

Sushobhan Avasthi

Assistant Professor

TF-06, Centre for Nano Science and Engineering (CeNSE),
Indian Institute of Science (IISc),
Bangalore 560012, India
savasthi@cense.iisc.ernet.in

O : +91-8022932949
M : +91-9902333360
DOB : 10/01/1983
Category : General

Education

2005-11 **Doctor of Philosophy** in Electrical Engineering, Princeton University, USA
 Thesis: *Crystalline-Silicon/Organic Heterojunctions for Solar Photovoltaics*

2005-07 **Master of Arts** in Electrical Engineering, Princeton University, USA

2001-05 **Bachelor of Technology** in Electrical Engineering, Indian Institute of Technology Kanpur, India

Research Interests

Photovoltaics Si/metal-oxide and Si/organic heterojunctions for low-cost and high-efficiency silicon solar cells.
 Organic and inorganic perovskite solar cells.
 Solar cells on flexible substrates.

Metal-oxides High-mobility p-channel metal-oxide TFTs.
 Metal-oxide based sensors.

Work Experience

2014-Present **Assistant Professor** at Indian Institute of Science (IISc), India
 Currently at the Centre for Nano Science and Engineering (CeNSE). Pursuing research in photovoltaics and metal-oxide semiconductors

2011-14 **Postdoctoral Research Associate** at Princeton University, USA
 Pursued research in silicon/metal-oxide heterojunctions for photovoltaics at the Princeton Institute for the Science and Technology of Materials (PRISM). Specifically, focused on fabrication and characterization of silicon/titanium-oxide heterointerfaces.

2011-12 **Founder** of SuryaTech LLC, USA
 Co-founder of SuryaTech, a startup to commercialize the silicon heterojunction solar cell developed during my doctorate. Authored several SBIR proposals. Worked closely with the angel and venture-capital community in New Jersey, USA.

Awards

2016 **Young Faculty Research Fellowship**
 Awarded under the Visvesvaraya PhD Scheme for Electronics and IT by DeitY. Government of India

2011 **Prize at 6th Princeton Innovation Forum**
 Innovation Forum was a business case competition that provided seed funding for my startup.

2010 **Edith and Martin B. Stein Solar Energy Innovation Award**
 From the Global Photonic Energy Corporation for pioneering contribution in the field of solar energy.

2009 **Materials Research Society Student Poster Award**, Fall Meeting 2009 at Boston, MA.
 Selected from a pool of more than 100 posters presented at the meeting.

2005 **Motorola Student of the Year**, IIT Kanpur
 For outstanding performance among the 120 students of Electrical Engg. and Computer Science & Engg.

NE203: Advanced Micro & Nano Fabrication Technology & Processes (Credit 3:0)

Offered in the fall semester. The course provides an in-depth understanding of the various unit processes in micro & nano fabrication, including crystal growth, doping, vapor deposition, photolithography, wet etching, dry etching, and packaging. The course is accessible to students from diverse backgrounds, such as materials, physics, chemistry, mechanical engineering, and electrical engineering.

NE202: Micro and Nano Fabrication (Credit 0:1)

The course provides hands-on exposure to semiconductor device fabrication. NE202 is a laboratory-only course with one session per week. Students participate in fabrication of a solar cell, a MOS capacitor, a graphene FET, a MEMS cantilever. The course also includes a term project, in which groups of 3-4 students either fabricate a complete device or optimize some unit process.

Peer-Reviewed Publications

1. K. A. Nagamatsu, **S. Avasthi**, G. Sahasrabudhe, G. Man, J. Jhaveri, A. Berg, J. Schwartz, A. Kahn, S. Wagner, J. C. Sturm, "Titanium dioxide/silicon hole-blocking selective contact to enable double-heterojunction crystalline silicon-based solar cell," *Applied Physics Letters* **106**, 123906 (2015).
2. K. A. Nagamatsu, **S. Avasthi**, J. Jhaveri, J. C. Sturm, "A 12% Efficient Silicon/PEDOT:PSS Heterojunction Solar Cell Fabricated at <100 °C," *IEEE Journal of Photovoltaics*, **4**, 260 (2014).
3. **S. Avasthi**, W. McClain, G. Man, A. Kahn, J. Schwartz, and J. C. Sturm, "Hole-Blocking Titanium-Oxide/Silicon Heterojunction and its Application to Photovoltaics", *Applied Physics Letters* **102**, 203901 (2013).
4. **S. Avasthi**, S. Lee, Y.L. Loo, and J. C. Sturm, "Role of Majority and Minority Carrier Barriers Silicon/Organic Hybrid Heterojunction Solar Cells", *Advanced Materials* **23**, 5762 (2011).
5. **S. Avasthi**, Y. Qi, G. Vertelov, J. Schwartz, A. Kahn, and J. C. Sturm, "Electronic structure and band alignment of 9,10-phenanthrenequinone passivated silicon surfaces", *Surface Science* **605**, 1308 (2011).
6. **S. Avasthi**, Y. Qi, G. Vertelov, J. Schwartz, A. Kahn, and J. C. Sturm, "Silicon Surface Passivation by an Organic Overlayer of 9,10-phenanthrenequinone", *Applied Physics Letters* **96**, 222109 (2010).
7. S. Shankar, A. M. Tyryshkin, **S. Avasthi**, S. A. Lyon, "Spin Resonance of 2D Electrons in a Large-area Silicon MOSFET", *PHYSICA E*, March 2008.

