

Kunal Mukherjee

Assistant Professor, Materials Science and Engineering, Stanford University

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RESEARCH INTERESTS

Semiconductor synthesis and integration, microstructure and crystal defects, infrared detectors and light sources, electron microscopy of interfaces and defects

PROFESSIONAL EXPERIENCE

2020 – now Assistant Professor, Materials Science and Engineering, Stanford University
2016 – 20 Assistant Professor, Materials, University of California Santa Barbara
2015 Postdoctoral Researcher, IBM Research, TJ Watson Center
2014 Postdoctoral Research Associate, Electroceramics Laboratory, MIT
2009 – 10 100G Transceiver Engineer, Finisar Corporation

EDUCATION

2014 Ph.D. Materials Science and Engineering, MIT
2009 M.S. Materials for Micro and Nano systems, National University of Singapore
2008 M.Eng. Materials Science and Engineering, MIT
2007 B.Eng. Electrical and Electronics, Nanyang Technological University, Singapore

AWARDS

2020-2022 Reid and Polly Anderson Faculty Fellow, Stanford University,
2020 NSF CAREER Award
2019 Corbett Prize, International Conference on Defects in Semiconductors, 2019
2013 IBM PhD Fellowship
2007-09 Singapore-MIT Alliance Graduate Fellowship
2004-06 President's Research Scholar, Nanyang Technological University
2004, 06, 07 Nanyang Technological University Dean's List
2003-07 Singapore Airlines Undergraduate Scholarship

AWARDS FOR SUPERVISED STUDENTS

Eamonn Hughes, MRS Electronic Materials Conference 2020, overall best student award
Jennifer Selvidge, MRS Electronic Materials Conference 2020, overall best student award
Brian Haidet, MRS Electronic Materials Conference 2018, overall best student award

JOURNAL PUBLICATIONS (*Group members underlined*)

1. J. Meyer, A.J. Muhowski, L.J. Nordin, E.T. Hughes, B.B. Haidet, D. Wasserman, K. Mukherjee, Bright mid-infrared photoluminescence from high dislocation density epitaxial PbSe films on GaAs, *APL Materials* 9 (2021) 111112
2. K. Mukherjee, J. Selvidge, E.T. Hughes, J. Norman, C. Shang, R.W. Herrick, J.E. Bowers, Post-growth formation of kinetically controlled misfit dislocations in III-V lasers on silicon, *Journal of Physics D: Applied Physics* 54 (2021) 494001
3. C. Shang, Y. Wan, J. Selvidge, E.T. Hughes, R.W. Herrick, K. Mukherjee, J. Duan, F. Grillot, W. Chow, J.E. Bowers, Perspective on advances in quantum dot lasers and integration with Si photonic integrated circuits, *ACS Photonics* 8 (2021) 2555–2566
4. E.T. Hughes, B.B. Haidet, B. Bonef, K. Mukherjee, Pipe-diffusion-enriched dislocations and interfaces in PbSe-SnSe heterostructures, *Physical Review Materials* 5, 073402 (2021)

