SHANTANU KALLAKURI

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EDUCATION

Cornell University — Ithaca, NY
M.S. with Thesis in Materials Science and Engineering — *Aug. 2018 – May 2021*

- **Advisors**: Prof. Richard Robinson and Prof. Tobias Hanrath
- Thesis: *'Development of multiscale hierarchical structures from nanocluster mesophases'* 10.7298/x221-2n24
- Graduated with successful thesis defense, a co-op, patents and publication; (CGPA: 3.84/4)

Birla Institute of Technology & Science (BITS) Pilani — Pilani, India
Dual degree - B.E. in Chemical Engineering and M.Sc. in Chemistry — *Aug. 2010 – Jul. 2015*

- **Advisor**: Prof. Gokulnath Sabapathi, IICT (Indian Institute of Chemical Technology) (now at IISER-TVM)
- Thesis: *'Bi-conjugated Porphyrin and Sapphyrin macro-cycles for Dye-sensitized solar cells'*
- Honors in both degrees & department rank 3 in Chemical engineering; (Major GPA: 9.11/10, CGPA: 7.44/10)

RESEARCH EXPERIENCE

Applied Materials Inc. — Santa Clara, CA
Process Engineer *(Now Senior), Atomic Layer Deposition, Semiconductor Products Group* — *Aug. 2021 – Present*

- Process owner for Olympia - Applied's primary line of dielectric Plasma-enhanced atomic layer deposition (PEALD) machines developing process & chemistry for thin-films in emergent Gate-all-around (GAA) transistors
- Spearheading a team of six to develop conformal thin-film plasma deposition processes through design of experiments (DOE) for advanced-node GAA & memory applications and integration flow (sub-1.5nm nodes)
- Executed multiple IP-protected projects in this role leading to multi-million dollar sales for Applied Materials product at various logic and memory customers. Filed 6 technology patents (Four granted, others pending)

Process Engineering Co-op *(Mid-degree), Varian division, Applied Materials (Massachusetts)* — *Sep. 2019 – Sep. 2020*

- Developed process and chemistry on proprietary glass to etch AR/VR waveguides and photonic gratings using directional ribbon beams, 2.5D grayscale lithography & innovative masking to pattern nanotopographic features
- Developed, executed, showed proof-of-concept and patented processes for three applications in plasma-enhanced chemical vapor deposition (PECVD) and reactive ion etch (RIE) using AMAT machines Sculpta & Sym3
- Developed PECVD process and chemistry for directional seeding and seam-free selective deposition of metal on Silicon and mixed Silicon substrates for Buried word-line (BWL) DRAM application

Cornell University — Ithaca, NY
Graduate Thesis *(Advisor: Prof. Richard Robinson), Materials Science & Engineering* — *Aug. 2018 – May 2021*

- Developed a one-pot synthesis of functional quantum dot magic-sized nanocrystals (MSNC) that hierarchically self-assemble into 99.9% pure, 6% monodisperse thin-films & fibers through a DNA-like biomimetic mesophase
- These electromagnetically tunable thin-films scale 7 orders in magnitude (nm-cm), have huge chiral g-factors (1.30), support diverse chemistry and are analyzed with simple laser diffraction. Published in *Nature Materials*

Massachusetts Institute of Technology — Cambridge, MA
Visiting Research Assistant *(Advisor: Prof. Julia Ortony), Materials Science & Engineering* — *Feb. 2017 – Aug. 2017*

- Developed initial precursors and head-group synthesis protocols for amphiphilic self-assembly at Prof. Ortony's lab that were later used in heavy metal remediation and catalysis studies by the team. This material platform was further developed and published by the team in some great work in *Nature Nanotechnology*

Brigham & Women's Hospital, Harvard-MIT HST — Cambridge, MA
Research Assistant *(Advisor: Prof. Hadi Shafiee), Engineering for Medicine* — *Aug. 2016 – Feb. 2017*