Conference Presentations & Papers

1. P. Ravindra, **S. Avasthi**, "Electron-Blocking Properties of Crystalline-Silicon/Cu₂O Heterojunctions for Photovoltaics, " *to be presented at 2016 MRS Spring Meeting* , Phoenix, AZ, March 2016.
2. **S. Avasthi**, K. A. Nagamatsu, J. Jhaveri, W. E. McClain, G. Man, A. Kahn, J. Schwartz, S. Wagner, and J. C. Sturm, "Double-Heterojunction Crystalline Silicon Solar Cell Fabricated at 250 °C with 12.9% Efficiency", *40th IEEE Photovoltaic Specialists Conference*, Denver CO, June 2014.
3. J. Jhaveri, **S. Avasthi**, K. A. Nagamatsu, and J. C. Sturm, "Stable Low- Recombination n-Si/TiO₂ Hole-blocking Interface and its Effect on Silicon Heterojunction Photovoltaics", *40th IEEE Photovoltaic Specialists Conference*, Denver CO, June 2014.
4. **S. Avasthi**, W. E. McClain, Y. Afsar, G. Man, J. Jhaveri, K. A. Nagamatsu, A. Kahn, J. Schwartz, S. Wagner, and J. C. Sturm, "Hole-Blocking Metal-Oxide/Crystalline-Silicon Heterojunctions with Recombination Velocity of < 100 cm/s", *2014 MRS Spring Meeting*, San Francisco, CA, March 2014.
5. **S. Avasthi**, W. E. McClain, G. Man, J. Jhaveri, K. A. Nagamatsu, A. Kahn, J. Schwartz, and J. C. Sturm, "Growth Mechanism and Carrier Transport in Hole-Blocking TiO₂/Silicon Heterojunctions", *2014 MRS Spring Meeting*, San Francisco, CA, March 2014.

