

KANWAR SINGH NALWA

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Materials Science and Engineering
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EDUCATION

- Doctor of Philosophy** – Electrical Engineering August 2011 (3.8/4.0)
Iowa State University, Ames, Iowa, USA
Thesis Title: *Increasing the efficiency of organic solar cells by Photonic and Electrostatic-field enhancements* **(Research Excellence Award, 2011)**
Advisor: Prof. Sumit Chaudhary
- Bachelor of Technology** – Materials and Metallurgical Engineering June 2007 (3.2/4.0)
Indian Institute of Technology, Kanpur, India **(Best Project Award, 2007)**

EXPERIENCE

Indian Institute of Technology, Kanpur, U.P. India
Department of Materials Science and Engineering
Assistant Professor Dec. 2019 - Present

Intel Corporation, Hillsboro, Oregon USA
PTD (R&D) Process Development Engineer. Aug. 2011 - Sept. 2019

- Portland Technology Development Senior Process engineer in the Copper Barrier/Seed module developing 22, 14, 10, and 7 nm process technologies.
- Drove the development of the process, hardware, and operational systems used for all PVD metal deposition steps for Intel's interconnect microprocessor technology.
- Close collaboration with Integration and Yield engineers to determine technology requirements.
- Partnered with equipment suppliers to drive the development of the hardware and process.
- Transfer of the technology to Intel's 300 mm factories worldwide.
- Demonstrated new barrier for 10nm technology and lead its process qualification and implementation. **(Divisional Award)**
- Routinely applied SPC, JMP and statistical Data Analytics to monitor trends and find causes for signals to improve device yield.

Iowa State University, Ames, Iowa USA
Graduate Research Assistant, Dept. of Electrical and Computer Engg. Aug. 2007 - Aug. 2011
Associate, Department of Energy - Ames Laboratory Aug. 2007 - Aug. 2011

- Contributed significantly to PhD adviser's National Science Foundation Career proposal titled "Utilizing Ferroelectrics for Multifaceted Device Engineering of Polymer Solar Cells", which was eventually awarded \$400,000 funding for 5 years.
- Implemented for the first time incorporation of ferroelectrics in polymer solar cells and im-

proved the efficiency by 50 % by virtue of enhanced electrostatic field in the device.

- Simulated and implemented a novel device-design for grating based textured organic solar cells to increase the power conversion efficiency by 20% and absorption at the band-edge by 100%.
- Established the relationship between recombination mechanism, the density of defect states and active-layer film growth rate in organic solar cells using characterization techniques like I-V, C-V, C-F, Quantum efficiency, Impedance and luminescence.
- Investigated effect of doping in amorphous silicon hybridized with organic based photovoltaics, on charge recombination at the organic/inorganic interface.
- Demonstrated for the first time photoluminescence based Bio-chemical sensor with organic photodetector operational in lifetime mode.
- A new methodology was implemented to fabricate ultra-long metallic nanoribbons and nanowires for transparent electrodes.
- Probed memristor characteristics of anodized titania thin film on nanometer scale using conductance-atomic force microscopy.
- Served as the lead graduate student/critical resource for projects funded by DOE Ames laboratory and state of Iowa's Office of Energy Independence.
- Initiated nanotechnology and device research, installation/maintenance of instrumentation (Glove box, Atomic Force Microscope) and developed process protocols in a newly founded research lab.
- Mentored undergraduate/graduate researchers to enable their swift orientation into research areas.