5. B.B. Haidet, L.J. Nordin, A.J. Muhowski, K.D. Vallejo, E.T. Hughes, J. Meyer, P.J. Simmonds, D. Wasserman, K. Mukherjee, Interface structure and luminescence properties of epitaxial PbSe films on InAs (111)A, Journal of Vacuum Science and Technology A 39 (2021) 023404
6. C. Shang, E.T. Hughes, Y. Wan, M. Dumont, R. Koscica, J. Selvidge, R.W. Herrick, A.C. Gossard, K. Mukherjee, J.E. Bowers High-temperature reliable quantum-dot lasers on Si with misfit and threading dislocation filters, Optica 8, (2021) 749-754
7. J. Selvidge, E.T. Hughes, J. Norman, C. Shang, MJ Kennedy, M. Dumont, A. Netherton, Z. Zhang, R.W. Herrick, J.E. Bowers, K. Mukherjee, Reduced dislocation growth leads to long lifetime InAs quantum dot lasers on silicon at high temperatures, Applied Physics Letters 118 (2021) 192101
8. R.M. Kennard, C.J. Dahlman, R.A. DeCrescent, J.A. Schuller, K. Mukherjee, R. Seshadri, M.L. Chabinyc, Ferroelastic Hysteresis in Thin Films of Methylammonium Lead Iodide, Chemistry of Materials 33 (2021) 298–309
9. A. Goswami, S. Šuran Brunelli, B. Markman, A. Taylor, H-Y. Tseng, K. Mukherjee, M. Rodwell, J. Klamkin, Jonathan, C. Palmstrøm, Controlling Facets and Defects of InP Nanostructures in Confined Epitaxial Lateral Overgrowth, Physical Review Materials 4 (2020) 123403
10. S.A. Meynell, C.A. McClellan, L.B. Hughes, T.E. Mates, K. Mukherjee, and A.C. Bleszynski Jayich, Engineering quantum-coherent defects: the role of substrate miscut in chemical vapor deposition diamond growth, Applied Physics Letters 117 (2020) 194001
11. C. Shang, J. Selvidge, E.T. Hughes, J. Norman, A.A. Taylor, A.C. Gossard, K. Mukherjee, and J.E. Bowers, A pathway to thin GaAs virtual substrate on on-axis Si (001) with ultralow threading dislocation density, Physica Status Solidi (A) (2020) 2000402
12. J. Selvidge, J. Norman, E.T. Hughes, C. Shang, D. Jung, A.A. Taylor, MJ Kennedy, R.W. Herrick, J.E. Bowers, and K. Mukherjee, Defect Filtering for Thermal Expansion Induced Dislocations in III-V Lasers on Silicon, Applied Physics Letters 117 (2020) 122101
13. K. Mukherjee, J. Selvidge, D. Jung, J. Norman, A.A. Taylor, M. Salmon, A.Y. Liu, J.E. Bowers, and R.W. Herrick, Recombination-enhanced dislocation climb in InAs quantum dot lasers on silicon, Journal of Applied Physics. 128 (2020) 025703
14. B.B. Haidet, E.T. Hughes, K. Mukherjee, Nucleation control and interface structure of rocksalt PbSe on (001) zincblende III-V surfaces, Physical Review Materials 4 (2020) 033402
15. R.M. France, P. Espinet-Gonzalez, B.B. Haidet, K. Mukherjee, H.L. Guthrey, H.A. Atwater, D. Walker, Development of Lattice-Mismatched GaInAsP for Radiation Hardness, IEEE Journal of Photovoltaics. 10 (2020) 103–108
16. O. Vail, P. Taylor, P. Folkes, B. Nichols, B.B. Haidet, K. Mukherjee, G. de Coster, Growth and Magnetotransport in Thin Film α-Sn on CdTe, Physica Status Solidi (B) 257 (2020) 1800513
17. A. Rice, K. Park, E.T. Hughes, K. Mukherjee, K. Alberi, Defects in Cd₃As₂ Epilayers Via Molecular Beam Epitaxy and Strategies for Reducing Them, Physical Review Materials 3 (2019) 121201(R)
18. J. Selvidge, J. Norman, M.E. Salmon, E.T. Hughes, J.E. Bowers, R.W. Herrick, K. Mukherjee, Non-radiative recombination at dislocations in InAs quantum dots grown on silicon, Applied Physics Letters 115, 131102 (2019)
19. Y. Hu, D. Liang, K. Mukherjee, Y. Li, C. Zhang, G. Kurczveil, X. Huang, and R. Beausoleil, III/V-on-Si MQW lasers by using a novel photonic integration method of regrowth on bonding template, Light Science and Applications 8 (2019) 1–9

