Shantanu Kallakuri

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Expertise: (in)organic synthesis, self-assembly (hierarchical/lipid/directed/modular), thin-films, quantum-dots, Cvd, Ald, Rie, nanomotors, ML/AI, python, lammps, gamess, atomic design, spin QCA, spintronics, click-chem, magic-size clusters

EDUCATION

Cornell University — Ithaca, NY
M.S. with Thesis in Materials Science and Engineering, GPA: 3.9/4 — *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)

a) Developed a 1-pot synthesis of functional quantum dot magic-sized nanocrystals (QD MSNC) that hierarchically self-assemble into a biomimetic mesophase akin to DNA/collagen giving 99.9% pure QD thin-films and helical fibers

b) This work is first-of-a-kind since the QDs and these thin-films:
i) Span 6-7 orders in magnitude - individual qd (nm) to thin-films (cm) that scalably inherit atomic properties
ii) Demonstrated a general path to various chemistries with huge improvement over today's hot-injection synthesis
iii) Allowed exploration of a larger, softer phase space than one offered by small molecules or bulk materials
iv) Ensured consistent shape (<6% monodisperse), were electrically and magnetically tunable, and optically chiral
v) Enabled transparent films that could be studied using simple laser-diffraction

c) Project work published in *Nature Materials* (10.1038/s41563-022-01223-3)

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

- **Thesis:** *Bi-conjugated aromatic Porphyrin and Sapphyrin macro-cycles for Dye-sensitized solar cells*
- **Advisor:** Prof. Giribabu Lingamallu, IICT (Indian Institute of Chemical Technology), CSIR
- **Award:** Ranked department 3rd in the four-year Chemical engineering programme with a major GPA of 9.1/10

EXPERIENCE

Applied Materials Inc. — Santa Clara, CA
Senior Process Engineer, Semiconductor Products Group — *Sept. 2021 – Present*

- AMAT is the world's largest semiconductor equipment maker & Gate-all-around (GAA) transistors are cornerstones of today's logic and memory applications in advanced-node (n+2, sub-1nm & beyond) PC/AI microprocessor chips
- As Process owner for the Olympia line of machines, AMAT's primary PEALD product (Plasma-enhanced atomic layer deposition), I work in a leading capacity to develop process/chemistry for upcoming gate-all-around devices
- In this role, I have executed multiple IP-covered projects directly enabling 8-figure dollar AMAT product sales and process development for sub-2nm nodes, 3D-DRAM, 3D-NAND, along with 4 granted patents

Process Engineering Co-op Intern (Mid-thesis) — *Sept. 2019 – Sept. 2020*

- Developed a PECVD & an RIE method for graded-deposition & variable-depth ion etch of dielectrics (SiN_x, SiO_x)
- This enabled selective and directional plasma process on glass for optical applications (AR waveguides, gratings)
- The project led to 2 patents (Both published & pending), an award, and a cash prize for excellence at work

Massachusetts Institute of Technology — Cambridge, MA
Research Assistant, Julia Ortony lab, Dept. of materials science and engineering — *Mar. 2017 – Aug. 2017*

- Contributed to ideation/synthesis of self-assembling aramid amphiphiles to extract heavy-metals from groundwater
- This work was accepted for the MRS Fall Meet, 2017, Boston, MA, and served as the initial proto-type for future work continued in the following paper in *Nature Nanotechnology* (Doi:10.1038/s41565-020-00840-w)

Harvard Medical School — Cambridge, MA
Research Assistant, Hadi Shafiee Lab, Division of engineering for medicine — *Aug. 2016 – Feb. 2017*

- Designed & synthesized a catalytic Janus Pt/Au nanomotor system for cheap HIV/Zika microfluidic diagnostics
- Used Thiol chemistry, PCR, Loop-mediated isothermal DNA amplification (LAMP), & particle velocimetry. The microchip is 99% accurate and has been published in *ACS nano* and *Nature communications*

PUBLICATIONS

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**, J. Subbalakshmi

PATENTS

US11956978B2 | *Techniques and device structure based upon directional seeding and selective deposition (April 2024)*
M. A. Zeeshan, K. Chan, **S. Kallakuri**, S. Varghese. This IP describes a process to selectively, angularly deposit metals & dielectrics on SiN_x vs SiO_x vs Si, the three most common substrates in semiconductor microchip fabrication

US20240040808A1 | *Techniques and device structure based upon directional seeding and selective deposition (February 2024)*
S. Varghese, M. A. Zeeshan, **S. Kallakuri**, K. Chan. Split patent encompassing parts of the above project idea

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

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

US20220100078A1 | *Devices and methods for variable etch depths (Pending)*
M. A. Zeeshan, R. Bandy, P. F. Kurunczi, **S. Kallakuri**, T. Soldi, J. C. Olson. This work covers a process-flow crucial to plasma etch processing of waveguides and gratings on optical glass (Various glass types) for Augmented Reality

US20220119955A1 | *Techniques for variable deposition profiles (Abandoned by us)*
M. A. Zeeshan, **S. Kallakuri**, J. C. Olson. This IP modulates refractive index for AR. Abandoned it due to commercials

CERTIFICATIONS

Stanford: *Harnessing the Power of AI/ML to Address New Engineering Challenges*
Successfully completed a semester-long comprehensive 15-week program on ML and implemented CNNs, kNNs, decision trees, SVM, linear regression, logistic regression and a final project applying CNNs for semiconductor defect classification

AWARDS

Awards: Applied Materials performance award | T.I.M.E undergraduate engineering & management scholarship
Accolades: Secured Bronze representing my state & university in Carom, Soccer at national sports fests BOSM, SPREE

TEACHING / OUTREACH

Teaching assistantships:- ENGRG1160 *Intro to engg.* | MSE5860 *Atomic structure* | MSE4330 *Energy materials*
Outreach:- *Expanding your horizons*: Mentoring 7th - 10th grade students as an EYH mentor since July 2019
Volunteering: Regular organizer since 2018 at Asha: a non-profit that raises funds for underprivileged students in rural India through concerts, fests, student-cooked dinners & at Spicmacay: a non-profit popularizing Indian classical music

SKILLS

Lab: (in)organic synthesis, self-assembly, quantum-dot nanocrystals, spinels, amphiphiles, donor-acceptors, porphyrins
Techniques: PEALD, PECVD, RIE, UV-Vis, XRD, NMR, FTIR, SAXS, OES, Ellipsometry, SRIM, Optical diffraction
Simulation & modelling: LAMMPS & MD, GAMESS (Basic), Blender, Cinema4D, Solidworks, Ansys Fluent
ML & AI: Convolutional neural networks, support vector regression, logistic & linear regression, kNNs, decision trees
Programming: Python (proficient), Java (proficient), MatLab, C/C++, VBA, SQL, JavaScript, HTML/CSS
Statistics & libraries: Pandas, NumPy, Scikit-learn, Tensorflow, SciPy, Seaborn, Matplotlib, SAS (JMP), DOE