Jeehwan Kim

Associate Professor of Mechanical Engineering and Materials Science
Associate Editor of Science Advances

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Projects

Artificial heterostructures (3D integration)

- Freestanding membranes of III-V/III-N/Complex oxides (DARPA/DOE/AFRL)
- Wafer-scale single-crystalline 2D material heterostructures (Intel/NSF)
- 3D complex oxide heterostructures
- 3D stacking of various freestanding single-crystalline membranes for multifunctional ubiquitous electronics (LG)
- Self-powered sensor network (IoT) system (Shell)

Bio-inspired neuromorphic computing

- Single-crystalline based resistive memory system (IBM)
- 3D artificial neural network hardware (Samsung)
- Artificial neural network arrays for online training/inference (NSF)
- Insect-inspired artificial neural network hardware (ROHM)

Bio-Electronic Interface

- Skin sensor arrays for health monitoring (Amore Pacific)
- Implantable electronics for brain mapping (NSF)
- Electronic skin-based controller-free AR/VR motion tracker (NCSOFT)

Renewable energy, Energy storage

- Wafer recycling technique for GaAs solar cells based on remote epitaxy (DOE)
- High efficiency III-V multi-junction solar cells based on remote epitaxy (AFRL)
- Single-crystalline all solid-state battery (Samsung)

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

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 (Without tenure)	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

Award

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

Services

Internal

Organizer of MIT's Micro-Nano Seminar, Graduate Admission Committee, Organizer of MIT Workshop on AI Hardware

External

Associate Editor of Science Advances, Organizer of Materials Research Society 2020 for two symposiums, Session Chair of Materials Research Society 2016-2019, Session Lead of Gordon Conference 2018, Organizer of Compound Semiconductor Week 2018, Committee of IEEE Electron Device Society 2015-2019, Committee of The International Conference on Silicon Epitaxy and Hetero-structures 2010-2014, Committee of The International Society for Optics and Photonics 2014

Journal referee

Nature, Nature Materials, Nature Nanotechnology, Nature Communications, Science Advances, Advanced Materials, Advanced Energy Materials, Nano Letters, ACS Nano, Scientific Reports, Small, Nanoscale, Applied Physics Letters, Journal of Materials Chemistry A, IEEE Electron Device Letters, IEEE transactions on Nanotechnologies, Journal of Electrochemical Society, Organic Electronics

List of Publications

Journal Papers (*corresponding author)

1. 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)

2. 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)

3. 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)

4. 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

5. 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)

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

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

8. Luozheng Zhang, Xianyong Zhou, Jiaming Xie, Shi Chen, Sang-Hoon Bae, Jeehwan Kim, and Baomin Xu, "Conjugated polyelectrolyte with potassium cations enables inverted perovskite solar cells with an efficiency over 20%", ***Journal of Materials Chemistry A***, Vol. 8, 8238 (2020)

9. 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)

10. 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*

11. 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)

12. 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)

13. 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)

14. 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)

15. 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)

16. 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)

14. 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*

15. 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*

16. 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)

17. 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)

18. 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)

19. 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)

20. 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)

21. **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)

22. **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)

23. **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)

24. **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*

25. 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)

26. 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)

27. 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)

28. **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)

29. 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)

30. **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)

31. **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)

32. **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)

33. **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)

34. **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)

35. 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)

36. **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)

37. **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)

38. **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)

39. **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)

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

41. **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)

42. **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)

43. 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)

44. 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)

45. **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)

46. 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)

47. **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)

48. 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 US patents: 122 Issued, 87 pending)

