

Jungseok Chae

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Education

Seoul National University, Seoul, Korea

Ph. D in Physics (2010) Thesis Adviser: Prof. Young Kuk

M. S. in Physics (2004) Thesis Adviser: Prof. Young Kuk

B. S. in Physics (2002)

Research Experience

2017 – present **Center for Quantum Nanoscience, Institute for Basic Science**

2013 - 2016 **CNST/NIST and University of Maryland**, Postdoctoral Research Associate

- **Nanoscale Characterization of Energy Materials:** Research on the distribution of ions and defects and their kinetics in organic and inorganic photovoltaic materials using photothermal induced resonance (PTIR) technique.
- **Plasmonic Metamaterials:** Fabricated plasmonic nanostructures and analyzed the surface-enhanced infrared absorption at the nanoscale hot spots.
- **PTIR Improvement:** Developed a new measurement setup of applying opto-mechanical resonance tips to increase the detection sensitivity.

2010 - 2013 **CNST/NIST and University of Maryland**, Postdoctoral Research Associate

- **Graphene Electronics:** Research on the many-body physics in graphene determining the Fermi velocity renormalization using gate map scanning tunneling spectroscopy.

2004 - 2010 **Seoul National University** (Korea), Ph. D. Candidate

- **Local Transport in Graphene Devices:** Research on the role of the edge channels separated on graphene devices using scanning gate microscopy.
- **Local Potential in Quantum Dot Devices:** Research on the limiting mechanism on cleaved quantum dot light emitting devices using electrostatic force microscopy.

2002 - 2004 **Seoul National University** (Korea), M. S. Candidate

- **Construction of Atomic Force Microscope (AFM):** Designed and built a whole cryogenic AFM instrument operating in an ultra-high vacuum.

Teaching Experience

- 2013 – 2015 Volunteer Teacher for Korean School at New Covenant Fellowship Church
Teaching non-Korean adults and developing Korean curricula for various levels.
- 2002 - 2006 Teaching Assistant at Seoul National University, Korea
General Physics, Electro-Magnetism, Solid State Physics, Physics and
Philosophy, graduate level seminar for experimental instruments in solid state
physics (8 semesters).
- 1995 - 2008 Personal mentoring for high school students (Mathematics, Physics)

Technical Skills

- Expertise in scanning probe microscope and related spectroscopic techniques:
atomic force microscope, scanning tunneling microscope and spectroscopy, scanning gate
microscopy, electrostatic force microscopy, photothermal induced resonance and infrared
spectroscopy.
- Extensive knowledge about ultra-high vacuum, cryogenics, high magnetic fields and electronic
circuits for feedback controls and data acquisition.
- Graphene device fabrication and transport measurement.
- Nanofabrication techniques: e-beam/photo lithography, scanning electron microscope,
materials depositions, etching etc.
- Notable software skills: 3D CAD design (AutoCAD, CoCreate), visual C++, LabVIEW, IDL,
Mathematica, Matlab and COMSOL etc.

Awards

The President Volunteer Service Award - Bronze in Education, 2015

Samsung Electronics Scholarship, 2006-2009

Principal Accomplishments

- 2015 – 2016: **PTIR improvement:** Improved the detection sensitivity of photothermal induced resonance (PTIR) technique applying opto-mechanical resonance tips. Achieved the sensitivity down to the thickness of self-assembled monolayer of organic molecules.
- 2014 – 2016: **Nanoscale characterization of energy materials:** Research on the material properties of photovoltaic materials including organometal trihalide perovskite (OTP) and CdTe at the nanoscale using PTIR. Determined the vacancy formation mechanism by ionic sublimation and the electric poling mechanism by electro-migration due to the mapping of the organic molecule distribution. Investigated the kinetics of highly debating Cl incorporation in mixed halide OTP due to the mapping of the local bandgap variation. Studied the local bandgap variation on CdTe lamellas originated from atomic inter-diffusion and defect distribution.
- 2013 – 2015: **Plasmonic metamaterials:** Fabricated plasmonic nanostructures using electron beam lithography and the lift-off technique. Analyzed the near-field surface enhanced infrared absorption (SEIRA) leveraged by strong light-matter interactions in nanoscale volumes in plasmonic resonators as a function of shape, size, composition and arrangement.
- 2010 – 2013: **Graphene electronics:** Research on the many-body graphene physics at graphene on boron nitride van der Waals heterostructures, which were fabricated at Columbia University, at the atomic scale using gate map scanning tunneling spectroscopy. Determined the graphene's Fermi velocity renormalization by electron-electron interactions as a function of carrier density.
- 2008 – 2010: **Local transport in graphene devices:** Investigated the local transport in graphene devices, which were fabricated at the National Institute of Science and Technology, at the nanoscale using scanning gate microscopy (SGM). Distinguished the importance of the edge channels from the bulk counterpart.
- 2009 – 2010: **Local Potential in Quantum Dots Devices:** Research on the potential profiles across cleaved quantum dot light emitting devices, which were fabricated at Samsung Advanced Institute of Technology, at the nanoscale using electrostatic

force microscopy. Developed the electrostatic force microscopy capability with home-built room-temperature AFM.

2002 – 2008: **AFM instrumentation:** Designed and built a whole cryogenic AFM instrument operating in ultra-high vacuum (UHV). Included AFM head design, UHV chamber design, and cryogenics design, electronic circuits for feedback and AFM operation, phase lock looped frequency modulation, vibration isolation and noise reduction.