HONORS & AWARDS

- Awarded funding of Rs 30 Lakhs from SERB-DST as Start-up Research Grant (2020-2021)
- Received 3 Intel divisional awards for innovations in contact and interconnect process development down to 7nm feature size in 2015, 2017 and 2018.
- Awarded Research Excellence Award (to recognize $\leq 10\%$ Ph.D. graduates) by Iowa State University in 2011.
- One of the 12 graduate students in the country to receive graduate student support of \$1000 for attending USC-DOE conference on Materials for Energy Applications, Los Angeles, CA, March 30-April 1, 2011.
- Research featured as news in Material Views (*'High-Efficiency Polymer Solar Cells on Textured Substrates'* Dec 3, 2010) - a Wiley-VCH news service.
- Research featured as news by The Tribune (Iowa newspaper), Science Daily, Physorg.com, Eureka Alert (AAAS, the science society) and Iowa State University, in Dec 2010.
- Research featured in news by Institute of Physics (*'Long metallic nanowires fabricated for transparent electrode tests'*, nanotechweb.org, Aug. 4, 2010)
- Research poster nominated for Best Poster Award in Materials Research Society Fall Meeting, Boston, MA, Dec. 2009. (Total 10 nominees in 200 presenters).
- Awarded the Best Bachelor of Technology Project in the Department of Materials and Metallurgical Engineering (2007-08), by the Indian Institute of Technology, Kanpur.
- Was one of the 12 shortlisted candidates (all over India) for the prestigious Innovative Student Projects Award 2007, by Indian National Academy of Engineering at bachelor's level.
- Received \$200 cash award from IIT Kanpur (India) for publishing in a peer reviewed International journal (Journal of Applied Physics) as an undergraduate student.
- First prize in poster presentation in XIVth National Seminar on Ferroelectrics Dielectrics 2006, I.I.T. Kharagpur, India.
- First prize in poster presentation in Non Ferrous category, at NMD-ATM 2005 conference, Chennai, India.

Patents and Invention Disclosures:

3. S. Ranjan, R. Ranjan, A. Singh, K. S. Nalwa, A. Garg and R. K. Gupta, "Microwave assisted low temperature processing of TiO₂ as an effective electron transport layer for perovskite solar cell applications," Indian Patent application number 202111000910 (Filed January 8, 2021).
2. K. S. Nalwa, and S. Chaudhary, "Organic photovoltaic device with ferroelectric dipole and method of making same," U.S. Patent No. 10,038,142 (Granted July 31, 2018).
1. S. Chaudhary, K. M. Ho, J. M. Park, K. S. Nalwa, and W. Leung, "Textured micrometer scale templates as light managing fabrication platform for organic solar cells," U.S. Patent No. 9,401,442 (Granted July 26, 2016).

Sponsored Projects:

2. "Perovskite solar cells: moisture, thermal and photophysical stability improvement," SERB, DST, India; Duration: 2 years (2020-2021); Budget: Rs 30 lakhs.
1. "Development of high efficiency and environmentally stable Perovskite solar cells," Initiation Grant Proposal, IIT Kanpur, India; Duration: 2 years (2020-2021); Budget: Rs 25 lakhs.

PUBLICATIONS

Journal Papers:

18. S. K. Gupta, J. Yadav, N. Chaturvedi, R. Ranjan, L. S. Pali, K. S. Nalwa, A. Garg "Role of DIO vis-a-vis microstructural kinetics during thermal annealing on the performance of PTB7:PC71BM organic solar cells", *Solar Energy*, vol. 213, pp 27-35, 2021. [Elsevier. Impact factor 4.6]
17. B. Usmani, R. Ranjan, Prateek, S. K. Gupta, R. K. Gupta, K. S. Nalwa, A. Garg, "Inverted PTB7-Th:PC71BM Organic Solar Cells with 11.8 % PCE via Incorporation of Gold Nanoparticles in ZnO Electron Transport Layer", *Solar Energy*, vol. 214, pp 220-230, 2021. [Elsevier. Impact factor 4.6]
16. R. Ranjan, S. Ranjan, M. Monalisa, A. Singh, K. S. Nalwa, A. Garg and R. K. Gupta "Enhanced thermal and moisture stability via dual additives approach in methylammonium lead iodide based planar perovskite solar cells", *Solar Energy*, Accepted, 2020. [Elsevier. Impact factor 4.6]
15. R. C. Mahadevapuram, A. J. Carr, Y. Chen, S. Bose, K. S. Nalwa, J. W. Petrich, S. Chaudhary, "Low-boiling-point solvent additives can also enable morphological control in polymer solar cells", *Synthetic metals*, vol. 185, pp 115-119, 2013. [Elsevier. Impact factor 2.87]
14. J. Carr, K. S. Nalwa, R. C. Mahadevapuram, Y. Chen, J. Andereg, and S. Chaudhary, "Plastic-syringe induced silicone contamination in organic photovoltaic fabrication: implications for small-volume additives", *ACS Applied Materials and Interfaces*, vol. 4 (6), pp 2831-2835, 2012. [American Chemical Society. Impact factor 8.76]
13. K. S. Nalwa, J. Carr, R. C. Mahadevapuram, H. K. Kodali, S. Bose, Y. Chen, J. W. B. Petrich, B. Ganapathysubramanian, and S. Chaudhary, "Enhanced charge separation in organic photovoltaic films doped with ferroelectric dipoles" *Energy and Environmental Science*, vol. 5 (5), pp. 7042-7049, 2012. [Royal Society of Chemistry. Impact factor 33.25]

