022, Konstanz, Germany.
- 36th EU PVSEC, 09 - 13 September 2019, Marseille, France
- 25th International Photovoltaic Science and Engineering Conference (PVSEC-25), 15th to 20th Nov 2015, Busan, Korea.
- International Conference on Energy Harvesting, Storage and Conversion (IC-EEE), 4th to 7th Feb 2015, Cochin, India.
- International Conference on Advanced Materials and Energy Technology (ICAMET), 17th to 19th Dec 2014, IEST, Shibpur, Howrah, India.
- International Conference on Solar Energy Photovoltaic (ICSEP-2012) 19th - 21st December 2012, KIIT University, India.

Academic Qualifications:

Degree	University	Duration	Specialization
Ph.D	Indian Institute of Engineering Science and Technology, Shibpur, Howrah, Kolkata, West Bengal - 711103, INDIA.	2012 to 2016	Solar Photovoltaics
M. Sc.	Bengal Engineering and Science University, Shibpur, Howrah, Kolkata, West Bengal -711103, INDIA.	2007 to 2009	Applied Physics
B.Sc	University of Calcutta, 87, 1, College St, Calcutta University, College Square, Kolkata, West Bengal 700073, INDIA.	2004 to 2007	Physics (Hons.)

Working Experience

Name and Address of Organization	Designation and Department	Duration (from mm/yy to mm/yy)
Indian Institute of Technology Delhi, Hauz Khas, New Delhi-110016	DST-INSPIRE Faculty, Department of Energy Science and Technology	10/2017 to present
Indian Institute of Technology Delhi, Hauz Khas, New Delhi-110016	Research Associate, Center for Energy Studies	09/2017 to 10/2017
Indian Institute of Engineering Science and Technology, Shibpur Botanic Garden, Shalimar, Howrah, West Bengal, India Pin-711103	Research Associate in Centre of Excellence for Green Energy and Sensor Systems (CEGESS)	11/2016 to 08/2017

List of Publications

- [1] **S. Mandal**, S. Dhar, G. Das, S. Mukhopadhyay, and A. K. Barua, “Development of optimized n- μ c-Si:H/n-a-Si:H bilayer and its application for improving the performance of single junction a-Si solar cells,” **Solar Energy**, vol. 124, pp. 278–286, 2016.
- [2] **S. Mandal**, S. Mitra, S. Dhar, H. Ghosh, C. Banerjee, S. K. Datta, and H. Saha, “Potential of ITO nanoparticles formed by hydrogen treatment in PECVD for improved performance of back grid contact crystalline silicon solar cell,” **Appl. Surf. Sci.**, vol. 349, pp. 116–122, 2015.
- [3] **S. Mandal**, G. Das, S. Dhar, R. M. Tomy, S. Mukhopadhyay, C. Banerjee, and A. K. Barua, “Development of a novel fluorinated n-nc-SiO:H material for solar cell application,” **Mater. Chem. Phys.**, vol. 157, pp. 130–137, 2015.
- [4] **S. Mandal**, G. Das, S. Dhar, R. M. Tomy, S. Mukhopadhyay, C. Banerjee, and A. K. Barua, “Fabrication of single junction amorphous silicon solar cell/mini module using novel n-type nanocrystalline SiO_x:F:H back reflector,” **J. Mater. Sci. Mater. Electron.**, vol. 26, no. 1, pp. 331–335, 2015.
- [5] S. Dhar, **S. Mandal**, G. Das, S. Mukhopadhyay, P. P. Ray, C. Banerjee, and A. K. Barua, “Silicon heterojunction solar cells with novel fluorinated n-type nanocrystalline silicon oxide emitters on p-type crystalline silicon,” **Jpn. J. Appl. Phys.**, vol. 54, no. 8S1, p. 08KD03, 2015.
- [6] G. Das, **S. Mandal**, M. R. Tomy, C. Banerjee, S. Mukhopadhyay, and A. K. Barua, “Development of oxide based window and buffer layer for single junction amorphous solar cell: Reduction of light induced degradation,” **Materials Science in Semiconductor Processing**, vol. 24, no. 1, pp. 50–56, 2014.

