Jeehwan Kim

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Projects

Monolithic 3D (M3D) integration

- M3D of 2D materials
  - Growth-based M3D of 2D logic [*Nature*, 614, 81–87 (2023)]
  - Stacking-based M3D of 2D logic [*Science*, 362, 665-670 (2018)]
- M3D of compound semiconductors
  - Discovery of graphene-based releasable epitaxy of III-V [*Nature*, 544, 340–343 (2017)]
  - New mechanism of remote epitaxy [*Nature Nanotechnology*, Vol. 18, 464-470 (2023); *Nature Nanotechnology*, 17, 1054-1059 (2022); *Nature Nanotechnology*, 15, 272-276 (2020); *Nature Materials*, 17, 999–1004 (2018)]
  - Vertically stacked full color microLEDs [*Nature* 614, 81–87 (2023)]
- M3D of complex oxides
  - Oxide-based heterostructures for multifunctional chips [*Nature*, 578, 75-81 (2020)]

Bio-Electronic Interface

- Skin sensor arrays for health monitoring
  - Breathable e-skins [*Science Advances*, 7 (2021)]
  - Chip-less wireless communication of biosensors [*Science* 377, 859-864 (2022)]
- Implantable electronics for brain mapping

AI hardware & Edge computing

- Brain-inspired neuromorphic computing
  - Precision analog computing [*Nature Materials*, 17, 335–340 (2018)]
  - Long-term multi-value programing for ANN arrays [*Nature Nanotechnology*, 15, 574–579 (2020)]
  - 3D neural network hardware [*Nature Materials*, 22, 1470 (2023); *Nature Electronics*, 5, 386–393 (2022)]

Education

Ph.D.	Materials Science and Engineering	University of California at Los Angeles, CA, USA	2008
M.S.	Materials Science and Engineering	Seoul National University, Seoul, Korea	1999
B.S.	Materials Science and Engineering	Hongik University, Seoul, Korea	1997

Work Experience

Samsung Electronics, *Korea (Sabbatical)*	Executive Vice President	2022-2023
Science Advances, AAAS	Associate Editor	2019 – date
Massachusetts Institute of Technology, *Cambridge, MA* Department of Mechanical Engineering Department of Materials Science and Engineering	Associate Professor (Tenured)	2018 – date
Massachusetts Institute of Technology, *Cambridge, MA* Department of Materials Science and Engineering	Assistant Professor	2016 – 2018
Massachusetts Institute of Technology, *Cambridge, MA* Department of Mechanical Engineering	Assistant Professor	2015 – 2018
IBM T.J. Watson Research Center, *Yorktown Heights, NY* Department of Silicon Technology	Research Staff Member	2008 – 2015
IBM T.J. Watson Research Center, *Yorktown Heights, NY* Department of Silicon Technology	Research Intern	2007
Korea Air Force, *Suwon, Korea*	Airman First Class	1999 – 2002

Awards/Honors

Falling Walls Global Calls	2024
Samsung Fellow	2022
DARPA Director's Award	2021
DARPA Young Faculty Award	2019
IBM Faculty Award	2016
LAM Research Foundation Award (3 times)	2016
IBM Master Inventor	2012
High Value Patent Application (10 times)	2011 – 2015
Invention Achievement Awards (23 times)	2009 – 2015

List of Publications

Journal Papers (*corresponding author)

1. Sangho Lee et al., and **Jeehwan Kim***
   Mixed-Dimensional Integration of 3D-on-2D Heterostructures for Advanced Electronics
   Nano Letters, Vol. 24, 9117–9128 (2024)

2. Ki Seok Kim et al., and **Jeehwan Kim***
   The future of two-dimensional semiconductors beyond Moore's law
   Nature Nanotechnology, Vol. 19, 895–906 (2024)

3. Kuangye Lu et al., and **Jeehwan Kim***
   2D materials can unlock single-crystal-based monolithic 3D integration
   Nature Electronics, Vol. 7, 416-418 (2024)

4. Bo-In Park et al., and **Jeehwan Kim***
   Remote Epitaxy: Fundamentals, Challenges, and Opportunities
   Nano Letters, Vol. 24, 2939-2952 (2024)

5. Junyoung Kwon et al., and **Jeehwan Kim***
   200-mm-wafer-scale integration of polycrystalline molybdenum disulfide transistors
   Nature Electronics, Vol. 7, 356-364 (2024)

6. Sangmoon Han et al., and Sanghoon Bae
   High energy density in artificial heterostructures through relaxation time modulation
   Science, Vol. 384, 312-317 (2024)

