Nikhil Tilak, Ph.D.

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SUMMARY

I am a Postdoctoral Associate in physics at Rutgers University with over 8 years of expertise in nanofabrication, electronic tunneling, and transport measurements. My extensive research experience has honed my problem-solving abilities. I excel in collaborative environments and am adept at communicating findings effectively. I'm highly skilled at designing experiments, collecting and analyzing data, and presenting findings as evidenced by my 6 peer-reviewed journal publications and conference talks. I have a strong aptitude for programming, particularly in Python, and am well-versed in numerical and machine learning techniques. My unique blend of technical expertise, analytical skills, and a passion for learning make me a valuable asset in roles that require precision, innovation, and a data-driven approach. I'm currently seeking process/yield engineering roles in the semiconductor industry.

SKILLS

- **Device fabrication:** Silicon wafer cleaning (RCA), nanofabrication using e-beam lithography (FEI Sirion, Hitachi SU5000), electron beam metal deposition (gold, chromium, titanium), reactive ion/plasma etching (gases: O_2, CHF_3), HF wet etching of silicon dioxide, wire bonding (West Bond).
- **Characterization:** Scanning tunneling microscopy (built my own system), electrostatic gating, I-V characterization, four-probe resistance measurement using lock-in amplifier (SR 830, Keithley 6221, 2100), atomic force microscopy (NT-MDT, Asylum Cypher), Kelvin probe force microscopy, Electrostatic force microscopy, Piezoresponse microscopy, force-distance spectroscopy, Raman spectroscopy (Renishaw inVia), optical microscopy (Nikon).
- **Vacuum & cryogenics:** Expert at design, construction and maintenance of HV/UHV chambers and cryogenic temperature measurement apparatus. Helium leak detection (Agilent).
- **Mechanical and electronics:** Soldering, Brazing, CAD (Fusion 360, AutoCAD), Machining (Drilling, Lathe, Milling), Arduino circuits.
- **Data analysis & programming:**
  - **Languages & platforms**: Python, C, SQL, MATLAB, HTML, CSS, Git/Github.
  - **Python packages**: NumPy, SciPy, Pandas, Scikit-Learn, OpenCV, NLTK, TensorFlow.
  - **Machine learning**: Linear/Logistic regression, KNN, SVM, PCA, Random Forests, XGBoost, NLP.
  - **Certificates**: Erdos institute data science bootcamp 05/2020 - 07/2020
    Applied data science with Python.(Univ. of Michigan on Coursera) 01/2020 - 06/2020

PROFESSIONAL EXPERIENCE

- **Postdoctoral Associate** | Rutgers University, Piscataway, New Jersey 07/2023 - present
  Studying correlated phases in two-dimensional heterostructures and moire materials with tunneling and electrical transport measurements.
- **Graduate Research Assistant** | Rutgers University, Piscataway, New Jersey 05/2018 - 06/2023
  Conducted Scanning tunneling microscopy experiments on twisted two-dimensional materials leading to 6 high impact journal publications.
- **Teaching Assistant** | Rutgers University, Piscataway, New Jersey 09/2015 - 05/2018
  TA for extended analytical physics (115), analytical physics (123 & 124), intro solid state physics (406), graduate quantum mechanics 1 (501), electromagnetism (385) and classical physics lab (276).
- **Physics Faculty** | Bakliwal Tutorials, Pune, India. 06/2014 - 05/2015
  Taught calculus-based physics for the highly selective Indian institutes of technology joint entrance exam (IIT-JEE). 1200+ hours of teaching experience to over 550 high school juniors and seniors.
- **Research Intern** | INRS, Montreal, Canada 05/2013 - 07/2013
  Won the prestigious MITACS Globalink summer internship award. Worked on lead-sulfide quantum dots.

RESEARCH PROJECTS

- **Proximity-induced charge density wave in graphene/1T-TaS_2.**
  First observation of a charge density wave (CDW) proximity effect between graphene and 1T-TaS2. Revealed that graphene alters the band structure at the TaS2 surface, impacting electron correlations.
- **Structure and electronic properties of marginally twisted MoS_2.**

Studied twisted MoS2 bilayers near 0° twist angles using STM. The moiré pattern is twist-angle-dependent, with lattice reconstruction for small angles, revealing a strong moiré-potential. In reconstructed areas, we observed bias-dependent asymmetry, linked to rhombohedral stacked TMDs' inherent vertical polarization. These findings shed light on interfacial ferroelectrics and heterostructure design possibilities.