- [7] S. Banerjee, **S. Mandal**, A. K. Barua, N. Mukherjee, "Hierarchical indium tin oxide (ITO) nano-whiskers: Electron beam deposition and sub-bandgap defect levels mediated visible light driven enhanced photocatalytic activity," **Catalysis Communications**, vol.87, pp 86-89, 2016.
- [8] G. Ahmad, **S. Mandal**, A.K.Barua, T.K. Bhattacharya, J.N. Roy, "Band Offset Reduction at Defect-Rich p/i Interface Through Wide Bandgap a-SiO:H Buffer Layer," **IEEE Journal of Photovoltaics**, vol. 7, no. 2, pp. 414–420, 2017.
- [9] G. Das, **S. Mandal**, S. Dhar, S. Bose, S. Mukhopadhyay, C. Banerjee, A. K. Barua, "Development of n-type microcrystalline SiO_x:H films and its application by innovative way to improve the performance of single junction μ c-Si:H solar cell," **J. Mater. Sci. Mater. Electron.**, vol. 28, Issue 8, pp. 5746–5753, 2017.
- [10] G. Das, **S. Mandal**, S. Dhar, S. Bose, J.R. Sharma, S. Mukhopadhyay, C. Banerjee, A. K. Barua, "Development of Improved n- μ c-SiO_x:H Films and Its Innovative Application in Silicon-Based Single Junction Thin Film Solar Cells," **IEEE Journal of Photovoltaics**, vol.7, pp 892-899, 2017.
- [11] G. Das, **S. Mandal**, S. Dhar, S. Bose, B. P. Bhargav, S. Mukhopadhyay, C. Banerjee, A. K. Barua, "Synthesis of ITO nanoparticles at room temperature using plasma treatment process and use it as back reflector in a-Si flexible solar cell," **Surfaces and Interfaces**, vol. 7, pp. 83-86, 2017.
- [12] G. Das, **S. Mandal**, S. Dhar, S. Bose, J.R.Sharma, S. Mukhopadhyay, C. Banerjee, A. K. Barua, "Influence of excitation frequency and electrode separation on the growth of microcrystalline silicon films and their application in single junction microcrystalline solar cell," **J. Mater. Sci. Mater. Electron.**, vol. 28, no. 14, pp. 10382–10390, 2017.
- [13] G. Das, S. Mandal, S. Dhar, S. Bose, S. Mukhopadhyay, C. Banerjee, A. K. Barua, "Role of dual SiO_x: H based buffer at the p/i interface on the performance of single junction microcrystalline solar cells," **Materials Science in Semiconductor Processing**, vol. 66, pp. 9–14, 2017.
- [14] S. Bose, D. Dey, S. Banerjee, G. Ahmad, S. Mandal, A. K. Barua, N. Mukherjee, "Blue and violet defect levels mediated absorption hot spots in tapered ZnO nanorods toward improved photocatalytic activity", **Journal of Material Science**, vol. 52, pp 12818–12825, 2017.
- [15] G. Das, **S. Mandal**, S. Mukhopadhyay, C. Banerjee, A.K. Barua, " Effect of oxide based graded buffer and bottom n-layer on the performance of the single junction amorphous silicon solar cells", **J. Mater. Sci. Mater. Electron.** vol. 28, no. 21, pp. 16165–16172, 2017.
- [16] S. Dhar, **S. Mandal**, S. Mitra, H. Ghosh, S. Mukherjee, C. Banerjee, H. Saha, A.K. Barua, "Light trapping in a-Si/c-Si heterojunction solar cells by embedded ITO nanoparticles at rear surface," **J. Phys. D. Appl. Phys.**, vol. 50, no. 49, p. 495110, 2017.
- [17] S. Chakrabarty, **S. Mandal**, S. Biswas, A. K. Pramanick, M. Ray, and S. M. Hossain, "Trap-Assisted Switching in Silicon Nanocrystal Based p-i-n Device," **IEEE Trans. Device Mater. Reliab.**, vol. 18, no. 4, pp. 620–627, 2018.
- [18] G. Ahmad, **S. Mandal**, A. K. Barua, T. K. Bhattacharyya, and J. N. Roy, "Parasitic loss mitigation and photocurrent enhancement in amorphous silicon solar cells by using phosphorous-

doped fluorinated $\mu\text{c-SiO:H}$ back reflector,” **J. Mater. Sci. Mater. Electron.**, vol. 29, no. 13, pp. 11104–11116, 2018.

[19] S. Bose, R. Arokiyadoss, P.B. Bhargav, G. Ahmad, **S. Mandal**, A.K. Barua, S. Mukhopadhyay, “Modification of surface morphology of sputtered AZO films with the variation of the oxygen,” **Mater. Sci. Semicond. Process.**, vol. 79, pp. 135–143, 2018.