List of Publications

• E. Strelcov*, Q. Dong*, T. Li*, **J. Chae***, Y. Shao, Y. Deng, A. Gruveman, J. Huang, and A. Centrone, "CH₃NH₃PbI₃ Perovskites: Ferroelasticity Revealed", accepted at Science Advances (2017)

* Authors equally contributed to this paper

• **J. Chae**, B. Lahiri, and A. Centrone, "Engineering Near-Field SEIRA Enhancements in Plasmonic Resonators", ACS Photonics, 3, 87-95 (2016)

• **J. Chae**, Q. Dong, J. Huang and A. Centrone, "Chloride Incorporation Process in CH₃NH₃PbI_{3-x}Cl_x Perovskites via Nanoscale Bandgap Maps", Nanoletters, 15, 8114-8121 (2015)

• A. M. Katzenmeyer, G. Holland, **J. Chae**, A. Band, K. Kjoller and A. Centrone, "Mid-infrared Spectroscopy beyond the Diffraction Limit via Direct Measurement of Photothermal Effect", Nanoscale, 7, 17637-17641 (2015)

• **J. Chae**, B. Lahiri, J. Kohoutek, G. Holland, H. Lezec and A. Centrone, "Metal-Dielectric-Metal Resonators with Deep Subwavelength Dielectric Layers Increase the Near-Field SEIRA Enhancement", Optics Express, 23, 25912-25922 (2015)

• Y. Yuan*, **J. Chae***, Y. Shao*, Q. Wang, Z. Xiao, A. Centrone and J. Huang, "Photovoltaic Switching Mechanism in Lateral Structure Hybrid Perovskite Solar Cells", Advanced Energy Materials, 5, 1500615 (2015)

* Authors equally contributed to this paper

• R. Dong, Y. Fang, **J. Chae**, J. Dai, Z. Xiao, Q. Dong, Y. Yuan, A. Centrone, X. Zeng and J. Huang, "High Gain and Low-Driving-Voltage Photodetectors Enabled by Organolead Triiodide Perovskites", Advanced Materials, 27, 1912-1918 (2015), Inside Back Cover

• A. M. Katzenmeyer, **J. Chae**, R. Kasica, G. Holland, B. Lahiri and A. Centrone, "Nanoscale Imaging and Spectroscopy of Plasmonic Modes with the PTIR Technique", Advanced Optical Materials, 2, 718-722 (2014), Inside Front Cover

- **J. Chae**, S. Jung, A. F. Young, C. R. Dean, L. Wang, Y. Gao, K. Watanabe, T. Taniguchi, J. Hone, K. L. Shepard, P. Kim, N. B. Zhitenev and J. A. Stroscio, “Renormalization of the Graphene Dispersion Velocity Determined from Scanning Tunneling Spectroscopy”, *Physics Review Letters*, 109, 116802 (2012), Editor’s Suggestion
- **J. Chae**, S. Jung, S. Woo, H. Baek, J. Ha, Y. –J. Song, Y. –W. Son, N. B. Zhitenev, J. A. Stroscio, and Y. Kuk, “Enhanced Carrier Transport along Edges of Graphene Devices”, *Nanoletters*, 12, 1839-1844 (2012)
- **J. Chae**, H. Yang, H. Baek, J. Ha, Y. Kuk, S. Jung, Y. –J. Song, N. B. Zhitenev, J. A. Stroscio, S. Woo, and Y. –W. Son, “Graphene: Materials to devices (invited)”, *Microelectronic Engineering*, 88, 1211-1213 (2011), Invited Paper
- **J. Chae**, H. Yang, H. Baek, J. Ha, Y. Kuk, S. Jung, Y. –J. Song, N. B. Zhitenev, J. A. Stroscio, S. Woo, and Y. –W. Son, “Charge Puddles and Edge Effect in a Graphene Device as Studied by a Scanning Gate Microscope”, *International Journal of High Speed Electronics and Systems*, 20, 205-216 (2011)
- T. –H. Kim, K. –S. Cho, E. Lee, S. Lee, **J. Chae**, J. Kim, D. Kim, J. –Y. Kwon, G. Amaratunga, S. Lee, B. Choi, Y. Kuk, J. Kim and K. Kim, “Full-colour quantum dot displays fabricated by transfer printing”, *Nature Photonics*, 5, 176-182 (2011)
- J. Son, X. –D. Wen, J. Joo, **J. Chae**, S. –I. Baek, K. Park, J. Kim, K. An, J. Yu, S. Kwon, S. –H. Choi, Z. Wang, Y. Kim, Y. Kuk, R. Hoffmann, and T. Hyeon, “Large-Scale Soft Colloidal Template Synthesis of 1.4 nm Thick CdSe Nanosheets”, *Angewandte Chemie International Edition*, 48, 6861-6864 (2009)
- J. Lee, **J. Chae**, C. Kim, H. Kim, S. Oh, and Y. Kuk, “Versatile low-temperature atomic force microscope with in situ piezomotor controls, charge-coupled device vision, and tip-gated transport measurement capability”, *Review of Scientific Instruments*, 76, 093701 (2005)

Presentations

Invited

- “Gate Map Tunneling Spectroscopy of Interactions in Graphene”
American Physical Society March Meeting (APS'13), Baltimore, MD, March 18, 2013