

# Rudresh Ghosh, Ph.D.

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## EDUCATION

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**Ph.D. in Physics** (2012) University of North Carolina, Chapel Hill, NC

**MS in Physics** (2006) Indian Institute of Technology, Bombay, India

**B.S. in Physics** (2004) University of Calcutta, Kolkata, India

## WORK EXPERIENCE

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**2013 – Present: Postdoctoral Fellow, Microelectronics Research Center, University of Texas at Austin.**

**2014 – Present: Senior Research Scientist, Applied Novel Devices (AND) Inc.**

ADVISORS: Prof. Sanjay K. Banerjee and Prof. Rodney Ruoff (2013)

RESEARCH AREA: 2-Dimensional (2D) materials, chemical vapor deposition, material characterization and engineering.

ACCOMPLISHMENTS:

- Led UT Austin – AND Inc. collaboration. Total funding of 1.15M USD over 2.5 years (funding agency: Army Research Laboratories). Defined research goals for the whole team, prepared proposals, monthly reports and successfully communicated progress/accomplishments to program manager at end of Phase 1.
- Set up 2D Materials Synthesis Lab, a multi-user facility at the Microelectronics Research Center.
- Established material characterization protocol for CVD grown 2D materials.
- Applied novel characterization techniques (MIM, TOF-SIMS, Pump Probe spectroscopy) to investigate material defects in CVD grown 2D materials. Material improvement directly led to TMD based electronic devices with highest recorded mobilities and current density for CVD grown material.

**2007 – 2012: Research Fellow, Energy Frontier Research Center, University of North Carolina at Chapel Hill.**

ADVISOR: Prof Rene Lopez

RESEARCH AREA: Dye sensitized solar cells, photo-voltaic properties and applications, tailoring thin film growth using pulsed laser deposition (PLD).

ACCOMPLISHMENTS:

- Introduced pulsed laser deposition for making photo anodes used in Dye Sensitized Photo-electrochemical cells. This allowed much quicker scanning of different possible materials/ morphologies as opposed to conventional sol-gel techniques. This directly led to highest power conversion efficiency of any non-TiO<sub>2</sub> based DSSCs.
- Modelled thin film growth as a function of PLD parameter space in collaboration with researchers from Oak ridge National Lab.
- Instrumental in setting up and daily operation of the Solar Cell Characterization Facility (a user facility at UNC Chapel Hill – EFRC).

## TECHNICAL SKILLS

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### *Thin Film/ Device Fabrication:*

- Pulsed Laser Deposition
- Chemical Vapor Deposition
- Metal Evaporation
- Sputtering
- E-beam Lithography
- Photolithography

### *Material Characterization:*

- Raman Spectroscopy
- Photoluminescence Spectroscopy
- Spectroscopic Ellipsometry
- Electron Microscopy
- Atomic Force Microscopy
- TOF-SIMS
- XPS

### *Photovoltaic Characterization*

- UV-Vis and near IR absorbance spectroscopy
- Spectral Electrochemistry
- Current Voltage Characterization
- Electrochemical Impedance Spectroscopy
- Open Circuit Voltage Decay measurements