12. K. S. Nalwa, H. K. Kodali, B. Ganapathysubramanian, and S. Chaudhary, "Dependence of recombination mechanisms and strength on processing conditions in polymer solar cells" *Applied Physics Letters*, vol. 99, 263301, 2011. [American Physical Society. Impact-factor 3.52]
11. P. Kuang, J. M. Park, W. Leung, R. C. Mahadevapuram, K. S. Nalwa, S. Chaudhary, K. M. Ho, and K. Constant, "A new architecture for transparent electrodes: Relieving the tradeoff between electrical conductivity and optical transmittance", *Advanced Materials*, vol. 23, pp. 2469-2473, 2011. [Wiley-VCH. Impact factor 27.40]
10. K. S. Nalwa, R. C. Mahadevapuram, and S. Chaudhary, "Growth rate dependent trap density in polythiophene:fullerene solar cells and its implications", *Applied Physics Letters*, vol. 98, 093306, 2011. [American Physical Society. Impact factor 3.52] Also in *Virtual Journal of Nanoscale Science and Technology*, vol. 23 (11), 2011.
9. J. F. Mike, K. S. Nalwa, A. Makowski, D. Putnam, A. L. Tomlinson, S. Chaudhary, and M. Jeffries-El, "Synthesis, characterization and photovoltaic properties of poly(thiophenevinylene) benzobisoxazoles", *Physical Chemistry Chemical Physics*, vol. 13, pp. 1338-1344, 2011. [Royal Society of Chemistry. Impact factor 3.91]
8. K. S. Nalwa, J. M. Park, K. M. Ho, and S. Chaudhary, "On realizing higher efficiency polymer solar cells on a textured substrate platform", *Advanced Materials*, vol. 23, pp. 112-116, 2011. [Wiley-VCH. Impact factor 27.40] (Featured as news on materialviews.com)
7. K. S. Nalwa, Y. Cai, A. L. Thoeming, J. Shinar, R. Shinar, and S. Chaudhary, "Polythiophene-fullerene based photodetectors: tuning of spectral response and application in photoluminescence based bio(chemical) sensors", *Advanced Materials*, vol. 22, pp. 4157-4161, 2010. [Wiley-VCH. Impact factor 27.40]
6. K. S. Nalwa, and S. Chaudhary, "Design of light-trapping microscale-textured surfaces for efficient organic solar cells", *Optics Express*, vol. 8(5), pp. 5168-5178, 2010. [Optical Society of America. Impact factor 3.56]
5. J. M. Park, K. S. Nalwa, W. Leung, K. Constant, S. Chaudhary, and K. M. Ho, "Fabrication of metallic nanowires and nanoribbons using laser interference lithography and shadow lithography", *Nanotechnology*, vol. 21, pp. 215301, 2010. [Institute of Physics. Impact factor 3.40]
4. K. Miller, K. S. Nalwa, A. Bergured, N. Neihart, and S. Chaudhary "Memristive behavior in thin anodic titania", *IEEE Electron Device Letters*, vol. 31, pp. 737-739, 2010. [Impact factor 3.75]
3. D. Maurya, H. Thota, K. S. Nalwa, and A. Garg, "BiFeO₃ ceramics synthesized by mechanical activation assisted versus conventional solid-state-reaction process: A comparative study", *Journal of Alloys and Compounds*, vol. 477, pp. 780-784, 2009. [Elsevier. Impact factor 4.17]
2. K. S. Nalwa, and A. Garg, "Phase evolution, magnetic and electrical properties in Sm-doped bismuth ferrite", *Journal of Applied Physics*, vol. 103, pp. 044101, 2008. [American Physical Society. Impact factor 2.33]
1. K. S. Nalwa, A. Garg, and A. Upadhyaya, "Effect of samarium doping on the properties of solid-state-synthesized multiferroic bismuth ferrite", *Materials Letters*, vol. 62, pp. 878-881, 2008. [Elsevier. Impact factor 3.02]

