Saban M. Hus

hussm@ornl.gov
Oak Ridge National Laboratory
P.O. Box 2008 MS-6487, Oak Ridge TN 37831
Phone: (865) 951 8517

Education

The University of Tennessee, Knoxville
Ph.D. in Physics ***2014***
Advisor: Hanno H Weitering

Thesis: Growth, Structure, Electronic and Transport Properties of Yttrium Disilicide Nanowires

Middle East Technical University (Ankara / TURKEY)

M.Sc. in Physics ***2006***
Advisor: Mehmet Parlak

Thesis: Physical properties of CdSe thin films produced by thermal evaporation and e-beam techniques

B.Sc. in Physics ***2004***

Coursework focused on condensed matter physics, optical and structural properties of thin films

B.Sc. in Electrical and Electronics Engineering ***2003***

Coursework focused on software development, computer architecture, solid state devices and VLSI design

Work and Research Experience

Oak Ridge National Laboratory- Center for Nanophase Materials Sciences (CNMS)
R&D Research Associate ***2021- present***

- Conducting research focusing on electronic and transport properties in low-dimensional quantum materials using cryogenic scanning tunneling microscope (STM) and four-probe STM (4P-STM) systems. Research topics include:
  - Atomic level investigation and modification of heterogeneities on 2D materials for spintronic and quantum information science applications.
  - 2D heterostructures and twisted layers
  - Atomic scale memory devices, 2D memory devices for neuromorphic computing
  - Development of new methodologies for spin polarized STM, thermopower and potentiometry measurements with atomic resolution.

The University of Texas at Austin - Department of Electrical and Computer Engineering
Postdoctoral Fellow ***2018-2021***

- Conducted research projects focusing on electron transport in low dimensional materials and nanoscale devices using a cryogenic scanning tunneling microscope (STM) and four-probe STM (4P-STM). With a research focus on:
  - Atomic level investigation of nonvolatile resistance switching in transition metal dichalcogenide monolayers.
  - Atomic level investigation and modification of heterogeneities on 2D materials for spintronic and quantum computational applications.
  - Investigation of novel resistance switching mechanisms in 2D phase-change memory devices
- Developing new scanning probe microscopy modes for spatially resolved investigation of STM induced phase-change in layered materials and their van der Waals heterostructures.

Oak Ridge National Laboratory- Center for Nanophase Materials Sciences (CNMS)
Postdoctoral Research Associate ***2014- 2017***

- Studied electron transport in semiconducting nanowires, graphene nanowires and nanoribbons, topological insulators (TIs) and other low dimensional systems using cryogenic STM and 4P-STM systems.
- Developed a four-probe spectroscopy method to distinguish surface and bulk conductivities in TIs. The method provided the first quantitative measurements of bulk and surface contributions to the total conductance in the systems with mixed conduction channels. High precision of the experiments has enabled us to detect minuscule changes in surface conductance of TIs due to the residual gas doping.
- Developed pioneering experimental methods for 4P-STM to detect spin polarized electron transport on the surfaces of topological insulator materials.
- Developed Scanning Tunneling Potentiometry (STP) methods for simultaneous, atomic resolution investigation of surface electrochemical potential and topography.
- Studied structural and electronic properties of TIs (Bi_2Te_2Se, $ZrTe_5$), transition metal chalcogenides (TMDCs) and other 2D materials with cryogenic STM.
- Worked with a large number of CNMS users and performed STM and 4P-STM measurements on various types of user samples.
- Performed routine maintenance and repair of ultra-high vacuum (UHV) systems. Developed and/or improved control software for 4P-STM systems.