20. R.M. Kennard, C.J. Dahlman, H. Nakayama, R.A. DeCrescent, J.A. Schuller, R. Seshadri, K. Mukherjee, M.L. Chabiny, Phase Stability and Diffusion in Lateral Heterostructures of Methyl Ammonium Lead Halide Perovskites, ACS Applied Materials and Interfaces. (2019)
21. E.T. Hughes, R.D. Shah, K. Mukherjee, Glide of threading dislocations in (In)AlGaAs on Si induced by carrier recombination: Characteristics, mitigation, and filtering, Journal of Applied Physics. 125 (2019) 165702
22. B. Bonef, R.D. Shah, K. Mukherjee, Fast diffusion and segregation along threading dislocations in semiconductor heterostructures, Nano Letters 19 (2019) 1428–1436
23. K. Mukherjee, M. Vaisman, P.G. Callahan, M.L. Lee, Anomalous tilting in InGaAs graded buffers from dislocation sources at wafer edges, Journal of Crystal Growth. 512 (2019) 169–175
24. J.S. Lee, B. Shojaei, M. Pendharkar, M. Feldman, K. Mukherjee, C.J. Palmstrøm, Contribution of top barrier materials to high mobility in near-surface InAs quantum wells grown on GaSb(001), Physical Review Materials 3, 014603 (2019)
25. D. Jung, J. Norman, Y. Wan, S. Liu, R. Herrick, J. Selvidge, K. Mukherjee, A.C. Gossard, J.E. Bowers, Recent Advances in InAs Quantum Dot Lasers Grown on On-Axis (001) Silicon by Molecular Beam Epitaxy, Physica Status Solidi (A). (2019) 1800602
26. P.G. Callahan*, B.B. Haidet*, D. Jung, G.G.E. Seward, K. Mukherjee, "Direct observation of recombination-enhanced dislocation glide in heteroepitaxial GaAs on silicon". Phys. Rev. Materials. 2 (2018) 081601. (*Equal contribution)
27. K. Mukherjee, C.H. Reilly, P.G. Callahan, G.G.E. Seward, "Recombination activity of threading dislocations in GaInP influenced by growth temperature", Journal of Applied Physics. 123 (16) 165701 (2018).
28. D. Jung, P.G. Callahan, B. Shin, K. Mukherjee, A.C. Gossard, J.E. Bowers, "Low threading dislocation density GaAs growth on on-axis GaP/Si (001)", J. Appl. Phys. 122 (22), 225703 (2017)
29. K. Mukherjee, B.A. Wacaser, S.W. Bedell, D.K. Sadana, "Rapid imaging of misfit dislocations in SiGe/Si in cross-section and through oxide layers using electron channeling contrast", Appl. Phys. Lett. 110, 232101 (2017)
30. K. Mukherjee, Y. Hayamizu, C. Kim, L. Kolchina, G. Mazo, S.Y. Istomin, S.R. Bishop, H.L. Tuller, "Praseodymium cuprate thin film cathodes for intermediate temperature solid oxide fuel cells: Roles of doping, orientation, and crystal structure", ACS Appl. Mater. Interfaces, 2016, 8 (50), pp 34295–34302
31. M. Vaisman*, K. Mukherjee*, T. Masuda, K.N. Yaung, E.A. Fitzgerald and M. L. Lee, "Direct-gap 2.1-2.2 eV AlInP Solar Cells on GaInAs/GaAs Metamorphic Buffers", IEEE J. Photovolt. 6, 571 (2016) (*Equal contribution)
32. K. Mukherjee, A.G. Norman, A.J. Akey, T. Buonassisi, and E.A. Fitzgerald, "Spontaneous lateral phase separation of AlInP during thin film growth and its effect on luminescence" J. Appl. Phys. 118 (11), 115306 (2015)
33. K. Mukherjee, P.B. Deotare and E.A. Fitzgerald, "Improved photoluminescence characteristics of order-disorder AlGaInP quantum wells at room and elevated temperatures", Appl. Phys. Lett. 106 (14), 142109 (2015)