[20] G. Ahmad, **S. Mandal**, A. K. Barua, T. K. Bhattacharyya, and J. N. Roy, “Reduction of Hole Injection Barrier Height at TCO/P Interface Using a-SiO:H Interlayer,” **IEEE J. Photovoltaics**, vol. 8, no. 1, pp. 8–15, 2018.

[21] J.R. Sharma, S. Mitra, H. Ghosh, G. Das, S. Bose, **S. Mandal**, S. Mukhopadhyay, H. Saha, A.K. Barua, “Growth of KOH etched AZO nanorods and investigation of its back scattering effect in thin film a-Si solar cell,” **Phys. B Condens. Matter**, vol. 530, pp. 147–156, 2018.

[22] S. Bose, R. Arokiyadoss, P.B. Bhargav, G. Ahmad, **S. Mandal**, A.K. Barua, S. Mukhopadhyay, “Optimization of the texturization of ZnO:Al surface using $\text{HCl} + \text{HNO}_3$ for application in thin film silicon solar cells,” **J. Mater. Sci. Mater. Electron.**, vol. 29, no. 4, pp. 3210–3218, 2018.

[23] G. Ahmad, **S. Mandal**, A. K. Barua, T. K. Bhattacharyya, and J. N. Roy, “Mixed-Phase $\text{nc-SiO}_x\text{:H}$ Interlayer to Improve Light Trapping and Shunt Quenching in a-Si:H Solar Cell,” **IEEE J. Photovoltaics**, vol. 9, no. 1, pp. 18–25, 2019.

[24] S. Bose, **S. Mandal**, A. K. Barua, and S. Mukhopadhyay, “Sacrificial layer assisted front textured glass substrate with improved light management in thin film silicon solar cells,” **J. Mater. Sci. Mater. Electron.**, vol.30, no. 3, pp. 2622–2629, Feb. 2019.

[25] A. Nandi, **S. Mandal**, S. Ghosh, S. Dhar, S. Majumdar, H. Saha, and S. M. Hossain, “Application of Hybrid rGO-ITO Bilayer TCO on a-Si Solar Cell for Performance Enhancement,” **IEEE J. Photovoltaics**, vol. 9, no. 1, pp. 12–17, 2019.

[26] M. Nayak, K. Singh, S. Mudgal, **S. Mandal**, S. Singh, and V. K. Komarala, “Carrier-Selective Contact Based Silicon Solar Cells Processed at Room Temperature using Industrially Feasible Cz Wafers,” **Phys. status solidi (a)**, p. 1900208, 2019.

[27] S. Banerjee, **S. Mandal**, S. Dhar, A. B. Roy, and N. Mukherjee, “Nano-mirror embedded back reflector layer (BRL) for advanced light management in thin silicon solar cells,” **Ind. Eng. Chem. Res.**, vol. 58, pp. 12678-12686, 2019.

[28] M. Nayak, **S. Mandal**, A. Pandey, S. Mudgal, S. Singh, V.K. Komarala, Nickel Oxide Hole-Selective Heterocontact for Silicon Solar Cells: Role of SiO_x Interlayer on Device Performance, **Sol. RRL.**, vol. 3, no. 11, pp 1900261, 2019.

[29] S. Bose, **S. Mandal**, A.K. Barua, S. Mukhopadhyay, Properties of boron doped ZnO films prepared by reactive sputtering method: Application to amorphous silicon thin film solar cells, **J. Mater. Sci. Technol.**, Vol. 55, pp.136-143, 2020.

[30] **S. Mandal**, A. Pandey, V.K. Komarala, “Investigation of optoelectrical properties of indium oxide thin films with hydrogen and oxygen gas concentration variation during sputtering,” **Mater. Sci. Semicond. Process.**, Vol. 123, pp.105576, 2021.

[31] A. Pandey, S. Bhattacharya, J. Panigrahi, **S. Mandal**, V. K. Komarala, “Effect of gas flow rate in PECVD of amorphous silicon thin films for interface passivation of silicon heterojunction solar cells,” **Phys. status solidi** (a), May 2022. doi:10.1002/pssa.202200183.

Conference publications

[1] **S. Mandal**, S. Dhar, and A. K. Barua, “Improvement of short circuit current of single junction amorphous silicon solar cells by incorporating nanoparticle as back reflector,” **EUPVSEC Proc.**, no. July, pp. 249–252, 2016.