The University of Tennessee, Knoxville
Research Assistant ***2008- 2014***

- Led and conducted a research project investigating the structural and electronic properties of ultra-thin YSi_2 nanowires with cryogenically cooled STM and RHEED.
- Developed in-situ metal contact deposition methods for connecting metal-silicide nanowires to mesoscopic structures for transport measurements. Investigated these structures with STM and SEM. Performed in-situ electron transport measurements in these systems.
- Performed preliminary experiments investigating quantum size effects in collective excitations in ultra-thin Mg films and hydrogen storage capability of these films.
- Designed and implemented UHV chambers and components for thin film deposition and in-situ sample characterization.
- Collaborated in large (7 person) team in designing layout of new UHV lab. Actively involved in purchasing, maintenance and repair of many UHV systems.

Middle East Technical University (Ankara / TURKEY)
Research Assistant ***2004- 2007***

- Grown and analyzed the structural, opto-electronic properties of II-VI thin films. Investigated the effects of ion implantation on these properties.
- Automated several experimental procedures. Developed software in C++ and LabView to reduce measurement times up to 90% while increasing the accuracy and reliability.

Teaching Experience

The University of Tennessee, Knoxville
Graduate Teaching Assistant ***2007-2014***

- Taught and evaluated undergraduate physics laboratory courses for pre-medical students

Middle East Technical University (Ankara / TURKEY)
Graduate Teaching Assistant ***2004-2007***

- Taught and evaluated the freshmen physics laboratory course for physics majors

Teaching Assistant ***2000-2004***

- Taught freshmen and sophomore level physics laboratory courses to an elite group of high school students preparing for International Physics Olympiads.

Journal Articles

- Observation of single-defect memristor in an MoS2 atomic sheet, **S. M. Hus**, R. Ge, P. Chen, L. Liang, G. E. Donnelly, W. Ko, F. Huang, M.H. Chiang, A.P. Li, D. Akinwande, *Nature Nanotechnology* **16** (1), 58 (2021).
- A library of atomically-thin 2D materials featuring conductive-point resistive switching phenomenon, R. Ge, X. Wu, L. Liang, **S. M. Hus**, Y. Gu, E. Okogbue, H. Chou, J. Shi, Y. Zhang, S. K. Banerjee, Y. Jung, J. C. Lee, D. Akinwande, *Advanced Materials* **33** (7), 2007792 (2021)
- Tip-induced local strain on MoS2/graphite detected by inelastic electron tunneling spectroscopy, W. Ko, **S. M. Hus**, X. Li, T. Berlijn, G. D. Nguyen, K. Xiao, A.P.Li, *Phys. Rev. B **97**, 125401 (2018)*