- Synthesized and surface-modified Janus Pt/Au nanomotors using Thiol cross-linking chemistry, Polymerase chain-reaction (PCR), Loop-mediated (LAMP) DNA amplification to spontaneously bind DNA to nanomotors
- Achieved 99% accurate HIV & Zika diagnosis by comparing the DNA-bound to free nanomotor velocities using cellphones for inexpensive point-of-care diagnosis. Research published in *ACS Nano* & *Nature Communications*

Indian Institute of Chemical Technology Hyderabad, India

Undergraduate Thesis *(Advisor: Prof. Gokulnath Sabapathi), Polymers & Functional Materials* *Jan. 2015 – Jul. 2015*

- Designed and synthesized a light-harvesting expanded *Porphyrin (Sapphyrin)* and characterized it using electrochemical impedance spectroscopy (EIS) for Dye-sensitized solar cell (DSSC) photosensitizer application
- Iterated through multiple pathways to successfully develop a high-yield solution based on *Dithienopyrrole* (80%). The novelty was the donor-Pi bridge-acceptor dye which integrates usually disparate electronic regions
- Integrated the dye with a TiO_2 scaffold and *Carbon, Indium Tin Oxide (ITO)* counter-electrode to build a working cell. Achieved the objective for a dye with broad Q, Soret bands to allow high-efficiency DSSC (10.3%)

Certifications

Stanford: *Harnessing the Power of AI/ML to Address New Engineering Challenges*: Comprehensive 15-week course on regression, classification, clustering, support vector machines, trees, random forests, neural networks & final project

Skills

Thin-film growth & nanopatterning: Chiral thin-films, Plasma-based CVD & ALD, Plasma-based ALE, Plasma-based RIE, Selective and directional deposition, grayscale lithography, Conductivity and Optical characterization
Organic & Inorganic Synthesis: Quantum-dots, core-shell nanoparticles, spinels, amphiphilic self-assembly, macrocycles, conductive polymers, donor-acceptors, Porphyrins, Thio-Azo conjugation, ligand chemistry, trap-states
Characterization: UV-Vis, XRD, NMR, FTIR, SAXS, OES, Thin-film ellipsometry, optical diffraction simulation
Simulation & modelling: LAMMPS, GAMESS (Basic), Blender, Cinema4D, Solidworks, AutoCAD, Ansys Fluent
ML & AI: Neural networks, support vector regression, logistic & linear regression, classification, clustering, trees
Software & Statistics: Python, Java, C, VBA, MatLab, Javascript, HTML/CSS, SQL, Pandas, NumPy, Scikit-learn, Tensorflow, SciPy, Matplotlib, Seaborn, Tableau, SAS (JMP), Statistical Process Control (SPC), Design of experiments (DOE), Root-cause analysis, Failure analysis

Selected Publications & Conferences

- ***AIx conference, Applied Materials*** (2024) : "*Detect or defect: A CNN-powered AI-driven approach to semiconductor defect classification*" **S. Kallakuri**, Z. Zhang, R. Patil, L. Sun, M. Copic
- ***Nature Materials,*** 21(5): 518-525 (2022) : "*Multiscale hierarchical structures from a nanocluster mesophase*" H. Han, **S. Kallakuri**, Y. Yao, C. B. Williamson, D. R. Nevers, B. H. Savitzky, R. S. Skye, M. Xu, O. Voznyy, J. Dshemuchadse, L. F. Kourkoutis, S. J. Weinstein, T. Hanrath, R. D. Robinson
- ***Nature Communications,*** 9(1): 4282 (2018) : "*DNA-engineered micromotors powered by metal nanoparticles for motion-based cellphone diagnostics*" M. S. Draz, K. M. Kochehbyoki, A. Vasan, D. Battalapalli, A. Sreeram, M. K. Kanakasabapathy, **S. Kallakuri**, A. Tsibris, D. R. Kuritzkes, H. Shafiee
- ***ACS Nano,*** 12(6): 5709-5718 (2018) : "*Motion-based immunological detection of Zika Virus using Pt-nanomotors and a cellphone*" M. S. Draz, N. K. Lakshminaraasimulu, S. Krishnakumar, D. Battalapalli, A. Vasan, M. K. Kanakasabapathy, A. Sreeram, **S. Kallakuri**, P. Thirumalaraju, Y. Li, S. Hua, X. G. Yu, D. R. Kuritzkes, H. Shafiee
- ***Functionalized engineering materials & their applications,*** 1(1):117-124 (2016) : "*Synthesis and characterization of templated Polyanilines: A new class of polymeric materials*" J. Avusula, **S. Kallakuri**, S. Jayanty

