

Suyong Kim

PhD Candidate
Mechanical Engineering
Massachusetts Institute of Technology

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EDUCATION

Ph.D. Candidate, Massachusetts Institute of Technology 09/2018-Present

- Department: Mechanical Engineering
- Research focus: Energetic Materials Combustion, Scientific Machine Learning (SciML), Inverse Modeling
- Advisor: Professor Sili Deng

M.S., Seoul National University 09/2015-08/2017

- Department: Mechanical Engineering
- Thesis: Measurement of Eccentricity Effects on Stability of a High-Speed Shrouded Centrifugal Compressor
- Advisor: Professor Seung Jin Song

B.S., Seoul National University 03/2009-02/2015

- Department: Mechanical and Aerospace Engineering (Graduated with *Summa Cum Laude*)
- Thesis: Optimization Study of Operating Patterns and Effectiveness for a Distributed Energy System

RESEARCH INTERESTS

- **Fundamental studies of multi-phase/scale solid combustion** for clean energy conversion towards carbon neutrality, metal fuel combustion, hydrogen production via metal-water reaction.
- **Material designs** for energetic materials (i.e. solid propellants, explosives, and pyrotechnics) and energy storage, functionalization of nano-materials via interfacial engineering, novel composites for high performing engines, novel single-streamline powder production methods.
- **Architected microstructures** of energetic materials and energy storage for better mechanical properties and performance tunability, additive manufacturing of high-particle-loading polymer systems.
- **Scientific machine learning and uncertainty quantification**, novel neural network frameworks integrated with PDE solvers, image-based inverse modeling of chemical kinetics and thermal properties of reaction-diffusion systems, uncertainty quantification of model and experimental data.
- **Humanitarian responsibility**, clean cookstove design protecting women and children from harmful emission in low-/middle-income countries, co-design approach by integration of participatory designs and computational simulations.

RESEARCH EXPERIENCE

Graduate Research Assistant & Mathworks Fellow, *Massachusetts Institute of Technology* 01/2019-Present

Advisor: Professor Sili Deng

- Fundamental knowledge of energetic materials combustion with time- & space-resolved imaging techniques
- PDE-constrained inverse modeling and uncertainty quantification of chemical kinetics and thermal properties
- Tunability of energetic performance by exploiting micro-architectures of energetic materials
- Interfacial functionalization of metal fuels to improve reactivity and mechanical properties
- First-principle single-streamline design tool combining inverse modeling and architected energetic materials
- Academic collaborators: Prof. John Wen (U. Waterloo), Dr. Chris Rackauckas (Julia Lab, MIT)

Researcher, Seoul National University 09/2017-05/2018

Supervisor: Professor Seung Jin Song

- Installation of a large-scale axial turbine and an instrumentation system to evaluate cooling efficiency of secondary flows in rim seals (team leading)
- Initial operation of rim seal testing
- Industrial collaborator: Doosan Heavy Industry

Graduate Research Assistant, Seoul National University 01/2015-08/2017

Advisor: Professor Seung Jin Song

- Design of an industrial high-speed centrifugal compressor with ~ 200 sensors to test aerodynamic instability
- Experimental observation and analysis of eccentricity effects on rotating stall and surge in a compressor
- Analytical modeling of aerodynamic loss due to film cooling on a turbine blade
- Academic&industrial collaborator: Korea Aerospace Research Institute and Hanwha Techwin

Undergraduate Research Assistant, Seoul National University 01/2012-06/2012

Advisor: Professor Seung Jin Song

- Engineering-policy model to optimize configuration and operating strategy of the distributed energy systems
- Industrial collaborator: Blue Economy Strategy Institute

