Joon-Seok "Jason" KIM

Postdoctoral Researcher

#3087, Cook Hall, 2220 Campus Drive
Northwestern University, Evanston, IL 60208
+1 (512) 658-9969
joonseok.kim@northwestern.edu
www.joonseok.kim

Research Interest

Material Characterization & Strain Engineering.

Device Nanofabrication.

Two-Dimensional Materials & Mixed-Dimensional Materials.

Education

Aug 2018 **Ph.D.**, *The University of Texas at Austin*, Austin, TX, USA.
Department of Electrical and Computer Engineering
Dissertation Title: "*Optoelectronic, Structural, and Topological Properties of van der Waals Layered Materials Under Extreme Conditions*"

May 2016 **M.S.E.**, *The University of Texas at Austin*, Austin, TX, USA.
Department of Electrical and Computer Engineering
Solid State Electronics (GPA: 3.87/4.0)

Aug 2013 **B.S.**, *Seoul National University*, Seoul, Korea.
Department of Electrical and Computer Engineering, (3.65/4.3; *Cum Laude*)

Experience

Research Experience

Sept 2018 - *(present)* **Postdoctoral Researcher**, Northwestern University.
- Advisor: Prof. Lincoln J. Lauhon
- Strain engineering of mixed-dimensional materials.

Jan 2014 – Aug 2018 **Graduate Research Assistant**, The University of Texas at Austin.
- Advisor: Prof. Deji Akinwande (Electrical and Computer Engineering)
- Co-advisor: Prof. Jung-Fu "Afu" Lin (Geological Sciences; Materials Sciences & Engineering)
- Characterized opto-electronic, phononic, crystallographic properties, and phase transitions of two-dimensional (2D) materials and topological insulators (TIs) under hydrostatic pressure and/or laterally strained conditions:
  - Analyzed structural & electronic phase transitions of Bi-Sb-Te-Se topological insulator, and revealed the relationship between crystal structure and topological surfsce state. Suggested strain-tuning of surface topological states without crystal structure transition.
  - Experimentally confirmed the pressure-induced phase transition of WTe_2, which agrees well with the theoretical predictions and the onset of the superconductivity.
  - Reported disorder-activated inter-layer Raman peaks in $Mo_{0.5}W_{0.5}S_2$ under elevated pressure, indicating dramatically increased inter-layer interaction between the van der Waals layers.
  - Investigated band gap and band edge evolution as a function of compressive strain and composition of monolayer $Mo_{1-x}W_xS_2$. Proposed a novel device mechanism using strain to modulate the band offsets.
  - Explored polarized Raman spectroscopy of low-symmetry 2D materials under lateral strain condition, using flexible substate structure.

- Fabricated, measured & characterized 2D materials-based devices to investigate chemical, electronic, and structural degradation of air-sensitive materials:
  - Developed an efficient encapsulation method for phosphorene devices to enhance the stability of devices to >1 year, which opened up a possibility of the long-term stability & reliability analyses of the material for the first time.
  - Fabricated Polyimide (PI) polymer substrate to fabricate flexible devices.
- Developed and optimized chemical vapor deposition (CVD) method for large-area growth of transition metal dichalcogenides (TMDs):
  - Synthesized large-area monolayer WS_2 with excellent crystal quality and transport properties, using powder WO_x and sulfur precursors.
  - Synthesized large-area monolayer $MoSe_2$ using MoO_3 and diethyl selenide precursor, and investigated controlled sulfurization into MoS_2 monolayer.

Jul – Dec 2012 **Undergraduate Research Assistant**, Seoul National University, Korea, Micro Sensors and Actuators Lab.
- Advisor: Prof. Yong-Kweon Kim
- Developed LabVIEW code and operated polydimethylsiloxane (PDMS)-based peristaltic micropumps & microvalves.

Jul – Aug 2008 **Undergraduate Research Assistant**, Seoul National University, Korea, National Creative Research Center for Plasmonics Application Systems.
- Advisor: Prof. Byoungho Lee
- Constructed super-resolution image capturing system for 3-D image acquisition application, using image scanner and view camera bellows.

Industry Experience

Aug 2009 – Jun 2012 **Software Test Engineer**, *PIOLINK, Inc.*, Korea.
- Served as Substitutionary Military Service
- Designed and executed software testing and quality control for network switches
- Developed test automation system for daily-build development tool.