7. See-On Park et al., and Shinhyun Choi
   Phase-change memory via a phase-changeable self-confined nano-filament
   Nature, Vol. 628, 293-298 (2024)

8. Ji-Hoon Kang et al., and **Jeehwan Kim***
   Monolithic 3D integration of 2D materials-based electronics towards ultimate edge computing solutions
   Nature Materials, Vol. 22, 1470-1477 (2023)

9. Celesta S. Chang et al., and **Jeehwan Kim***
   Remote epitaxial interaction through graphene
   Science Advances, Vol. 9 (42), eadj537 (2023)

10. Min-Kyu Song et al., and **Jeehwan Kim***
    Recent Advances and Future Prospects for Memristive Materials, Devices, and Systems
    ACS Nano, Vol. 17 (13), 11994-12039 (2023)

11. Hyunseok Kim et al., and **Jeehwan Kim***
    High-throughput manufacturing of epitaxial membranes from a single wafer by 2D materials-based layer transfer process
    Nature Nanotechnology, Vol. 18, 464-470 (2023)

12. Jiho Shin et al., and **Jeehwan Kim***
    Vertical full-colour micro-LEDs via 2D materials-based layer transfer
    Nature, Vol. 614, 81–87 (2023)

13. Ki Seok Kim et al., and **Jeehwan Kim***
    Non-epitaxial single-crystal 2D material growth by geometric confinement
    Nature, Vol. 614, 88–94 (2023)

14. Hyunseok Kim et al., and **Jeehwan Kim***
    Graphene nanopattern as a universal epitaxy platform for single-crystal membrane production and defect reduction

Nature Nanotechnology, Vol. 17 (10), 1054-1059 (2022)

15. Yeongin Kim et al., and **Jeehwan Kim***
    Chip-less wireless electronic skins by remote epitaxial freestanding compound semiconductors
    Science, Vol. 377 (6608), 859-864 (2022)

16. Chanyeol Choi et al., and **Jeehwan Kim***
    Reconfigurable heterogeneous integration using stackable chips with embedded artificial intelligence
    Nature Electronics, Vol. 5 (6), 386–393 (2022)

17. Hyunseok Kim et al., and **Jeehwan Kim***
    "Remote epitaxy"
    Nature Reviews Methods Primers, Vol. 2, 40 (2022)

18. Hanwool Yeon, et al., and **Jeehwan Kim***,
    "Long-term reliable physical health monitoring by sweat pore–inspired perforated electronic skins"
    Science Advances, Vol. 7, Issue 27 (2021)

19. Hyunseok Kim, et al., and **Jeehwan Kim***,
    "Impact of 2D–3D Heterointerface on Remote Epitaxial Interaction through Graphene"
    ACS Nano, Vol. 15, 6, 10587–10596 (2021)

20. Kuan Qiao, et al., and **Jeehwan Kim***,
    "Graphene Buffer Layer on SiC as a Release Layer for High-Quality Freestanding Semiconductor Membranes"
    Nano Letters, Vol. 21, 4013-4020 (2021)

21. Areej Aljarb, et al, **Jeehwan Kim**, Lain-Jong Li, and Vincent Tung,
    "Ledge-directed epitaxy of continuously self-aligned single-crystalline nanoribbons of transition metal dichalcogenides"
    Nature Materials (2020) Published online

22. Hanwool Yeon, Peng Lin, Chanyeol Choi, et al., and **Jeehwan Kim***
    "Alloying conducting channels for reliable neuromorphic computing"
    Nature Nanotechnology, Vol. 15, 574–579(2020)

23. Hyun Kim, et al, and **Jeehwan Kim***,
    "Heterogeneous integration of single-crystalline complex-oxide membranes"
    Nature, Vol 578, 75-81 (2020)

24. Sang-Hoon Bae, et al., and **Jeehwan Kim***,
    "Graphene allows spontaneous relaxation towards dislocation-free heteroepitaxy"
    Nature Nanotechnology, Vol. 15, 272-276 (2020)

25. Hyun Kum, Doeon Lee, Wei Kong, Byunghun Lee, Yongmo Park, Yunjo Kim, Yongmin Baek, Sang-Hoon Bae, Kyusang Lee, and **Jeehwan Kim***,
    "Recent advances in epitaxial growth and layer transfer techniques for emerging electronics and optoelectronics"
    Nature Electronics Vol. 2, 439–450 (2019)