Conference Proceedings/Presentations:

7. R. C. Mahadevapuram, K. S. Nalwa, V. Dalal, and S. Chaudhary, "Photovoltaics using doped and undoped amorphous silicon heterojunctions with conjugated polymers", *TMS 2011 Annual Meeting and Exhibition*, San Diego, CA, Feb 27 - March 3, 2011.
6. K. S. Nalwa, J. M. Park, W. Leung, K. Constant, K. M. Ho, and S. Chaudhary, "Textured substrate based organic solar cell for higher absorption and improved performance", *Materials Research Society Symposium Proceedings 2010*. (BEST POSTER NOMINEE)
5. A. L. Thoeming, K. S. Nalwa, R. Liu, J. Shinar, R. Shinar, and S. Chaudhary, "Single substrate integration of organic light-emitting diode, organic photodetector and sensing element for photoluminescence based bio(chemical) sensors", *SPIE Optics+Photonics*, San Diego, CA, August 2010. (Oral presentation)
4. K. Miller, K. S. Nalwa, A. Bergured, N. Neihart, and S. Chaudhary, "Tunable anodized-titania memristors: Study on effects of annealing and extent of anodization", *Materials Research Society Spring Meeting 2010*, San Francisco, CA. (Oral presentation)
3. K. S. Nalwa, Y. Cai, A. L. Thoeming, R. Shinar, J. Shinar, and S. Chaudhary, "Photoluminescence based sensors on all organic platform (organic-light-emitting-diode/ dye:analyte/ organic-photodetectors)", *Materials Research Society Spring Meeting 2010*, San Francisco, CA. (Poster presentation)
2. R. C. Mahadevapuram, K. S. Nalwa, V. Dalal, and S. Chaudhary, "Intrinsic and doped amorphous silicon hybridized with polymer-based photovoltaics: status, our results, and opportunities", *Materials Research Society Spring Meeting 2010*, San Francisco, CA. (Oral presentation)
1. K. S. Nalwa, and S. Chaudhary, "Design of three-dimensional textured organic solar cell" *Materials Research Society Symposium Proceedings 2009*, 1168, 1168-P05-17.

Invited Talks:

[*invited speaker]

6. K. S. Nalwa* "Ways of Overcoming Energy Losses in Organic Solar Cells", *India-UK SUNRISE Bengaluru Symposium*, IISC Bangalore, India, Feb. 13, 2020.
5. K. S. Nalwa* "Route towards Increasing the Efficiency of Organic Solar cells", *IITK-Rice University Collaborative Workshop*, IIT Kanpur, India, Jan. 8, 2020.
4. K. S. Nalwa* "Increasing the efficiency of organic solar cells by Electrostatic field enhancements", *Faculty candidate seminar at IIT Kanpur*, IIT Kanpur, India, Oct. 5, 2019.
3. K. S. Nalwa, R. C. Mahadevapuram, and S. Chaudhary*, "Controlling defect density in polymer-fullerene bulk heterojunction solar cells by optimizing growth conditions", *TMS 2011 - 140th Annual Meeting and Exhibition*, San Diego, CA, Feb. 27 - March 3, 2011.
2. K. S. Nalwa*, "Increasing the efficiency of organic solar cells by photonic and electrostatic field enhancements", *seminar at Intel Corporation*, Hillsboro, OR, Nov. 8, 2010
1. M. Jeffries-El*, J. F. Mike, K. S. Nalwa, A. Makowski, D. Putnam, and S. Chaudhary, "Design and synthesis of new thiophene containing polymers for use in photovoltaic applications", *American Chemical Society 239th National Meeting*, San Francisco, March 21-26, 2010.