- **Carrier confinement in magic-angle twisted bilayer graphene.**
  Investigated the effects of substrate potential disorder on magic-angle twisted bilayer graphene using STM/STS.
- **Design and construction of a low temperature scanning tunneling microscope.**
  Designed and constructed a dip-stick style STM and a scanner head capable of operating from 300 K to 4.2 K. System was optimized to reduce heat-load to reduce cryogen consumption.
- **Effect of strain on CVD graphene microdrums.**
  Optimized the growth of monolayer graphene on copper foils. Transferred the graphene to holey silicon nitride substrates to make suspended graphene devices for strain measurements.

EDUCATION

- **Ph.D. in Physics** | Rutgers University, Piscataway, New Jersey 09/2015 - 06/2023
  Dissertation: *Scanning tunneling microscopy studies of twisted van der Waals heterostructures.*
- **B.Tech. in Engineering Physics** | Indian Institute of Technology, Guwahati, Assam, India. 08/2010 - 05/2014
  Placed 2nd in my cohort with a GPA of 9.04/10.

SELECTED PUBLICATIONS (google scholar)

[1] N. Tilak, M. A. Altvater, S.-H. Hung, *et al.*, "Revealing the charge density wave proximity effect in graphene 1t-TaS_2.," *(under review at Nature materials)*, 2023.

[2] N. Tilak, G. Li, T. Taniguchi, K. Watanabe, and E. Y. Andrei, "Moiré potential, lattice relaxation, and layer polarization in marginally twisted MoS_2 bilayers," *Nano Letters*, 2022.

[3] N. Tilak, X. Lai, S. Wu, *et al.*, "Flat band carrier confinement in magic-angle twisted bilayer graphene," *Nature communications*, vol. 12, no. 1, p. 4180, 2021.

[4] M. A. Altvater, N. Tilak, S. Rao, *et al.*, "Charge density wave vortex lattice observed in graphene-passivated 1t-tas2 by ambient scanning tunneling microscopy," *Nano Letters*, vol. 21, no. 14, pp. 6132–6138, 2021.

[5] M. A. Altvater, N. Tilak, S. Rao, *et al.*, "Observation of a topological defect lattice in the charge density wave of 1t-tas2," *Applied Physics Letters*, vol. 119, no. 12, p. 121 601, 2021.

[6] R. S. Bisht, J. Park, H. Yu, *et al.*, "Spatial interactions in hydrogenated perovskite nickelate synaptic networks," *Nano Letters*, Jul. 2023.

[7] R. K. Biroju, N. Tilak, G. Rajender, S. Dhara, and P. Giri, "Catalyst free growth of zno nanowires on graphene and graphene oxide and its enhanced photoluminescence and photoresponse," *Nanotechnology*, vol. 26, no. 14, p. 145 601, 2015.

CONFERENCE TALKS & POSTERS

- STM studies of marginally twisted MoS_2 bilayers [poster] Rutgers Center for Materials Theory symposium, 2022
- Moiré bands in twisted MoS2 homobilayers [talk] APS March Meeting 2022, Chicago
- Observation of charging peaks near the flat band in magic-angle twisted bilayer Graphene [talk] APS March Meeting 2021, Virtual
- A method for controllably inducing ultra-high strain in suspended 2D materials [talk] APS March Meeting 2018, Los Angeles

RECENT HONORS

- **David C. Langreth Graduate Development Award** 2017
  "Presented annually to an especially promising early-stage graduate student by the Department of Physics and Astronomy at Rutgers"

LEADERSHIP AND MENTORSHIP

- Directly mentored five undergraduate students leading to successful transitions to graduate school and industry.
- Student representative on the graduate studies and life committee (AY 2018-19)
- Vice President of the Physics and Astronomy Graduate Student Organization. (AY 2016-17)