26. Sang-Hoon Bae, Hyun Kum, Wei Kong, Yunjo Kim, Chanyeol Choi, Byunghun Lee, Peng Lin, and **Jeehwan Kim***,
    "Integration of bulk materials with two-dimensional materials for physical couplings",
    Nature Materials Vol. 18, 550–560 (2019) *Featured as a front cover*

27. Wei Kong, Hyun Kum, Sang-Hoon Bae, Jaewoo Shim, Hyunseok Kim, Lingping Kong, Yuan Meng, Kejia Wang, Chansoo Kim, and **Jeehwan Kim***,
    "Path towards graphene commercialization from lab to market"
    Nature Nanotechnology Vol. 14, 927–938 (2019)

28. Scott Tan, Peng Lin, Hanwool Yeon, Shinhyun Choi, Yongmo Park, and **Jeehwan Kim***
    "Uniform switching of artificial synapses for large-scale neuromorphic arrays"
    APL Materials, Vol. 6, 12 (2018)

29. Jaewoo Shim, Sang-Hoon Bae, Wei Kong, Doyoon Lee, et al, and **Jeehwan Kim***

"Controlled crack propagation for atomic precision handling of wafer-scale two-dimensional materials"
Science Vol. 362, 665–670 (2018)

30. Wei Kong, Huashan Li, Kuan Qiao, et al., Jeffrey C. Grossman*, and **Jeehwan Kim***
"Polarity governs atomic interaction through two-dimensional materials"
Nature Materials Vol. 17, 999–1004 (2018)

31. Tsung-Ju Lu, Michael Fanto, Hyeongrak Choi, Paul Thomas, Jeffrey Steidle, Sara Mouradian, Wei Kong, Di Zhu, Hyowon Moon, Karl Berggren, Jeehwan Kim, Mohammad Soltani, Stefan Preble, and Dirk Englund, "Aluminum nitride integrated photonics platform for the ultraviolet to visible spectrum" ***Optics Express***, Vol. 26, 1147-1160 (2018)

32. Jaewoo Shim, Dong-Ho Kang, Yunjo Kim, Hyun Kum, Wei Kong, Sang-Hoon Bae, Ibraheem Almansouri, Kyusang Lee, Jin-Hong Park, and **Jeehwan Kim***
Recent progress in Van der Waals (vdW) heterojunction-based electronic and optoelectronic devices
Carbon, Vol. 133, 78-89 (2018)

33. Shinhyun Choi, Scott Tan, Yunjo Kim, Chanyeol Choi, Pai-Yu Chen, and Shimeng Yu, and **Jeehwan Kim***,
"SiGe Epitaxial Memory for Neuromorphic Computing with reproducible high performance based on engineered dislocations",
Nature Materials, Vol. 17, 335–340 (2018) *Featured as a table of content cover*

34. Yunjo Kim, Samuel S. Cruz, Kyusang Lee, Babatunde O. Alawode, Chanyeol Choi, Yi Song, Jared M. Johnson, Chris Heidelberger, Wei Kong, Shinhyun Choi, Kuan Qiao, Eugene A. Fitzgerald, Jing Kong, Alexie M. Kolpak, Jinwoo Hwang, and **Jeehwan Kim***,
"Remote epitaxy through graphene enables two-dimensional material-based layer transfer"
Nature, Vol. 544, 340–343 (2017) *Featured as a front cover*

35. Sang-Hoon Bae, Xiaodong Zhou, Seyoung Kim, Yun Seog Lee, Samuel Cruz, Yunjo Kim, James B. Hannon, Yang Yang, Devendra K. Sadana, Frances M. Ross, Hongsik Park, and **Jeehwan Kim***
"Unveiling the carrier transport mechanism in epitaxial graphene for forming wafer-scale, single-domain graphene",
Proceedings of the National Academy of Science, Vol. 114, 4082-4086 (2017)

36. Piran R. Kidambi, Michael S. Boutilier, Luda Wang, Doojon Jang, **Jeehwan Kim**, and Rohit Karnik, "Selective Nanoscale Mass Transport across Atomically Thin Single Crystalline Graphene Membranes", ***Advanced Materials***, (2017)

37. Jaewoo Shim, Seo-Hyeon Jo, Minwoo Kim, Young Jae Song, **Jeehwan Kim**, and Jin-Hong Park, "Light-Triggered Ternary Device and Inverter Based on Heterojunction of van der Waals Materials", ***ACS Nano***, Vol. 11, 6319 (2017)