6. J. Jhaveri, **S. Avasthi**, G. Man, K. A. Nagamatsu, W. E. McClain, J. Schwartz, A. Kahn, J. C. Sturm, "Effect of Annealing on Stability of Low Interface Recombination Velocity at TiO₂/p-Silicon Interface", *2014 MRS Spring Meeting*, San Francisco, CA, March 2014.
7. K. A. Nagamatsu, J. A. Spechler, **S. Avasthi**, C. B. Arnold, J. C. Sturm, "Silicon/Organic Heterojunction Photovoltaic Cell with 12.7% Efficiency by Use of Spray-Coated Nanowire Transparent Conductor", *2014 MRS Spring Meeting*, San Francisco, CA, March 2014.
8. J. C. Sturm, **S. Avasthi**, K. A. Nagamatsu, J. Jhaveri, W. E. McClain, G. Man, A. Kahn, J. Schwartz, S. Wagner, "Wide Bandgap Heterojunctions on Crystalline Silicon", *ECS Trans.*, **58**, 97-105 (2013).
9. J. Jhaveri, **S. Avasthi**, G. Man, W. E. McClain, K. Nagamatsu, A. Kahn, J. Schwartz, J. C. Sturm, "Hole-Blocking Crystalline-Silicon/Titanium-Oxide Heterojunction with Very Low Interface Recombination Velocity", *39th IEEE Photovoltaic Specialists Conference*, Tampa, FL, June 2013.
10. K. A. Nagamatsu, **S. Avasthi**, J. Jhaveri, J. C. Sturm, "12% Efficient Silicon/PEDOT:PSS Heterojunction Solar Cell Fabricated at <100 °C," *39th IEEE Photovoltaic Specialists Conference*, Tampa, FL, June 2013.
11. J. Jhaveri, **S. Avasthi**, K. A. Nagamatsu, J. C. Sturm, "Wide Bandgap HBT on Crystalline Silicon using Electron-Blocking PEDOT:PSS Emitter", *71st Device Research Conference*, Notre Dame, IN, June 2013.
12. K. A. Nagamatsu, **S. Avasthi**, J. Spechler, C. B. Arnold, J. C. Sturm, "Current Mechanisms in Silicon-organic Heterojunction Solar Cells with Transfer Printed Metallization", *2012 MRS Fall Meeting*, Boston, MA, December 2012.
13. **S. Avasthi**, W. McClain, J. Schwartz, and J. C. Sturm, "Hole-blocking TiO₂/Silicon Heterojunction for Silicon Photovoltaics", *70th Device Research Conference*, College Park, PA, June 2012.
14. **S. Avasthi**, and J. C. Sturm, "Charge Separation and Minority Carrier Injection in P3HT-Silicon Heterojunction solar cells", *37th IEEE PVSC*, Seattle, WA, June 2011.
15. **S. Avasthi**, S. Lee, Y. L. Loo, and J. C. Sturm, "The Role of P3HT Barriers in P3HT-Silicon Heterojunction Solar Cells with a High Open-Circuit Voltage", *2011 MRS Spring Meeting*, San Francisco, CA, March 2011.
16. **S. Avasthi**, Y. Qi, S. Ha, G. Vertelov, J. Schwartz, A. Kahn, and J. C. Sturm, "P3HT-Silicon Organic-Silicon Heterojunction for Photovoltaic Applications", *2010 MRS Fall Meeting*, Boston, MA, December 2010.
17. **S. Avasthi**, Y. Qi, G. Vertelov, J. Schwartz, A. Kahn, and J. C. Sturm, "Stability of Electrical Properties of Silicon (100) Surfaces Passivated with 9,10-phenanthrenequinone", *2009 MRS Fall Meeting*, Boston, MA, December 2009.
18. J. C. Sturm, B. Hekmatshoar, L. Han, **S. Avasthi**, G. Vertelov, Y. Qi, J. Schwartz, A. Kahn and S. Wagner, "Towards Organic-based Dielectrics for Low-Temperature Silicon -based Devices for Large-Area Electronics", *2009 Materials Research Society Fall Meeting*, Boston, MA, December 2009.
19. **S. Avasthi**, Y. Qi, J. Schwartz, A. Kahn, and J. C. Sturm, "Electronic Passivation of Silicon (100) Surfaces by Organic Layer of 9,10-phenanthrenequinone", *51st Electronic Materials Conference*, College Park, PA, June 2009.
20. **S. Avasthi**, G. Vertelov, J. Schwartz and J. C. Sturm, "Reduction of Minority Carrier Recombination at Silicon Surfaces and Contacts Using Organic Heterojunctions", *34th IEEE PVSC*, Philadelphia, PA, June 2009.
21. S. Shankar, A. M. Tyryshkin, **S. Avasthi**, S.A. Lyon "Electron Spin Resonance of Electrons in a Large-Area Silicon MOSFET," *APS Meeting Abstracts* 1, 43009 (2007).

Patent Applications

1. **S. Avasthi**, W. E. McClain, J. Schwartz, and J. C. Sturm, "Hole-blocking TiO₂/Silicon Heterojunction for Silicon Photovoltaics," US application 14/385,347, provisional application 61/610,891 (2013), PCT application 13761284.2 - 1555.
2. Y. Huang, **S. Avasthi**, K.A. Nagamatsu, J. C. Sturm, "Silicon/Organic Heterojunction (SOH) Solar Cell And Roll-To-Roll Fabrication Process For Making Same," US application 13/467,515, provisional application 61/484128 (2012).
3. **S. Avasthi**, J. Schwartz, and J. C. Sturm, "Photovoltaic Device and Method of Making the Same", Taiwan patent 100118094 (2011), US application 13/113,606 (2011), provisional application 61/416986 (2010).
4. **S. Avasthi**, J. Schwartz, and J. C. Sturm, "Reduction of Minority Carrier Recombination at Silicon Surfaces and Contacts Using Organic Heterojunctions," provisional application 61/347666 (2010).

Grants

| S.No. | Title | PI/Co-PI | Funding | Amount (in lakhs) | Duration |
|-------|--|----------|---------|----------------------|-----------|
| 1. | Crystalline-silicon/perovskite tandem solar cell for high-efficiency photovoltaics | PI | SERB | 55 | 2014-2017 |
| 2. | Solar Energy Research Institute for India and the United States (SERIUS), Task PV3 | Co-PI | IUSSTF | 625 | 2014-2016 |