Skills & Certifications

Research Skills

Fabrication E-beam lithography, Photo lithography, Chemical Vapor Deposition (CVD), Metal Deposition, Atomic Layer Deposition (ALD), Reactive Ion Etching (RIE)

Characterization Transmission electron microscopy (TEM), Scanning Electron Microscope(SEM), Raman spectroscopy, Photoluminescence (PL) spectroscopy, Conductive Atomic Force Microscopy (cAFM), Kelvin Probe Force Microscopy (KPFM), Energy-dispersive X-ray spectroscopy (EDX), Electrical transport measurement, Ellipsometry, X-ray Diffraction (XRD)

High-Pressure Diamond Anvil Cell (DAC) preparation & operation

Software Skills

Python, MATLAB, L-Edit, LaTeX, LabVIEW, SAS, PSpice, Multisim, C/C++, Java, TCL, Scheme

Language Skills

Korean (native), English (fluent)

Certifications

2016 **Introduction to Data Science in Python, Summer Statistics Institute 2016**, *Department of Statistics and Data Sciences, UT Austin*.

2011 **International Software Testing Qualifications Board**, *ISTQB*, Foundation Level.

Publications

1. **Joon-Seok Kim**, Rinkle Juneja, Nilesh P. Salke, Witold Palosz, Venkataraman Swaminathan, Sudhir Trivedi, Abhishek K. Singh, Deji Akinwande, and Jung-Fu Lin, **"Structural, Vibrational, and Electronic Topological Transitions of $Bi_{1.5}Sb_{0.5}Te_{1.8}Se_{1.2}$ under Pressure"**, *Journal of Applied Physics*, **123**, 115903 (2018)

2. **Joon-Seok Kim**, Rafia Ahmad, Tribhuwan Pandey, Amritesh Rai, Simin Feng, Jing Yang, Zhong Lin, Mauricio Terrones, Sanjay K. Banerjee, Abhishek K. Singh, Deji Akinwande, Jung-Fu Lin, **"Towards Band Structure and Band Offset Engineering of Monolayer $Mo_{(1-x)}W_{(x)}S_2$ via Strain"**, *2D Materials*, **5**, 1 (2017) *(Media coverage by 2D Research)*

3. Yury Yuryevich Illarionov, Michael Waltl, Gerhard Rzepa, Theresia Knobloch, **Joon-Seok Kim**, Deji Akinwande, and Tibor Grasser, **"Highly-Stable Black Phosphorus Field-Effect Transistors with Low Density of Oxide Traps"**, *npj 2D Materials and Applications*, **1**, 23 (2017)

4. Ke Chen, Rudresh Ghosh, Xianghai Meng, Anupam Roy, **Joon-Seok Kim**, Feng He, Sarah C. Mason, Xiaochuan Xu, Jung-Fu Lin, Deji Akinwande, Sanjay K. Banerjee, and Yaguo Wang **"Experimental evidence of exciton capture by mid-gap defects in CVD grown monolayer $MoSe_2$"**, *npj 2D Materials and Applications*, **1**, 15 (2017) *(Media coverage by 2D Research)*

5. Yu Yu Illarionov, M Waltl, M Tech, **J-S Kim**, D Akinwande, T Grasser, **"Reliability of black phosphorus field-effect transistors with respect to bias-temperature and hot-carrier stress"**, *IEEE International Reliability Physics Symposium (IRPS)* (2017)

6. Yu Yu Illarionov, G Rzepa, M Waltl, T Knobloch, **J-S Kim**, D Akinwande, T Grasser, **"Accurate mapping of oxide traps in highly-stable black phosphorus FETs"**, *IEEE Electron Devices Technology and Manufacturing Conference (EDTM)* (2017)

7. Deji Akinwande, Christopher J. Brennan, J. Scott Bunch, Philip Egberts, Jonathan R. Felts, Huajian Gao, Rui Huang, **Joon-Seok Kim**, Teng Li, Yao Li, Kenneth M. Liechti, Nanshu Lu, Harold S. Park, Evan J. Reed, Peng Wang, Boris I. Yakobson, Teng Zhang, Yong-Wei Zhang,Yao Zhou, and Yong Zhu, **"A Review on Mechanics and Mechanical Properties of 2D Materials - Graphene and Beyond" (Review paper)**, *Extreme Mechanics Letters*, **13**, 47(2017)

8. Pengchao Lu,* **Joon-Seok Kim**,* Jing Yang, Hao Gao, Juefei Wu, Dexi Shao, Bin Li, DaWei Zhou, Jian Sun, Deji Akinwande, Jung-Fu Lin, Dingyu Xing, **"Origin of the Superconductivity of Weyl Semimetal WTe_2 under Pressure"**, *Physical Review B*, **94**, 224512 (2016)