38. Talia Gershon, Yun Seog Lee, Teodor K. Todorov, Wei Wang, Mark T. Winkler, Marinus Hopstaken,Oki Gunawan, **Jeehwan Kim***
''Atomic layer deposited aluminum oxide for interface passivation of $Cu_2ZnSn(S,Se)_4$ thin-film solar cells
Advanced Energy Materials, 1600198 (2016)

39. Jaewoo Shim, Hyo Seok Kim, Yoon Su Shim, Dong-Ho Kang, Hyung-Youl Park, Jaehyeong Lee, Jaeho Jeon, Seong Jun Jung, Young Jae Song, Woo-Shik Jung, Jaeho Lee, Seongjun Park, **Jeehwan Kim**, Sungjoo Lee, Yong-Hoon Kim, and Jin-Hong Park, "Extremely Large Gate Modulation in Vertical Graphene/WSe2 Heterojunction Barristor Based on a Novel Transport Mechanism", ***Advanced Materials***, Vol. 28, 5293 (2016)

40. **Jeehwan Kim*,** Ziruo Hong*, Gang Li, Tze-bin Song, Jay Chey, Devendra Sadana, and Yang Yang*, "10.5% amorphous silicon/polymer tandem photovoltaic cell", ***Nature Communications***, Vol. 6, 6391 (2015)

41. **Jeehwan Kim***, Can Bayram*, Hongsik Park*, Cheng-Wei Cheng, Christos Dimitrakopoulos, John A. Ott, Kathleen B. Reuter, Stephen W. Bedell, and Devendra K. Sadana, "Principle of direct van der Waals epitaxy of single-crystalline films on epitaxial graphene", ***Nature Communications,*** Vol. 5, 4836 (2014)

42. **Jeehwan Kim***, Corsin Battaglia*, Mathieu Charrière, Augustin Hong, Wooshik Jung, Hongsik Park, Christophe Ballif, and Devendra Sadana, "9.4% efficient three-dimensional amorphous silicon solar cells on high aspect-ratio glass microcones", ***Advanced Materials***, Vol. 26, 4082 (2014)

43. **Jeehwan Kim*,** Homare Hiroi*, Teodor K. Todorov*, Oki Gunanwan, Masaru Kuwahara, Tayfun Gokmen, Dhruv Nair, Marinus Hopstaken, Byungha Shin, Hiroki Sugimoto, and David Mitzi, "High-efficiency $Cu_2ZnSn(S,Se)_4$ solar cells by applying a double In_2S_3/CdS emitter" ***Advanced Materials,*** Vol. 26, 7427 (2014) *Frontispiece*

44. Can Bayram, John Ott, Kuen-Ting Shiu, Cheng-Wei Cheng, Yu Zhu, **Jeehwan Kim**, Manijeh Razeghi, and Devendra Sadana, "Cubic Phase GaN on Nano-grooved Si (100) via Maskless Selective Area Epitaxy", ***Advanced Functional Materials***, Vol. 24, 4492 (2014)

45. In-yeal Lee, Hyung-Youl Park, Jin-hyung Park, Gwangwe Yoo, Myung-Hoon Lim, Junsung Park, Rathi Servin, Woo-Shik Jung, **Jeehwan Kim**, Sang-Woo Kim, Yonghan Roh, Gil-Ho Kim and Jin-Hong Park, "Poly-4-vinylphenol and Poly(melamine- co-formaldehyde)-based Graphene Passivation Method for Flexible, Wearable and Transparent Electronics", ***Nanoscale,*** Vol. 6, 3830 (2014)

46. Young T Chae, **Jeehwan Kim**, Hongsik Park, and Byungha Shin, "Building Energy Performance Evaluation of Building Integrated Photovoltaic (BIPV) Window with Semi-transparent Solar Cells", ***Applied Energy,*** Vol. 129, 217 (2014)

47. **Jeehwan Kim***, Hongsik Park*, James B. Hannon, Stephen W. Bedell, Keith Fogel, Devendra K. Sadana, ChristosDimitrakopoulos*, "Layer-resolved graphene transfer via engineered strain layers", ***Science,*** Vol. 342, 833 (2013)

48. Seong-Uk Yang, Seung-Ha Choi, Jongtaek Lee, **Jeehwan Kim**, Woo-Shik Jung, Hyun-Yong Yu, Yonghan Roh, Jin-Hong Park, "Depth-Controllable Ultra Shallow Indium Gallium Zinc Oxide/Gallium Arsenide Hetero Junction Diode", ***Journal of Alloys and Compounds***, Vol. 561, 228 (2013)