34. K. Mukherjee, D. A. Beaton, A. Mascarenhas, M. T. Balsara, E.A. Fitzgerald, "Effects of dislocation strain on the epitaxy of lattice-mismatched AlGaN_xP layers", J. Cryst. Growth. 392 (2014), P74-P80
35. K. Mukherjee, D.A. Beaton, T. Christian, E.J. Jones, K. Alberi, A. Mascarenhas, M.T. Balsara, E.A. Fitzgerald, "Growth, microstructure, and luminescent properties of direct-bandgap InAlP on relaxed InGaAs on GaAs substrates", J. Appl. Phys. 113, 183518 (2013)
36. N.Y. Pacella, K. Mukherjee, M.T. Balsara, and E.A. Fitzgerald. "Silicon CMOS Ohmic Contact Technology for Contacting III-V Compound Materials." ECS J. Solid State Sci. Technol. 2(2013) P324–P331.
37. D.A. Beaton, T. Christian, K. Alberi, A. Mascarenhas, K. Mukherjee, and E.A. Fitzgerald. "Determination of the direct to indirect bandgap transition composition in AlInP." J. Appl. Phys. 114, 203504 (2013)
38. T. Christian, D.A. Beaton, K. Mukherjee, K. Alberi, E.A. Fitzgerald, A. Mascarenhas, "Amber-green light emitting diodes using order-disorder Al_xIn_{1-x}P heterostructures", J. Appl. Phys. 114, 074505 (2013)
39. K. Mukherjee, T. Teng, R. Jose, and S. Ramakrishna, Electron transport in electrospun TiO₂ nanofiber dye-sensitized solar cells, Appl. Phys. Lett. 95 (1), 012101 (2009)

BOOK CHAPTERS

1. K. Mukherjee, Materials science of defects in GaAs-based lasers, Reliability of Semiconductor Lasers and Optoelectronic Devices
2. J. Norman, D. Jung, A. Liu, J Selvidge, K. Mukherjee, J.E. Bowers, R.W. Herrick, Reliability of lasers on silicon substrates for silicon photonics, Reliability of Semiconductor Lasers and Optoelectronic Devices

PATENTS

1. J. P. de Souza, Y. S. Lee, K. Mukherjee, and D. K. Sadana, "United States Patent: 10,581,109- Fabrication method of all solid-state thin film battery", 3-Mar-2020.
2. S. W. Bedell, C.-W. Cheng, K. Mukherjee, J. A. Ott, D. K. Sadana, and B. A. Wacaser, "United States Patent: 10,460,937 - Post-growth heteroepitaxial layer separation for defect reduction in heteroepitaxial films", 29-Oct-2019.
3. S. W. Bedell, K. Mukherjee, J. A. Ott, D. K. Sadana, and B. A. Wacaser, "United States Patent: 10127649 - Electron channeling pattern acquisition from small crystalline areas", 13-Nov-2018.
4. N. Li, Q. Li, K. Mukherjee, D. K. Sadana, and G. G. Shahidi, "United States Patent: 10043941 – Light emitting diode having improved quantum efficiency at low injection current", 07-Aug-2018.
5. J. P. de Souza, Y. S. Lee, K. Mukherjee, and D. K. Sadana, "United States Patent: 9984949 – Surface passivation having reduced interface defect density", 29-May-2018.
6. S. W. Bedell, K. Mukherjee, J. A. Ott, D. K. Sadana, and B. A. Wacaser, "United States Patent: 9859091- Automatic alignment for high throughput electron channeling contrast imaging", 02-Jan-2018.
7. S. W. Bedell, K. Mukherjee, J. A. Ott, D. K. Sadana, and B. A. Wacaser, "United States Patent: 9741532 - Multi-beam electron microscope for electron channeling contrast imaging of semiconductor material", 22-Aug-2017.

8. S. W. Bedell, R. T. Mo, K. Mukherjee, J. A. Ott, D. K. Sadana, and B. A. Wacaser, "United States Patent: 9739728 - Automatic defect detection and classification for high throughput electron channeling contrast imaging", 22-Aug-2017.