9. Emily S. Walker, Seung Ryul Na, Daehwan Jung, Stephen D. March, **Joon-Seok Kim**, Tanuj Trivedi, Wei Li, Li Tao, Minjoo L. Lee, Kenneth M. Liechti, Deji Akinwande, and Seth R. Bank, **"Large-Area Dry Transfer of Single-Crystalline Epitaxial Bismuth Thin Films"**, *Nano Letters*, **16**, 11 (2016)

10. Yury Yuryevich Illarionov, Michael Waltl, Gerhard Rzepa, **Joon-Seok Kim**, Seohee Kim, Ananth Dodabalapur, Deji Akinwande, and Tibor Grasser, **"Long-term Stability and Reliability of Black Phosphorus Field-Effect Transistors"**, *ACS Nano*, **10**, 10 (2016)

11. Tribhuwan Pandey, Avinash P. Nayak, Jin Liu, Samuel T. Moran, **Joonseok Kim**, Lain-Jong Li, Jung-Fu Liu, Deji Akinwande, and Abhishek Singh, **"Pressure-Induced Charge Transfer Doping of Monolayer Graphene/MoS_2 Heterostructure"**, *Small*, **12**, 30 (2016)

12. **Joon-Seok Kim**, Samuel T. Moran, Avinash P. Nayak, Shahar Pedahzur, Itzel Ruiz, Gabriela Ponce, Daniela Rodriguez, Joanna Henny, Jin Liu, Jung-Fu Lin and Deji Akinwande, **"High Pressure Raman Study of Layered $Mo_{0.5}W_{0.5}S_2$ Ternary Compounds"**, *2D Materials*, **3**, 2 (2016)

13. Sandra H Aldave, Maruthi N Yogeesh, Weinan Zhu, **Joonseok Kim**, Sushant S Sonde, Avinash P Nayak and Deji Akinwande, **"Characterization and sonochemical synthesis of black phosphorus from red phosphorus"**, *2D Materials*, **3**, 1 (2016)

14. Cheng Tan, Yingnan Liu, Harry Chou, **Joon-Seok Kim**, Di Wu, Deji Akinwande, and Keji Lai, **"Laser-assisted Oxidation of Multi-layer Tungsten Diselenide Nanosheets"** *Applied Physics Letters*, **108**, 083112 (2016)

15. Rudresh Ghosh, **Joon-Seok Kim**, Anupam Roy, Harry Chou, Mary Vu, Sanjay Banerjee, and Deji Akinwande, **"Large area chemical vapor deposition growth of monolayer $MoSe_2$ and its controlled sulfurization to MoS_2"** *Journal of Materials Research*, **31**, 7 (2016)

16. Li Tao, Weinan Zhu, **Joon-Seok Kim**, and Deji Akinwande, **"(Invited) Silicene and Phosphorene: Progress on the Intriguing Case of Buckled Atomic Sheets"**, *ESSDERC* (2015)

17. Yingnan Liu, Cheng Tan, Harry Chou, Avinash Nayak, Di Wu, Rudresh Ghosh, Hsiao-Yu Chang, Yufeng Hao, Xiaohan Wang, **Joon-Seok Kim**, Richard Piner, Rodney S. Ruoff, Deji Akinwande, and Keji Lai, **"Thermal Oxidation of WSe_2 Nanosheets Adhered on SiO_2/Si Substrates"** *Nano Letters*, **15**, 8 (2015)

18. **Joon-Seok Kim**, Yingnan Liu, Weinan Zhu, Seohee Kim, Di Wu, Li Tao, Ananth Dodabalapur, Keji Lai and Deji Akinwande, **"Toward Air-Stable Multilayer Phosphorene Thin-Films and Transistors."** *Scientific Reports*, **5**, 8989 (2015)

19. Weinan Zhu, Maruthi N. Yogeesh, Shixuan Yang, Sandra H. Aldave, **Joon-Seok Kim**, Sushant Sonde, Li Tao, Nanshu Lu, and Deji Akinwande, **"Flexible Black Phosphorus Ambipolar Transistors, Circuits and AM Demodulator"** *Nano Letters*, **15**, 3 (2015)