49. **Jeehwan Kim***, Augustin Hong, Bhupesh Chandra, George Tulevski, and Devendra K. Sadana, "Engineering of contact resistance between transparent single-walled carbon nanotube films and a-Si:H single junction solar cells by gold nanodots", ***Advanced Materials,*** Vol. 24, 1899 (2012)

50. **Jeehwan Kim***, Augustin J. Hong, Jae-Woong Nah, Byungha Shin, Frances M. Ross, and Devendra K. Sadana, "Three-Dimensional a-Si:H Solar Cells on Glass Nanocone Arrays Patterned by Self-Assembled Sn Nanospheres", ***ACS Nano,*** Vol. 6, 265 (2012)

51. **Jeehwan Kim***, Stephen W Bedell, and Devendra Sadana, "Multiple implantation and multiple annealing of phosphorus doped germanium to achieve n-type activation near theoretical limit" ***Applied Physics Letters,*** Vol. 101, 112107 (2012)

52. **Jeehwan Kim***, Ahmed Abou-Kandil, Augustin J. Hong, Mohamed Saad, Devendra K. Sadana, and Tze-Chiang Chen, "Efficiency Enhancement of a-Si:H single junction solar cells by a-Ge:H incorporation at the p-type a- SiC:H/transparent conducting oxide interface", ***Applied Physics Letters,*** Vol. 99, 062102 (2011)

53. **Jeehwan Kim***, Stephen W. Bedell, and Devendra K. Sadana , "Improved germanium n+/p diodes formed by coimplantation of antimony and phosphorus", ***Applied Physics Letters,*** Vol. 98, 082112 (2011)

54. Osama Tobail, **Jeehwan Kim**, and Devendra Sadana, "Method to Determine the Collection Length in Field-Driven a-$Si_{1-x}Ge_x$:H Solar Cells", ***Energy Procedia***, Vol. 10, 213 (2011)

55. **Jeehwan Kim***, Ahmed Abou-Kandil, Keith Fogel, Harold Hovel, and Devendra K Sadana "The role of high work-function metallic nanodots on the performance of a-Si:H solar cells : Offering ohmic contacts to light trapping", ***ACS Nano,*** Vol. 4, 7331 (2010)

56. **Jeehwan Kim***, Daniel Inns, Keith Fogel, and Devendra K. Sadana, "Surface texturing of single-crystalline silicon solar cells using low density SiO_2 films as an anisotropic etch mask", ***Solar Energy Materials and Solar Cells,*** Vol. 94, 2091 (2010)

57. **Jeehwan Kim***, Daniel Inns, and Devendra K. Sadana, "Investigation on critical failure thickness of hydrogenated/non-hydrogenated amorphous silicon films", ***Journal of Applied Physics,*** Vol. 107, 073507 (2010)

58. **Jeehwan Kim***, Stephen W. Bedell, Siegfried Maurer, Rainer Loesing, and Devendra K. Sadana, "Activation of implanted n-type dopants in Ge over the active concentration of 1×10^{20} cm^{-3} using co-implantation of Sb and P", ***Electrochemical and Solid-state Letters***, Vol 13, H12 (2010)

59. **Jeehwan Kim***, Daniel Inns, and Devendra K. Sadana, "Cracking behavior of evaporated amorphous silicon films", ***Thin Solid Films***, Vol. 518, 4908 (2010)

60. **Jeehwan Kim***, Stephen Bedell, Devendra Sadana, "> 10^{20} cm^{-3} n-doping in Ge by Sb/P Co-implants: n+/p Diodes with

Improved Rectification", ***ECS Transactions***, Vol 33, 201 (2010)

61. **Jeehwan Kim***, Jae Young Lee, and Ya-Hong Xie, "Fabrication of dislocation-free Si films under uniaxial tension via oxidation of porous Si substrates", ***Thin Solid Films***, Vol 516, 7599 (2008)

62. J. Liu, T. M. Lu, **J. Kim**, K. Lai, D. C. Tsui, and Y. H. Xie, "The proximity effect of the regrowth interface on two-dimensional electron density in strained Si", ***Applied Physics Letters***, Vol 92, 112113 (2008)

63. J. Liu, **J.H. Kim**, Y.H. Xie, T.M. Lu, and K. Lai, "Epitaxial growth of two-dimensional electron gas (2DEG) in strained silicon for research on ultra-low energy electronic processes", ***Thin Solid Films***, Vol 517, 45 (2008)