- Visualization and manipulation of magnetic domains in quasi-2D material Fe_3GeTe_2, G. D. Nguyen, J. Lee, T. Berlijn, Q. Zou, **S. M. Hus**, J. Park, Z. Gai, C. Lee, A.P. Li, *Phys. Rev. B **97**, 014425 (2018)*
- Detection of the spin-chemical potential in topological insulators using spin-polarized four-probe STM, **S. M. Hus**, X. Zhang, G. D. Nguyen, W. Ko, A. P. Baddorf, Y. Chen, A.P Li, *Physical Review Letters* **119**, 137202 (2017).
- Spatially-resolved studies on the role of defects and boundaries in electronic behavior of 2D materials(*Review Article)*, **S. M. Hus**, A.P Li, *Progress in Surface Science* **92**, 176 (2017)
- Differentiation of surface and bulk conductivities via four-probe spectroscopy, **S. M. Hus**, C. Durand, X. Zhang, , C. Ma, M. Mcguire, Y, Xu, H. Cao, I. Vlassiouk, Y. Chen, A.P Li, *Microscopy and Microanalysis* **22**(S3), 384 (2016)
- High-throughput electrical measurement and microfluidic sorting of semiconductor nanowires, C. Akin, J. Yi, L.C. Feldman, C. Durand, **S. M. Hus**, A.P. Li, H. Y. Hui, M.A. Filler, J.W. Shan, *Royal Society of Chemistry Lab on a Chip* **16** (11), 2126 (2016)
- Isoelectronic tungsten doping in monolayer MoSe2 for carrier type modulation, X. Li, M.W Lin, L Basile, **S. M. Hus**, A. Puretzky, B. Huang, J. Lee, Y.C Kuo, L. Y Chang, K. Wang, J. C. Idrobo, A.P Li, M. Moon, C. H. Chen, C. M. Rouleau, B. G. Sumpter, D. B. Geohegan, K. Xiao, *Advanced Materials* **28** (37), 8240 (2016)
- Differentiation of surface and bulk conductivities in topological insulator via four-probe spectroscopy, C. Durand, X. Zhang, **S. M. Hus**, C. Ma, M. Mcguire, Y, Xu, H. Cao, I. Vlassiouk, Y. Chen, A.P Li, *Nano Letters* **16** (2016)
- Contactless Determination of Electrical Conductivity of One-Dimensional Nanomaterials by Solution-Based Electro-orientation Spectroscopy, C. Akin, J. Yi, L.C. Feldman, C. Durand, **S. M. Hus**, A.P. Li, M.A. Filler, J.W. Shan, *ACS Nano.* **9**, 5405 (2015)
- Quantum oscillations in the surface excitations of ultrathin Mg(0001) films, A. Teng, K. Kempa, M. M. Ozer, **S. M. Hus**, P.C. Snijders, G. Lee, H. H. Weitering, *Physical Review B* **90**, 115416 (2014).
- Formation of uni-directional ultrathin metallic YSi_2 nanowires on Si(110), **S. M. Hus** and H.H. Weitering, *Appl. Phys. Lett.* **103**, 073101 (2013)
- Structure and growth of quasi-one-dimensional YSi_2 nanophases on Si(100), V. Iancu, P. R. C. Kent, **S. M. Hus**, H. Hu, C.G. Zeng, H.H. Weitering, *J. Phys.: Condens. Matter* **25** 014011 (2013)
- Electrical, photo-electrical, optical and structural properties of CdSe thin films deposited by thermal and e-beam techniques**, S. M. Hus** and M. Parlak, *J. Phys. D: Appl. Phys*. **41** 035405 (2008)