1. Rahimi, S.\* and **Ghosh, R.\*** and Kim, S. and Dodabalapur, A. and Banerjee, S. and Akinwande, D.: "The positive effects of hydrophobic fluoropolymers on the electrical properties of MoS<sub>2</sub> transistors" – **Applied Sciences**, 2016, 6 (9), pp 236 (**\* equal contributions**)
2. Wu, D. and Li, X. and Luan, L. and Wu, X. and Li, W. and Yogeesh, M. N. and **Ghosh, R.** and Chu, Z. and Akinwande, D. and Niu, Q. and Lai, K.: "Uncovering edge states and electrical inhomogeneity in MoS<sub>2</sub> field-effect transistors" – **Proceedings of the National Academy of Sciences**, 2016, 113 (31), pp 8583-8588.
3. **Ghosh, R.** and Kim, J. S. and Roy, A. and Chou, H. and Vu, M. and Banerjee, S. K. and Akinwande, D.: "Large Area Chemical Vapor Deposition Growth of Monolayer MoSe<sub>2</sub> and its Controlled Sulfurization to MoS<sub>2</sub>" - **Journal of Materials Research**, 2016, 31 (07), pp 917-922.
4. McCreary, A. and **Ghosh, R.** and Amani, M. and Wang, J. and Duerloo, K-A N. and Sharma, A. and Jarvis, K. and Reed, E. and Dongare, A. and Banerjee, S. K. and Terrones, M. and Namburu, R. and Dubey, M. : "Effects of Uniaxial and Biaxial Strain on Few-Layered Terrace Structures of MoS<sub>2</sub> Grown by Vapor Transport" - **ACS Nano**, 2016, 10 (37), pp 386-3197.
5. Chang, H. and Yogeesh, M. N. and **Ghosh, R.** and Rai, A. and Sanne, A. and Yang, S. and Lu, N. and Banerjee, S. K. and Akinwande, D. : "Large Area Monolayer MoS<sub>2</sub> for Flexible Low Power RF Nanoelectronics in the GHz Regime" - **Advanced Materials**, 2016, 28, pp 1818-1823.
6. Park, S. and Zhu, W. and Chang, H. and Yogeesh, M. N. and **Ghosh, R.** and Banerjee, S. K. and Akinwande, D.: "High-frequency prospects of 2D nanomaterials for flexible nanoelectronics from baseband to sub-THz devices" – **IEEE International Devices Meeting (IEDM)**, 2015, pp 32.1.1 – 32.1.4.
7. Sanne, A. and **Ghosh, R.** and Rai, A. and Yogeesh, M. N. and Shin, S. H. and Sharma, A. and Jarvis, K. and Mathew, L. and Rao, R. and Akinwande, D. and Banerjee, S. K.: "Radio Frequency Transistors and Circuits Based on CVD MoS<sub>2</sub>" - **Nano Letters**, 2015, 15 (8), pp 5039 – 5045.
8. Liu, Y. and Cheng, T. and Chou, H. and Nayak, A. Wu, Di and **Ghosh, R.** and Chang, H. and Hao, Y. and Wang, X. and Kim, J. and Piner, R. and Ruoff, R. S. and Akinwande, D. and Lai, K.: "Thermal Oxidation of WSe<sub>2</sub> Nanosheets Adhered on SiO<sub>2</sub>/Si Substrates" – **Nano Letters**, 2015, 15 (8), pp 4979 – 4984.
9. Chou, H. and Ismach, A. and **Ghosh, R.** and Ruoff, R. and Dolocan, A.: "Revealing the Planar Chemistry of Two-Dimensional Heterostructures at an In-Depth Atomic Level" - **Nature Communications**, 2015, 6, 74822.
10. Rai, A. and Valsaraj, A. and Movva, H. C. P. and Roy, A. and **Ghosh, R.** and Sonde, S. S. and Kang, S. and Chang, J. and Trivedi, T. and Dey, R. and Guchhait, S. and Larentis, S. and Register, L. F. and Tutuc, E. and Banerjee, S. K.: "Air Stable Doping and Intrinsic Mobility Enhancement in Monolayer Molybdenum Disulfide by Amorphous Titanium Suboxide Encapsulation" – **Nano Letters**, 2015, 15 (7), pp 4329-4336.