64. **Jeehwan Kim***, Biyun Li, and Ya-Hong Xie, "A method for fabricating dislocation-free tensile-strained SiGe films via the oxidation of porous Si substrates", ***Applied Physics Letters***, Vol 91, 252108 (2007)

65. T. M. Lu, J. Liu, **J. Kim**, K. Lai, D. C. Tsui, and Y. H. Xie, "Capacitively induced high mobility two-dimensional electron gas in undoped $Si/Si_{1-x}Ge_x$ heterostructures with atomic-layer-deposited dielectric", ***Applied Physics Letters***, Vol 90, 182114 (2007)

66. **Jeehwan Kim*** and Ya-Hong Xie, "The fabrication of dislocation-free tensile strained Si thin films using controllably oxidized porous Si substrates", ***Applied Physics Letters***, Vol 89, 152117 (2006)

67. Z. M. Zhao, T. S. Yoon, W. Feng, B.Y. Li, **J. H. Kim**, J. Liu, O. Hulko, Y. H. Xie, H. M. Kim, K. B. Kim, H. J. Kim, K. L. Wang, C. Ratsch, R. Caflisch, D. Y. Ryu, and T. P. Russell, "The challenges in guided self-assembly of Ge and InAs quantum dots on Si", ***Thin Solid Films***, Vol 508, No.1, 195 (2006)

Selected US Patents, Master Inventor of IBM (> 200 Issued US patents)

1	10,115,894	Apparatus and methods for electrical switching
2	10,056,510	Cone-shaped holes for high efficiency thin film solar cells
3	10,056,251	Hetero-integration of III-N material on silicon
4	10,043,920	Highly responsive III-V photodetectors using ZnO:Al as n-type emitter
5	10,038,057	Junction interlayer dielectric for reducing leakage current in semiconductor devices
6	10,008,625	Atomic layer deposition for photovoltaic devices
7	10,002,929	Reduction of defect induced leakage in III-V semiconductor devices
8	9,991,417	Resonant cavity strained III-V photodetector and LED on silicon substrate
9	9,991,113	Systems and methods for fabricating single-crystalline diamond membranes
10	9,960,830	Method and apparatus for managing beam in beamforming system
11	9,947,533	Selective epitaxy using epitaxy-prevention layers
12	9,947,529	Porous fin as compliant medium to form dislocation-free heteroepitaxial films
13	9,935,215	Transparent conductive electrode for three dimensional photovoltaic device
14	9,929,060	Porous silicon relaxation medium for dislocation free CMOS devices
15	9,917,220	Buffer layer for high performing and low light degraded solar cells
16	9,917,215	Double layered transparent conductive oxide for reduced schottky barrier in photovoltaic devices
17	9,917,021	Porous silicon relaxation medium for dislocation free CMOS devices
18	9,916,984	Self-aligned source and drain regions for semiconductor devices
19	9,911,888	Photovoltaic device having layer with varying crystallinity
20	9,905,637	Reduction of defect induced leakage in III-V semiconductor devices
21	9,887,265	MOSFET with ultra low drain leakage
22	9,876,129	Cone-shaped holes for high efficiency thin film solar cells
23	9,865,520	Tunable semiconductor band gap reduction by strained sidewall passivation
24	9,865,509	FinFET CMOS with Si NFET and SiGe PFET
25	9,818,909	LED light extraction enhancement enabled using self-assembled particles patterned surface
26	9,818,901	Wafer bonded solar cells and fabrication methods
27	9,806,211	Tandem solar cell with improved absorption material
28	9,799,792	Substrate-free thin-film flexible photovoltaic device and fabrication method
29	9,799,747	Low resistance contact for semiconductor devices
30	9,786,756	Self-aligned source and drain regions for semiconductor devices
31	9,768,254	Leakage-free implantation-free ETSOI transistors
32	9,748,412	Highly responsive III-V photodetectors using ZnO:Al as N-type emitter
33	9,741,890	Protective insulating layer and chemical mechanical polishing for polycrystalline thin film solar cells
34	9,741,880	Three-dimensional conductive electrode for solar cell
35	9,722,120	Bandgap grading of CZTS solar cell
36	9,722,033	Doped zinc oxide as n+ layer for semiconductor devices
37	9,716,207	Low reflection electrode for photovoltaic devices
38	9,716,195	Dry etch method for texturing silicon and device
39	9,712,296	Hybrid zero-forcing beamforming method and apparatus
40	9,705,575	Advanced feedback and reference signal transmissions for MIMO wireless communication systems
41	9,691,847	Self-formation of high-density arrays of nanostructures
42	9,673,290	Self-aligned source and drain regions for semiconductor devices
43	9,666,674	Formation of large scale single crystalline graphene
44	9,660,116	Nanowires formed by employing solder nanodots
45	9,653,570	Junction interlayer dielectric for reducing leakage current in semiconductor devices
46	9,646,832	Porous fin as compliant medium to form dislocation-free heteroepitaxial films
47	9,634,164	Reduced light degradation due to low power deposition of buffer layer