Undergraduate Research Assistant, Seoul National University 01/2012-06/2012

Advisor: Professor Chong Am Kim

- Numerical analysis to suppress unsteady wake flow on a wind turbine tower

TEACHING EXPERIENCE

Teaching Assistant, Seoul National University

Applied Fluid Mechanics

Spring 2015

Basic Physics 1

Spring 2010, Spring 2011, Spring 2012

Pre-School College Mathematics

Winter 2010

Basic College Mathematics 2

Fall 2010

ADVISING AND MENTORING EXPERIENCE

Undergraduate Research Opportunities Program (UROP): Sophie Longawa (2020, MIT), Averitt Johns (2020-2022, MIT), Meghana Vemulapalli (2020-2021, MIT), Jason Chen (2021-Present, MIT), Pedro Alonso Hernandez (2022, MIT), Evan Bell (2022-Present, MIT)

MIT Summer Research Program (MSRP): Ian Michael Rivera Tosado (2022, UPenn)

One-on-One Mentoring Program: Three anonymous undergraduate students - fluid mechanics (2014, Seoul National University)

SELECTED AWARDS

Mathworks Mechanical Engineering Fellowship, Mathworks 09/2022-08/2023

KEF Scholarship, Kwanjeong Educational Foundation 09/2018-08/2024

MIT SMA2 Fellowship, Massachusetts Institute of Technology 09/2018-08/2019

BK 21 Plus Scholarship, Ministry of Education, Korea 09/2016-02/2017

Academic Excellence Scholarship, Seoul National University 09/2016-02/2017

09/2015-02/2016

National Scholarship For Science and Engineering, Ministry of Education, Korea 03/2009-02/2015

PUBLICATIONS

1. **S. Kim**, and S. Deng, 2023, "Inference of Chemical Kinetics and Thermodynamic Properties from Constant-Volume Combustion of Energetic Materials," Chemical Engineering Journal (submitted).
2. **S. Kim**, A. Johns, J. Wen, and S. Deng, 2022, "Burning Structures and Propagation Mechanisms of Nanothermites," Proceedings of the Combustion Institute, Vol. 39 (in press).
3. **S. Kim**, W. Ji, S. Deng, Y. Ma, and C. Rackauckas, 2021, "Stiff Neural Ordinary Differential Equations," Chaos: An Interdisciplinary Journal of Nonlinear Science, AIP, Vol. 31, 093122.
4. J. Song, **S. Kim**, T. C. Park, B-J. Cha, D. H. Lim, J. S. Hong, T. W. Lee, and S. J. Song, 2019, "Non-Axisymmetric Flows and Rotordynamic Forces in an Eccentric Shrouded Centrifugal Compressor – Part 1: Measurement," Journal of Engineering for Gas Turbines and Power, ASME, Vol. 141 (11), pp. 111014.
5. **S. Kim**, D. H. Jin, G. B. Lee, J. A. Kim, 2013, "Numerical Analysis for Suppressing Unsteady Wake Flow on Wind Turbine Tower using Edison_CFD," Korean Society for Computational Fluids Engineering, Vol. 18 (1), pp. 36-42.
6. S. Oh, Y. Lee, Y. Yoo, J. Kim, **S. Kim**, S. J. Song, H. Kwak, 2012, "A Support Strategy for the Promotion of Photovoltaic Uses for Residential Houses in Korea," Energy Policy, Elsevier, Vol. 53, pp. 248-256.