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 Invited Talks

1. **Plenary Talk**, "Challenges and opportunities in remote epitaxy", **CS MANTECH 2021**
2. **Plenary Talk**, "Stackable Electronics Enabled by Remote Epitaxy" **International Workshop on Epitaxy on 2D materials, MIT 2021**
3. "Stackable electronics enabled by freestanding 2D/3D materials", **University of Virginia 2021**
4. "1R neuromorphic computing array by confinement strategy and its application for reconfigurable edge computing", **Hong Kong Polytechnic University 2021**
5. "Material Innovations for next generation electronics", **Seoul National University, Korea 2021**
6. "Material Innovations for next generation electronics", **Samsung Electronics, Korea 2021**
7. **Keynote talk** "Mixed-dimensional stackable electronics enabled by freestanding 2D/3D materials" **Graphene 2020 (US)**, 2020
8. **Keynote talk** "Mixed-dimensional stackable electronics enabled by freestanding 2D/3D materials" **Graphene 2020 (Europe),** 2020
9. "Neuromorphic Materials and Devices for Bio-inspired Computing and Artificial Intelligence" **MRS Spring 2019**, Phoenix, AZ, 2019
10. **Plenary Talk** "Opportunities and challenges in 2D material-based layer transfer (2DLT)", **Global photovoltaic conference**, Korea, 2019
11. "Driving Advances in Neuromorphic Computers", **NSF workshop**, 2019
12. Material challenges and opportunities in next generation electronics, Department Colloquium, **Northwestern University**, 2019
13. Material challenges and opportunities in next generation electronics, **LAM Research**, CA, 2019
14. "Material challenges and opportunities in next generation electronics", **UC Berkeley**, 2019
15. "Vertical 3D RRAM Arrays", **Samsung SAIT**, Korea, 2019
16. "Remote epitaxy through graphene for producing wafer-scale freestanding 3D and 2D materials", **Seoul National University Physics colloquium**, 2019
17. "Material challenges and opportunities in next generation electronics", **Stanford University**2019
18. "Challenges and opportunities in resistive memory-based AI hardware", **MIT Quest**, 2019
19. "Manufacturing of wafer-scale freestanding 3D and 2D materials for advanced mixed heterostructures", **NSF 2D Crystal Consortium-Materials Innovation Platform**,2019
20. **Plenary Talk** "Remote epitaxy of compound semiconductors by MOCVD and its applications", **European Workshop on Metal-Organic Vapour Phase Epitaxy**, 2019
21. "Material challenges and opportunities in next generation electronics", **Google**, CA, 2019
22. "Material challenges and opportunities in next generation electronics", HKUST, Hong Kong 2019
23. "Material challenges and opportunities in next generation electronics" KAUST, Saudi Arabia 2019
24. "Epitaxial neuromorphic computing arrays for controllable switching", Memrisys, Germany 2019
25. "Remote epitaxy could enable dislocation-free GaN freestanding membranes", OSRAM, Germany 2019
26. "Strategies to precisely control synaptic weights for neuromorphic computing arrays", Nature Publishing Group Conference on neuromorphic computing 2019
27. "Wafer-scale 2D-3D mixed heterostructures enabled by remote epitaxy through graphene", Georgia Tech 2019
28. **European Workshop on MOVPE (Plenary)**, "Remote epitaxy of compound semiconductors and it applications", Lithuania, 2018
29. **UC Berkeley**, "Material challenges and opportunities in next generation electronics", Berkeley, CA 2019
30. **LAM Research**, "Material challenges and opportunities in next generation electronics", Fremont, CA 2019
31. **Northwestern University**, "Material challenges and opportunities in next generation electronics", Evanston, IL, 2019
32. **KAUST**, "Material challenges and opportunities in next generation electronics", Saudi Arabia 2018
33. **MRS Fall**, "2D Material-Based Layer Transfer to Revolutionize Photovoltaic Energy Generation", Boston, 2018
34. **Nature** London headquarter office, "Nanoelectronics Group at MIT" 2018
35. **Nanopia (Keynote)**, "New epitaxy paradigm: Remote epitaxy for 2D material-based layer transfer", Korea, 2018
36. **Low Dimensional Materials for Optoelectronics** "Manufacturing of wafer-scale freestanding 3D and 2D materials with atomic precision control", Shenzhen, China 2018
37. **University of Michigan** "Material challenges and opportunities in next generation electronics", 2018
38. **Michigan State University** "Material challenges and opportunities in next generation electronics", 2018
39. **IUMRS (Plenary)**, Korea "New Paradigm of Resistive Memory that can Enable Large-Scale Neuromorphic Computing" 2018
40. **Stanford University** "New Paradigm of Resistive Memory that can Enable Large-Scale Neuromorphic Computing" 2018
41. **University of California, Berkeley** "III-V epitaxy for low energy optoelectronics", 2018
42. **Stevens Institute of Technology** "Material challenges and opportunities in next generation electronics" 2018
43. **GPVC (Plenary)**, Korea "New strategy for recycling wafers: 2D material-based layer transfer (2DLT)" 2018
44. **ETRI**, Korea "Material challenges and opportunities in next generation electronics" 2018