48	9,620,592	Doped zinc oxide and n-doping to reduce junction leakage
49	9,607,952	High-z oxide nanoparticles embedded in semiconductor package
50	9,601,583	Hetero-integration of III-N material on silicon
51	9,583,562	Reduction of defect induced leakage in III-V semiconductor devices
52	9,577,196	Optoelectronics integration by transfer process
53	9,574,287	Gallium nitride material and device deposition on graphene terminated wafer and method of forming the same
54	9,559,120	Porous silicon relaxation medium for dislocation free CMOS devices
55	9,537,038	Solar cell made using a barrier layer between P-type and intrinsic layers
56	9,536,945	MOSFET with ultra low drain leakage
57	9,530,643	Selective epitaxy using epitaxy-prevention layers
58	9,515,215	Efficiency restoration in a photovoltaic cell
59	9,490,455	LED light extraction enhancement enabled using self-assembled particles patterned surface
60	9,484,347	FinFET CMOS with Si NFET and SiGe PFET
61	9,459,797	Uniformly distributed self-assembled cone-shaped pillars for high efficiency solar cells
62	9,443,997	Hybrid CZTSSe photovoltaic device
63	9,443,957	Self-aligned source and drain regions for semiconductor devices
64	9,418,870	Silicon germanium-on-insulator formation by thermal mixing
65	9,401,397	Reduction of defect induced leakage in III-V semiconductor devices
66	9,394,178	Wafer scale epitaxial graphene transfer
67	9,379,259	Double layered transparent conductive oxide for reduced schottky barrier in photovoltaic devices
68	9,337,436	Transferable transparent conductive oxide
69	9,337,274	Formation of large scale single crystalline graphene
70	9,331,220	Three-dimensional conductive electrode for solar cell
71	9,324,813	Doped zinc oxide as N.sup.+ layer for semiconductor devices
72	9,324,794	Self-formation of high-density arrays of nanostructures
73	9,324,566	Controlled spalling using a reactive material stack
74	9,318,641	Nanowires formed by employing solder nanodots
75	9,312,132	Method of forming high-density arrays of nanostructures
76	9,306,107	Buffer layer for high performing and low light degraded solar cells
77	9,231,133	Nanowires formed by employing solder nanodots
78	9,214,577	Reduced light degradation due to low power deposition of buffer layer
79	9,203,022	Resistive random access memory devices with extremely reactive contacts
80	9,190,549	Solar cell made using a barrier layer between p-type and intrinsic layers
81	9,153,729	Atomic layer deposition for photovoltaic devices
82	9,123,842	Photoreceptor with improved blocking layer
83	9,123,838	Transparent conductive electrode for three dimensional photovoltaic device
84	9,105,854	Transferable transparent conductive oxide
85	9,105,805	Enhancing efficiency in solar cells by adjusting deposition power
86	9,099,664	Transferable transparent conductive oxide
87	9,096,050	Wafer scale epitaxial graphene transfer
88	9,093,290	Self-formation of high-density arrays of nanostructures
89	9,070,617	Reduced S/D contact resistance of III-V mosfet using low temperature metal-induced crystallization of n+ Ge
90	9,059,272	Self-aligned III-V MOSFET fabrication with in-situ III-V epitaxy and in-situ metal epitaxy and contact formation
91	9,059,271	Self-aligned III-V MOSFET fabrication with in-situ III-V epitaxy and in-situ metal epitaxy and contact formation
92	9,059,013	Self-formation of high-density arrays of nanostructures
93	9,040,428	Formation of metal nanospheres and microspheres