CONFERENCE & WORKSHOP PRESENTATIONS

1. **S. Kim**, A. Johns, J. Wen, S. Deng, 2022, "Burning Structures and Propagation Mechanisms of Nanothermites," 39th International Symposium on Combustion, Vancouver, Canada.
2. **S. Kim***, J. Saadi*, K. Pendowski, J. Chen, C. Ly, D. Sweeney, M. Yang, S. Deng, 2022, "Participatory & Computational Design of Improved Cookstoves," The Health of The Planet Showcase, MIT Mechanical Engineering, Massachusetts, USA. *Equal Contribution.
3. **S. Kim**, A. Johns, J. Wen, S. Deng, 2022, "Non-Uniform Burning Propagation of Nanothermites," 2022 Spring Meeting of the Eastern States Section of the Combustion Institute (ESSCI 2022), Orlando, USA.
4. **S. Kim***, J. Saadi*, K. Pendowski, J. Chen, C. Ly, D. Sweeney, M. Yang, S. Deng, 2022, "Participatory & Computational Design of Improved Cookstoves," ETHOS Conference 2022, Virtual. *Equal Contribution.
5. J. Song, **S. Kim**, T. C. Park, B-J. Cha, D. H. Lim, J. S. Hong, T. W. Lee, and S. J. Song, 2019, "Non-Axisymmetric Flows and Rotordynamic Forces in an Eccentric Shrouded Centrifugal Compressor – Part 1: Measurement," Proceedings of ASME Turbo Expo 2019, GT2019-90237, Arizona, USA.
6. **S. Kim**, J. Song, T. C. Park, K. Kim, and S. J. Song, 2019, "Measurement of Shrouded Radial Compressor Stability under Eccentric Conditions," Global Power and Propulsion Society (GPPS), GPPS-TC-2019-0068, Zurich.
7. **S. Kim**, J. Song, B. Cha, T. C. Park, K. Kim, T. Lee, J. Hong, D. Lim, and S. J. Song, 2018, "Effects of Non-Axisymmetric Inflow on Vaneless Diffuser Rotating Stall," Asian Congress on Gas Turbines (ACGT), ACGT2018-TS50, Japan.
8. **S. Kim**, and S. J. Song, 2014, "Analytical Evaluation of Economic Feasibility of Cogeneration System in Building," Seoul National University (SNU)—University of Tokyo (UT) Work Shop 2014, Japan.
9. **S. Kim**, D. H. Jin, and J. A. Kim, 2012, "Numerical Analysis for Suppressing Unsteady Wake Flow on Wind Turbine Tower," The 1st EDISON Fluid-Thermo CFD Challenge, The Autumn Conference of Korean Society for Computational Fluids Engineering, Vol. 18 (1), pp. 33-36, Korea.

LABORATORY SERVICE

Proposal Drafting, Deng Energy and Nanotechnology Group, MIT

Proposed main ideas, produced the first draft, and made joint revisions for the following projects:

- Developing Carbon-Neutral Aluminum/Cellulose Fuels for Clean Energy Conversion, MIT Skoltech Program Awards Pilot Grants 2020, PI: Professor Sili Deng (funded, award size: \$200,000)
- Four proposals submitted to Army Research Office, Office of Naval Research, and MIT Energy Initiative (under review and in wait list)

EHS Representative, Deng Energy and Nanotechnology Group, MIT

01/2019-08/2022

COVID-19 Ambassador, Deng Energy and Nanotechnology Group, MIT

01/2020-12/2021

ACADEMIC COMMUNITY SERVICE

Symposium Assistant, MRS 2019 Fall Meeting, MA, USA

12/2019

Student Assistant, ASME 2016 Turbo Expo, Seoul, Korea

06/2016

Staff, Asian Congress on Gas Turbines 2014, Seoul, Korea

08/2014

PROFESSIONAL ASSOCIATION

The Combustion Institute

Material Research Society

The Korean Society of Mechanical Engineers

TECHNICAL SKILLS

Programming: Matlab; C; Java; Python (including PyTorch, OpenCV); Julia; Mathematica; Labview.

Computation: Ansys CFX; Fluent; ICEM; Cantera; Numerical Analysis; Optimization; Inverse Modeling; Bayesian Statistics.

Laboratory: Optical System; High-Speed Imaging; Static/Dynamic Sensors; Data Acquisition System; Circuits; Machining (Mill, Lathe, and CNC); Additive Manufacturing; Material Characterization (SEM/EDS, XRD, Raman Spectroscopy, TGA/DSC).

Design: AutoCAD; Fusion360; SolidWorks; Catia.