45. **KAIST** “Material challenges and opportunities in next generation electronics” 2018
46. **SKKU** “Material challenges and opportunities in next generation electronics” 2018
47. **Amore Pacific**, “Ultrasensitive electronic skin sensor system” 2018
48. **Samsung Electronics** “New Paradigm of Resistive Memory that can Enable Large-Scale Neuromorphic Computing” 2018
49. **ICFO**, Barcelona, Spain, “2D material-based layer transfer and its applications for wafer-scale 2D/3D heterostructures”, 2018
50. **UKC**, New York “New paradigm of resistive memory that can enable large-scale neuromorphic computing”, Shenzhen, China, 2018
51. **Gordon Conference** “2D Heterostructure Assembly”, Massachusetts, MA, 2018
52. **Harvard University** “Material challenges and opportunities in next generation electronics: From non-silicon electronics to artificial neural network”, 2018
53. **Hong Kong Polytechnic University** “Material challenges and opportunities in next generation electronics: From non-silicon electronics to artificial neural network”, 2018
54. **Huawei** “New paradigm of resistive memory that can enable large-scale neuromorphic computing”, Shenzhen, China, 2018
55. **Boston University** “Material challenges and opportunities in next generation electronics: From non-silicon electronics to artificial neural network”, 2018
56. **Naval Research Laboratory** “Material challenges and opportunities in next generation electronics: From non-silicon electronics to artificial neural network”, 2018
57. **Lawrence Epitaxy conference** “Material challenges and opportunities in next generation electronics” 2018
58. **MRS Fall** “Uniform epitaxial SiGe memory by one dimensional filament confinement for large-scale synaptic arrays”, Boston, 2017
59. **MIT Mechanical Engineering Colloquium**, “Material challenges and opportunities in next generation electronics: From non-silicon electronics to artificial neural network”, 2017
60. **Hynix** “New paradigm of resistive memory that can enable large-scale neuromorphic computing”, Ichon, Korea, 2018
61. **Tsinghua University** “2D material-based layer transfer based on remote epitaxy & uniform epitaxial RAM towards large-scale neuromorphic arrays”, 2017
62. **University of California, Berkeley** “2D material-based layer transfer based on remote epitaxy & uniform epitaxial RAM towards large-scale neuromorphic arrays”, 2017
63. **Stanford University** “2D material-based layer transfer based on remote epitaxy & uniform epitaxial RAM towards large-scale neuromorphic arrays”, 2017
64. **University of California, Santa Barbara** “2D material-based layer transfer based on remote epitaxy & uniform epitaxial RAM towards large-scale neuromorphic arrays”, 2017
65. **University of Illinois, Urbana-Champaign** “2D material-based layer transfer based on remote epitaxy & uniform epitaxial RAM towards large-scale neuromorphic arrays”, 2017
66. **University of Massachusetts, Amherst** “Innovation in epitaxy still required for next generation computing”, 2017
67. **2D Electronic Materials Symposium** “Remote epitaxy through graphene” Santa Fe, NM, 2017
68. **ECS**, “Recent Advance in graphene-based layer transfer”, New Orleans, LA, 2017
69. **TMS**, “Recent Advance in graphene-based layer transfer”, San Diego, CA, 2017
70. **Semicon Korea**, “Graphene-based layer transfer”, Seoul, 2017
71. **MIT-Japan conference**, “Extremely cost-effective semiconductor layer transfer & Advanced epitaxial RAM”, Tokyo, 2017
72. **MRS** Fall, “Recent Advance in graphene-based layer transfer”, Boston, 2016
73. **Samsung**, “Advanced ReRAM for neuromorphic computing”, Seoul, Korea, 2016
74. **Seoul National University**, “Nanoelectronics Group at MIT”, Seoul, Korea, 2016
75. **KAIST**, “Nanoelectronics Group at MIT”, Daejon, Korea, 2016
76. **Hynix**, “Nanoelectronics Group at MIT”, Ichon, Korea, 2016
77. **LG Electronics**, “Graphene-based layer transfer for low-cost, high-throughput, high-efficiency solar cells”, Seoul, Korea, 2015
78. **Lincoln Laboratory**, “Single-crystalline graphene and its application for semiconductor layer transfers”, 2015
79. **NASA Jet Propulsion Laboratory**, “Single-crystalline graphene and its application for semiconductor layer transfers”, Los Angeles, 2015
80. **SKKU**, “Single-crystalline graphene and its application for semiconductor layer transfers, Seoul, Korea, 2015
81. **Yale University**, “Nanotechnology for Photovoltaics: Strategies for scalable manufacturing of efficient solar cells”, Energy Science Institute, 2015
82. **MIT**, "Atomic-precision control of nanoscale materials via strain engineering towards scalable manufacturing", 2015
83. **Harvard University**, "Material innovations for nanoelectronics: Atomic-precision control of two-dimensional materials", School of Engineering and Applied Science, 2015
84. **University of Illinois, Urbana-Champaign**, "Atomic-Precision Control of Single-Crystalline 2D Materials & Design Principles of 3D PV Architectures", Electrical and Computer Engineering , 2014