Selected Patents

US11956978B2 and US20240040808A1 | *Techniques & devices using directional seeding & selective deposition (2024)*
M. Zeeshan, K. Chan, **S. Kallakuri**, S. Varghese. Two IPs describing selective, angular dielectric & metal deposition

US11749564B2 | *Techniques for void-free material depositions (2023)*
M. Zeeshan, K. Chan, **S. Kallakuri**, S. Varghese, J. Hautala. This IP covers a foundational way to deposit metal in void-free manner for Buried Wordline (BWL) DRAM application in advanced transistors since voids raise resistance

US11404314B2 | *Metal line patterning (2022)*
S. Varghese, M. Zeeshan, **S. Kallakuri**, K. Chan. This method describes a process-flow for selective fin patterning through deposition and etch using Plasma-enhanced CVD and/or ALD for transistor Wordline and Bitline application

US20220100078A1 | *Devices and methods for variable etch depths (Submitted, Pending)*
M. Zeeshan, R. Bandy, P. Kurunczi, **S. Kallakuri**, T. Soldi, J. Olson. This IP covers a process-flow crucial to plasma etch process of waveguides and gratings on special glass (Various glass types) for augmented reality (AR) applications

US20220119955A1 | *Techniques for variable deposition profiles (Submitted, Pending)*
M. Zeeshan, **S. Kallakuri**, J. Olson. This IP describes etch techniques to modulate refractive index for AR gratings

Scholastic Achievements and Awards

(2020) ***Applied Materials internship excellence award*** & cash prize **|** **(2014-2015)** ***T.I.M.E*** undergraduate engineering & management scholarship **|** **(2013-2015)** ***BITS Pilani MCN*** (merit cum need) undergraduate scholarship **|** **(2015)** ***Three Bronze*** and ***Two Gold*** medals for university in Carrom and Soccer at national sports fests BOSM, SPREE, and ARENA **|** **(2014)** ***Runner-up in National selection*** for Carom from Andhra Pradesh

Teaching and Mentorship

- *Teaching assistant*: **(2020) MSE5860** - *Atomic structure*, Prof. Richard Robinson | **(2020) ENGRG1160** - *Intro to Engineering*: Prof. Bruce Van Dover | **(2018) MSE4330** - *Energy materials*, Prof. Richard Robinson
- Mentored 4 batches of 7th-10th grade students as an *Expanding your horizons (EYH)* student engineering mentor
- Taught and mentored 32 undergraduates in Chemistry and Physics on Chegg/InstaEdu over the course of 3 years

Leadership & Outreach

- *Project coordinator, Asha*: Raised over $18000 in fund-raiser events (through concerts, workshops, and student-cooked dinners) for the non-profit, focused primarily on less privileged students in rural India
- *Artist Liaison, Spicmacay*: Organized 8 fund-raising concerts for the non-profit to help popularize Indian Carnatic & Hindustani music through artistes like Sikkil Gurucharan & Pt. Ronu Majumdar
- *Community outreach lead, Yuva (Youth under visionary action) & Nirmaan*: Organized over 6 summer education camps for 8th-10th grade students in Thimmapur & Dasarigudem villages focused on math and science education
- *Event planner, Make a Difference (MAD)*: Regularly organize blood-donation drives (3+) & vaccine camps (2+)