Conference Presentations/Papers

- 0D Defects in 2D Materials for Memory Effect, **S. M. Hus**, L. Liang, D Akinwande, *Materials Research Society, The Electrochemical Society, 240th ECS Meeting 2021 (Invited)*
- STM Observation of Atomistic Memory Effect in MoS2 Monolayers, **S. M. Hus**, Deji Akinwande, *American Physical Society, APS March Meeting 2021 (Invited)*
- Atomic Level Investigation of Resistance Switching in 2D Memory Devices, **S. M. Hus**, R Ge, X Wu, Y Gu, JC Lee, AP Li, D Akinwande, *The Electrochemical Society, 235th ECS Meeting 2019*

- Recent Progress on 2D Monolayer Memory Devices, R Ge, M.Kim, X Wu, **S. M. Hus**, JC Lee, D Akinwande, *Materials Research Society, MRS Spring Meeting 2019*
- Detection of Spin-Momentum Locking in Topological Insulators with Spin-Polarized Four-Probe STM, **S. M. Hus**, X. Zhang, C. Durand, W. Ko, Y. Chen, A.P Li, *American Physical Society, APS March Meeting 2018*
- Applying and detecting tip-induced local strain on monolayer MoSQ2/graphite with scanning tunneling microscopy and inelastic electron tunneling spectroscopy, W. Ko, **S. Hus**, X. Li, T. Berlijn, G. Nguyen, K. Xiao, A.P Li, *American Physical Society, APS March Meeting 2018*
- Detection of Current Induced Spin Polarization in Topological Insulators via Four-Probe Spectroscopy, **S. M. Hus**, X. Zhang, G. D. Nguyen, Y. Chen, A.P Li, *American Physical Society, APS March Meeting 2017*
- SP-STM study of layered magnetic material Fe3GeTe2, G. D. Nguyen, J. Park, **S. M. Hus**, Q. Zou, Z. Gai, J. Lee, R. Liu, C. Lee, A.P. Li, *American Physical Society, APS March Meeting 2017*
- Differentiation of surface and bulk conductivities in topological insulator via four-probe spectroscopy, A.P Li, C Durand, **S. Hus**, X. Zhang, M. McGuire, Y.Chen, *American Physical Society, APS March Meeting 2016*
- Direct Measurement of Conductance from Topological Surface States in Topological Insulators, **S. M. Hus,** C. Durand, X. Zhang, M. Mcguire, I. Vlassiouk, A.P. Li, *AVS 62nd International Symposium & Exhibition, 2015*
- Understanding Statistical Variability of Semiconductor-Nanowire Conductivity with High-Throughput Measurements, C. Akin, J. Yi, L.C. Feldman, C. Durand, **S. M. Hus**, A.P. Li, M.A. Filler, J.W. Shan, *The 2015 MRS Fall Meeting and Exhibit, 2015*
- Contactless, high-throughput determination of electrical conductivity of one-dimensional nanomaterials by solution-based electro-orientation spectroscopy, C. Akin, J. Yi, L.C. Feldman, J.W. Shan, C. Durand, **S. M. Hus**, A.P. Li, M.A. Filler, *68th Annual Meeting of the APS Division of Fluid Dynamics, 2015*
- Epitaxial growth of YSi2 nanowires the on Si(110) surface, **S. M. Hus**, H. H. Weitering, *American Physical Society, APS March Meeting 2013*
- Surface Electronic Excitations of Quantum Confined Mg Films on Si(111), A. Teng, K. Kempa, X. Li, M. Ozer, **S. Hus**, P. Snijders, G. Lee, H. Weitering, *American Physical Society, APS March Meeting 2013*
- Ultrathin YSi_2 nanowires for electrical readout of DNA , **S. M. Hus**, H. Hu, V. Iancu, A.P Li, L. Menard, M. W. Woodson, M. Ramsey, H. H. Weitering, *NHGRI Sequencing Technology Meeting 2011*
- Transport studies of ultrathin YSi2 nanowires, **S. M. Hus**, H. Hu, V. Iancu, H. H. Weitering, A.P Li, *American Physical Society, APS March Meeting 2011*
- Surface plasmon excitation in ultrathin Mg films on Si(111), A. Teng, G. Lee, **S. Hus**, H. Weitering, *American Physical Society, APS March Meeting 2011*

Relevant Experimental Skills

- Molecular Beam Epitaxy (MBE)
- Scanning Tunneling Microscopy (STM)
- Four-probe STM
- Cryogenics
- RHEED
- HREELS
- SEM
- XRD
- Electron transport in nanoscale
- Scanning Tunneling Potentiometry (STP)
- UHV (design and Maintenance)
- Metal-Semiconductor Epitaxy
- Lithography
- Programming Languages: C++, Labview, Python
- Transport and Photoconductivity in Thin Films

References

- Dr. Hanno H. Weitering

  Department of Physics and Astronomy
  The University of Tennessee
  Knoxville, TN 37996
  Tel: (865)-974-7841
  Email: hanno@utk.edu

- Dr. An-Ping Li

  CNMS Scanning Probe Microscopy Group
  Oak Ridge National Laboratory
  P.O. Box 2008
  Oak Ridge, TN 37831-6056
  Tel: (865) 574-6502
  Email: apli@ornl.gov

- Dr. Deji Akinwande

  Department of Electrical and Computer Engineering
  The University of Texas at Austin
  Austin, TX, 78758
  Tel: (512) 471-4345
  Email: deji@ece.utexas.edu

- Dr. Arthur P. Baddorf

  CNMS Scanning Probe Microscopy Group
  Oak Ridge National Laboratory
  P.O. Box 2008
  Oak Ridge, TN 37831-6056
  Tel: (865) 574-5241
  Email: baddorfap@ornl.gov

- Dr. Geun Seop Lee

  Department of Physics,
  Inha University
  Inchon 402-751, South Korea
  Tel: +82-32-860-7668
  Email: glee@inha.ac.kr