94	9,040,340	Temperature grading for band gap engineering of photovoltaic devices
95	9,035,282	Formation of large scale single crystalline graphene
96	8,933,456	Germanium-containing release layer for transfer of a silicon layer to a substrate
97	8,927,857	Silicon: hydrogen photovoltaic devices, such as solar cells, having reduced light induced degradation and method of making such devices
98	8,916,451	Thin film wafer transfer and structure for electronic devices
99	8,916,409	Photovoltaic device using nano-spheres for textured electrodes
100	8,901,695	High efficiency solar cells fabricated by inexpensive PECVD
101	10,249,737	Silicon germanium-on-insulator formation by thermal mixing
102	10,230,015	Temperature grading for band gap engineering of photovoltaic devices
103	10,230,010	Three-dimensional conductive electrode for solar cell
104	10,229,857	Porous silicon relaxation medium for dislocation free CMOS devices
105	10,204,836	Porous silicon relaxation medium for dislocation free CMOS devices
106	10,177,269	Controllable indium doping for high efficiency CZTS thin-film solar cells
107	10,170,372	FINFET CMOS with Si NFET and SiGe PFET
108	10,164,014	MOSFET with ultra low drain leakage
109	10,157,993	Low resistance contact for semiconductor devices
110	10,141,986	Method and apparatus for transmitting and receiving signal through beamforming in communication system
111	10,121,920	Aluminum-doped zinc oxysulfide emitters for enhancing efficiency of chalcogenide solar cell

Selected Keynote/Plenary/Tutorial Talks

1. **Plenary** “Seamless wafer-free monolithic 3D integration enabled by confined growth and remote epitaxy” **Advanced epitaxy for freestanding membranes,** Tokyo, Japan, **2024**
2. **Plenary** “Perspectives of TMD-based electronics”, **2DTMD,** Cambridge, UK **2023**
3. **Keynote** “Innovations for saving future of electronics”, **GCIM2023**
4. **Plenary** “Innovations for saving future of electronics: Wafer-free 3D integration a.k.a “monolithic 3D (M3D)” **Advanced epitaxy for freestanding membranes,** Seoul, Korea **2023**
5. **Plenary** “Innovations for saving future of electronics: Wafer-free 3D integration a.k.a “monolithic 3D (M3D)” **Graphene Korea, 2023**
6. **Tutorial** “Advanced Heterogeneous Integration Enabled by Freestanding Membranes”, **MRS Fall** 2022
7. **- From Material Growths to Applications Plenary** “2D materials for UV application”, **IWUMD2023**, France
8. **Keynote** “Wafer-free Heterogeneous Integration for next generation electronics”, **CSW2023**
9. **Keynote** “2D material transfer challenges on a wafer scale”, **Graphene Flagship 2022**
10. **Plenary** “Challenges and Opportunities in 2D Material-based Layer Transfer”**, Advanced epitaxy for freestanding membranes, MIT 2022**
11. **Keynote** "Remote epitaxy and large scale heterostructures" **Graphene 2022**
12. **Keynote** “Challenges and Opportunities in 2D Material-based Layer Transfer”**, Advanced epitaxy for freestanding membranes, ENGE 2022**
13. **Short Course**, “Material Strategies for Memristor-based AI Hardware and Their Heterointegration”, **IEDM 2021**
14. **Tutorial**, “Opportunity and challenges: Remote epitaxy”, **MRS Fall 2021**
15. **Plenary**, "Challenges and opportunities in remote epitaxy", **CS MANTECH 2021**
16. **Plenary**, "Stackable Electronics Enabled by Remote Epitaxy” **International Workshop on Epitaxy on 2D materials, MIT 2021**
17. **Keynote** "Mixed-dimensional stackable electronics enabled by freestanding 2D/3D materials" **Graphene 2020 (US)**, 2020
18. **Keynote** "Mixed-dimensional stackable electronics enabled by freestanding 2D/3D materials" **Graphene 2020 (Europe),** 2020
19. **Keynote “**Mixed-dimensional stackable electronics enabled by freestanding 2D/3D materials” **ENGE 2020**
20. **Plenary** "Opportunities and challenges in 2D material-based layer transfer (2DLT)", **Global photovoltaic conference**, Korea, 2019
21. **Plenary** "Remote epitaxy of compound semiconductors by MOCVD and its applications", **European Workshop on Metal-Organic Vapour Phase Epitaxy**, 2019
22. **Plenary Talk**, “Remote epitaxy of compound semiconductors and it applications”, **European Workshop on MOVPE** Lithuania, 2018
23. **Keynote Talk**, “New epitaxy paradigm: Remote epitaxy for 2D material-based layer transfer”, **Nanopia** Korea, 2018
24. **Plenary talk**, Korea “New Paradigm of Resistive Memory that can Enable Large-Scale Neuromorphic Computing” **IUMRS** 2018
25. **Plenary Talk**, Korea “New strategy for recycling wafers: 2D material-based layer transfer (2DLT)” **GPVC** 2018