Talks & Presentations

1. **J.-S. Kim**, R. Juneja, N.P. Salke, W. Palosz, V. Swaminathan, A. K. Singh, S. Trivedi, D. Akinwande, and J.-F. Lin, "Pressure-Induced Structural and Electronic Topological Transitions in $Bi_{1.5}Sb_{0.5}Te_{1.8}Se_{1.2}$ Alloy", *APS March meeting*, March 2018 (Oral)

2. **J.-S. Kim**, R. Ahmad, T. Pandey, J. Yang, A. Singh, D. Akinwande, J.-F. Lin, "Band Structure Modulation of Monolayer TMDs using Pressure", *COMPRES Annual Meeting*, July 2017 (Poster)

3. **J.-S. Kim**, R. Ahmad, T. Pandey, A. Rai, S. Feng, J. Yang, M. Terrones, S. Banerjee, A. Singh, D. Akinwande, J.-F. Lin, "Pressure and Composition Tuning of Optical Band Gap in Monolayer Transition Metal Dichalcogenides", *2017 MRS Spring Meeting*, April 2017 (Oral)

4. **J.-S. Kim**, T. Pandey, A. Nayak, A. Singh, D. Akinwande, J.-F. Lin, "Graphene and 2D materials in Extremes", *Deep Carbon Observatory Extreme Physics and Chemistry Workshop*, December 2016 (Poster)

5. **J.-S. Kim**, S. Moran, A. Nayak, J.-F. Lin, D. Akinwande, "Tuning the Properties of van der Waals 2D Materials by Applying Pressure ", *2016 IUCr High Pressure Workshop*, September 2016 (Oral; IUCr Young Scientist Award)

6. **J.-S. Kim**, J. Yang, A. Nayak, J. Liu, J. Wu, T. Yoshino, J.-F. Lin, and D. Akinwande, "Effects of Hydrostatic Pressure on Red and Black Phosphorus", *COMPRES Annual Meeting*, July 2015 (Poster)

7. **J.-S. Kim**, Y. Liu, W. Zhu, S. Kim, D. Wu, L. Tao, A. Dodabalapur, K. Lai, D. Akinwande, "Toward Air-Stable Multilayer Phosphorene Thin-Films and Transistors", *APS March meeting*, March 2015 (Oral)

8. **J.-S. Kim**, Y. Liu, W. Zhu, S. Kim, A. Dodabalapur, K. Lai, and D. Akinwande, "Effect of Capping Layer on Aging of Phosphorene Nanosheets", *SWAN Center Onsite Review*, September 2014 (Poster)

9. **J.-S. Kim**, Y. Liu, W. Zhu, D. Wu, K. Lai, and D. Akinwande, "Effect of Capping Layer on Aging of Phosphorene Nanosheets", *2D Technology Applications - International Exchange Meeting*, August 2014 (Poster)

Scholarships & Awards

May 2018 **Professional Development Award**, *UT Austin, Office of Graduate Studies*,
Travel support on presenting original research at a major professional meeting.

May 2017 **Professional Development Award**, *UT Austin, Office of Graduate Studies*,
Travel support on presenting original research at a major professional meeting.

Dec 2016 **IOP Publishing Reviewer Awards 2016**, *IOP Publishing*,
Journal of Physics: Condensed Matter Outstanding Reviewers of 2016,
Selected for quantity, timeliness and quality of their reviews in the year 2016.

Dec 2016 **Professional Development Award**, *UT Austin, Office of Graduate Studies*,
Travel support on presenting original research at a major professional meeting.

Sep 2016 **IUCr Young Scientist Award**,
International Union of Crystallography (IUCr), 2016 High Pressure Workshop,
Travel support for selected young scientists on presenting outstanding research.

Jun 2012 **Qualcomm IT Tour Awards**, *Qualcomm Inc.*,
Awarded for winning contest to suggest creative outlook of future devices. Granted travel support to Qualcomm HQ, and presented before then-CEO Paul E. Jacobs..

2006 **National Science and Technology Scholarship**, *National Research Foundation of Korea*,
4-year college tuition support based on excellence in Korean SAT.

Service

Referee

2016–Present *Physical Review B*

2016–Present *Nanotechnology*

2015–Present *Journal of Physics: Condensed Matter* (Awarded Outstanding Reviewers of 2016)

Others

Apr 2017 Symposium Session Assistant, 2017 MRS Spring Meeting

Summer 2015 Outreach Program. Led group of high school students to publish major journal paper

Personal History

PoB Seoul, South Korea

Citizenship South Korea; *Authorized for Employment in the U.S.A.*