11. Sanne, A. and **Ghosh, R.** and Rai, A. and Movva, H. C. P. and Sharma, A. and Rao, R. and Mathew, L. and Banerjee, S.K.: "Top-gated MoS<sub>2</sub> FETs on Si<sub>3</sub>N<sub>4</sub> Substrates" - **Applied Physics Letters**, 2015, 106 (6), pp 062101 - 062101(4).
12. Liu, Y. and **Ghosh, R.** and Wu, D. and Ismach, A. and Ruoff, R. and Lai, K.: "Mesoscale Imperfections in MoS<sub>2</sub> Atomic Layers Grown by a Vapor Transport Technique" - **Nano Letters**, 2014, 14 (8), pp 4682-4686.
13. Hara, Y. and Garvey, T. and Alibabaei, L. and **Ghosh, R.** and Lopez, R.: "Controlled Seeding of Laser Deposited Ta:TiO<sub>2</sub> Nanobrushes and Their Performances as Photoanode for Dye Sensitized Solar Cells" - **ACS Applied Materials & Interfaces**, 2013, 5 (24), pp 13140-13145.
14. Ok, M. R. and Ghosh, R. and Brennaman, M. K. and Lopez, R. and Meyer, T. J. and Samulski, E. T.: "Surface Patterning of Mesoporous Niobium Oxide Films for Solar Energy Conversion" - **ACS Applied Materials & Interfaces**, 2013, 5 (8), pp 3469-3474.
15. Luo, H. and Song, W. and Hoertz, P. and Hanson, K. G. and **Ghosh, R.** and Rangan, S. and Brennaman, M. K. and Concepcion, J. J. and Binstead, R. and Lopez, R. and Meyer, T. J.: "A Sensitized Nb<sub>2</sub>O<sub>5</sub> Photoanode for Hydrogen Production in a Dye-Sensitized Photoelectrosynthesis Cell" - **Chemistry of Materials**, 2012, 25 (2), pp 122-131.
16. **Ghosh, R.** and Alibabaei, L. and Hanson, K. and Rangan, S. and Bartynski, R. and Meyer, T.J. and Lopez, R.: Increasing Photocurrents in Dye Sensitized Solar Cells with Tantalum Doped Titanium Oxide Photoanodes Obtained by Laser Ablation" – **ACS Applied Materials & Interfaces** 2012, 4 (9), pp 4566-4570.
17. Hanson, K. and Brennaman, M. K. and Ito, A. and Luo, H. and Song, W. and Parker, K. and **Ghosh, R.** and Norris, M. R. and Glasson, C. R. K. and Concepcion, J. J. and Lopez, R. and Meyer, T. J.: "Structure-Property Relationships in Phosphonate-Derivatized, Ru<sup>II</sup> Polypyridyl Dyes on Metal Oxide Surfaces in an Aqueous Environment" – **Journal of Physical Chemistry C**. 2012, 116 (28), pp 14837-14847.
18. Brosnan, D. and **Ghosh, R.** and McNeil, L. and Lopez, R.: "Influence of Ionic Pretreatment on the Performance of Solid Electrolyte Dye-Sensitized Solar Cells" - **Solar Energy**, 2012, 86 (9), pp 2312-2317.
19. Wu, B. and Zimmers, A. and Aubin, H. and **Ghosh, R.** and Liu, Y. and Lopez, R. : "Electric-field-driven phase transition in vanadium dioxide" - **Physical Review B** 2011, 84 (24), pp 241410(R).
20. **Ghosh, R.** and Brennaman, M.K. and Uher, T. and Ok, M.R. and Samulski, E.T. and Mcneil, L.E. and Meyer, T.J. and Lopez, R.: "Nanoforest Niobium Oxide Photoanodes for Dye Sensitized Solar Cells by Pulsed Laser Deposition" - **ACS Applied Materials & Interfaces** 2011, 3 (10), pp 3929-3935.
21. **Ghosh, R.** and Brennaman, M.K. and Concepcion, J.J. and Hanson, K. and Kumbhar, A.S. and Meyer, T.J. and Lopez, R.: "Efficient high surface area vertically aligned metal oxide nanostructures for dye-sensitized photoanodes by pulsed laser deposition" - **Proceedings of SPIE** 2011, 8109, pp 8109U.
22. **Ghosh, R.** and Baker, M.B. and Lopez, R.: "Optical Properties and Aging of Gasochromic Tungsten Oxide" - **Thin Solid Films** 2010, 518, pp 2247-2249.