Applications

9. S. W. Bedell, N. Li, Q. Li, K. Mukherjee, D. K. Sadana, and G. Shahidi, "United States Patent Application: 20180331158 - Multi-junction photovoltaic cells", 15-Nov-2018.
10. J. Bowers, J. Norman, K. Mukherjee, J. Selvidge, E. Hughes, "United States Patent Application: 20210111087A1 - Dislocation glide suppression for misfit dislocation free heteroepitaxy 2021

INVITED PRESENTATIONS

1. APS March meeting, March 2022
2. UC Berkeley, Materials Science and Engineering, February 2022
3. Microscopy and Microanalysis, Defects in Materials July 2021
4. University of Illinois, Materials Science and Engineering, April 2021
5. University of Michigan, Materials Science and Engineering, November 2020
6. European Microscopy Congress, Copenhagen, August 2020 (declined/canceled)
7. Institute of Energy Efficiency, UC Santa Barbara
8. Stanford University, Department of Materials Science and Engineering, October 2018
9. Global Foundries, Malta, NY, August 2018
10. Materials Research Lab Outreach Symposium, UC Santa Barbara, February 2017
11. Materials Department, UC Santa Barbara, February 2016
12. Rutgers University, Materials Science and Engineering, February 2015
13. University of Cambridge, April 2015
14. Yale University, Department of Electrical Engineering, November 2014

TEACHING

Defects in Semiconductors (MATSCI 317) – Stanford, Fall 2021
Microstructure in Materials (MATSCI 213) – Stanford, Spring 2021
Electronic Materials Engineering (MATSCI 152) – Stanford, Winter 2021, 2022
Materials Structure and Properties (MATRL 100A), UCSB – Fall 2018, 2019
Characterization in scanning electron microscopy (MATRL 288C), UCSB – Spring 2018
Extended defects in semiconductors (MATRL 288I), UCSB – Fall 2017
Metal-organic chemical vapor deposition (MATRL 227), UCSB – Spring 2017, 2019
Fundamentals of Electronic Solids I (MATRL 206A/ECE 215A), UCSB – Winter 2017-20
Solid state chemistry (3.091), MIT (Teaching assistant) – Fall 2014

PROFESSIONAL ACTIVITIES

Invited organizer of the Electronic Materials Conference (Years: 2018-present)
Program committee North American Conference Molecular Beam Epitaxy (2019-present)
Focus topic organizer, American Physical Society March meeting (2020)
Program committee for the International Conference on Crystal Growth and Epitaxy (2019)
Program committee for the IEEE Photonics Conference (2018)

Reviewer for US NSF, Canadian NSERC, Nature, Applied Physics Letters, Optics Express, Light: Science and Applications, Journal of Applied Physics, Journal of Crystal Growth, Journal of the American Ceramic Society, IEEE Journal of Photovoltaics, Nanoscale, Solar Energy Materials and Solar cells, Journal of Vacuum Sciences and Technology B, Journal of Materials Science: Materials in Electronics

GRADUATE STUDENTS SUPERVISED/CO-SUPERVISED

1. Alexandra Zimmerman, Ph.D, Materials Science and Engineering, 2026 (Expected)
2. Tri Nguyen, Ph.D, Materials Science and Engineering, 2026 (Expected)
3. Pooja Reddy, Ph.D, Materials Science and Engineering, 2025 (Expected)
4. Jarod Meyer, Ph.D, Materials Science and Engineering, 2025 (Expected)
5. Lillian Hughes, Ph.D, Materials, UCSB, 2024 (Expected), co-advised with Ania Jayich
6. Eamonn Hughes, Ph.D, Materials, UCSB, 2023 (Expected), co-advised with John Bowers

7. Jennifer Selvidge, Ph.D, Materials, UCSB, 2021 (co-advised with John Bowers)
8. Brian Haidet, Ph. D. Materials UCSB, 2021
9. Jared Hoch, M.S. Materials UCSB, 2019
10. Connor Reilly, M.S. Materials UCSB, 2019

GRADUATE STUDENTS THESIS COMMITTEES

- Molly Andersen Ph.D. Materials Science and Engineering, Stanford, 2024
Emily Lindgren Ph.D. Materials Science and Engineering, Stanford, 2023
Yifan Wang Ph.D. Materials Science and Engineering, Stanford, 2022
Yunzhi Liu Ph.D. Materials Science and Engineering, Stanford, 2021
Rhys Kennard, Ph.D. Materials, UC Santa Barbara, 2021
Manik Goyal, Ph.D. Materials, UC Santa Barbara, 2021
Amanda Matheson, M.S. Materials, UC Santa Barbara, 2020
Michelle Labrecque, M.S. ECE, UC Santa Barbara, 2017