[2] G. Ahmad, **S. Mandal**, T. K. Bhattacharya, and J. N. Roy, “A simulation study of p-i-n amorphous silicon photovoltaic cell using ZnO nano rods,” **Int. Conf. 21st Century Energy Needs - Mater. Syst. Appl. ICTFCEN 2016**, pp. 2–6, 2017.

[3] J.R. Sharma, S. Mitra, H. Ghosh, S. Bose, **S. Mandal**, G. Das, S. Mukhopadhyay, H. Saha, A.K. Barua, “Investigation of Optical Absorption Spectra and Scattering Efficiency of ZnO:Al Nanorods on Different Substrates,” **Mater. Today Proc.**, vol. 4, no. 14, pp. 12635–12640, 2017.

[4] D. Roy, A. Nandi, A.R. Bardhan, S. Majumdar, **S. Mandal**, A. Kundu, S.M. Hossain, “Piezoelectricity in Amine Functionalized Reduced Graphene Oxide,” **Mater. Today Proc.**, vol. 5, no. 3, pp. 9876–9880, 2018.

[5] S. Chakrabarty, **S. Mandal**, U. Ghanta, J. Das, and S. Minhaz Hossain, “Current Controlled Switching in Si/PS/a-Si Heterostructure,” **Mater. Today Proc.**, vol. 5, no. 3, pp. 9790–9797, 2018.

[6] J. Roy Sharma, S. Bose, **S. Mandal**, G. Das, S. Mukhopadhyay, and A. K. Barua, “Influence of Acid and Alkali Etching on Sputtered Aluminium Doped Zinc Oxide Films,” **Mater. Today Proc.**, vol. 5, no. 3, pp. 9726–9732, 2018.

[7] K. Singh, **S. Mandal**, S. Singh, and V. K. Komarala, “Characterization of sputtered a-Si:H passivated silicon surface by temperature- And injection-dependent lifetime spectroscopy,” **AIP Conference Proceedings**, vol. 2147, p. 020014, 2019.

[8] M. Nayak, S. Mudgal, **S. Mandal**, S. Singh, and V. K. Komarala, “Electrical Characterization and Defect States Analysis of Ag/ITO/MoO_x/n-Si/LiF_x/Al Carrier Selective Contact Solar Cells Processed at Room-temperature,” **AIP Conference Proceedings**, vol. 2147, p. 040014, 2019.

Patent Filed:

1. Gourab Das, **S. Mandal**, Sukanta Dhar, Sukanta Bose, Jayasree R Sharma, Sumita Mukhopadhyay, Chandan Banerjee, Asok K Barua, Surface texturization of glass: a new and innovative way to improve the performance of superstrate type thin film solar cells. (Application No.- 201711009452) dated March 17, 2017.

2. Gourab Das, **S. Mandal**, Sukanta Dhar, Sukanta Bose, Jayasree R Sharma, Sumita Mukhopadhyay, Chandan Banerjee, Asok K Barua, A textured substrate and a method of producing a textured Substrate with pyramidal textured surface with a plurality of Macro size pillars (Application No.- 201711009453) dated March 17, 2017.

3. Vamsi Krishna Komarala, Mrutyunjay Nayak, Krishna Singh, **S. Mandal**, Sonpal Singh, Method for fabricating a heterojunction silicon solar cell at room temperature (Application No.- 201811017912) dated May 12, 2018.

Technical Training:

- Training at full form, address HHV, Bangalore on Plasma Enhancement Chemical Vapour Deposition (PECVD).
- Training at SHAVO technologies, Pune on operation of corrosive gas regulators.

Details of Sponsored Research Project:

Title: “**Photovoltaic technologies for crystalline silicon and thin film tandem solar cells**”.

Sponsoring Agency: Department of Science and Technology, India, Amount: Rs. 35 Lacks;

Duration: 5 years.

Ph.D Thesis Title

“**Development of innovative oxide and fluorinated amorphous and microcrystalline silicon (hydrogenated) materials and their applications to silicon based thin film Solar Cells**”.

Ph.D Supervisor: Prof. Asok Kumar Barua (honoured with Padam Shree award for his contribution in Science and Technology) & Dr. Syed Minahz Hossain

M.Sc Project Title

“**Development of an NMR spectrometer to measure proton ‘g’ factor**”.

Supervisor: Dr. Syed Minahz Hossain

Personal details: -

Father’s Name: Sri Sudarsan Mandal.

Date of Birth: 16th August 1985

Place of Birth: Kakdwip, West Bengal, India

Nationality: Indian