85. **UC Berkeley**, “Atomic-precision Control of Single-crystalline 2D Materials & Recent Progress on Thin Film PV in IBM”, Electrical Engineering, 2014
86. **Yale University**, “Atomic-precision Control of Single-crystalline 2D Materials & Recent Progress on Thin Film PV in IBM”, Yale Institute for Nanoscience and Quantum Engineering, 2014
87. **Caltech**, “Wafer-scale Single-crystalline Graphene & High-aspect Ratio Three-dimensional PV”, Applied Physics and Materials Science, 2014
88. **UCLA**, “Wafer-scale Single-crystalline Graphene and Its applications”, Department of Materials Science and Engineering, 2014
89. **UC Santa Barbara**, “Atomic-precision Control of Two-dimensional Materials & Design Principles of Three-dimensional PV Architectures”, Materials Department, 2014
90. **MIT**, “Atomic-precision Control of Two-dimensional Materials & Design Principles of Three-dimensional PV Architectures”, Department of Materials Science and Engineering, 2014
91. **SPIE**, “Nanocone-based three dimensional thin film silicon solar cells” San Diego, CA, 2012
92. **UCLA**, “Nanostructured 3D Solar cells”, Department of Materials Science and Engineering, 2012
93. **Sungkyunkwan University**, “Nanocone-based three dimensional thin film silicon solar cells”, Department of Electrical Engineering,
Korea, 2012
94. **Optical Society of America**, “Role of Nanostructures on the Performance of a-Si:H Solar Cells”, Austin, TX, 2011
95. **École Polytechnique Fédérale de Lausanne (EPFL)**, “Effect of Work-Function Engineering of p+/TCO interface on the Performance of a-Si:H Solar Cell”, IMT, Switzerland, 2011
96. **Seoul National University**, “The role of high work-function metallic nanodots on the performance of amorphous silicon solar cells”, Department of Materials Science and Engineering, Korea, 2010
97. **KAIST**, “Plasmonics in thin film solar cells”, Department of Electrical Engineering, Korea, 2010
98. **UCLA**, Solar cell and Advanced CMOS research in IBM”, Department of Materials Science and Engineering, 2010
99. **Hongik University**, “Plasmonics in thin film solar cells”, Department of Materials Science & Engineering, Korea, 2010