Shaoyan Liu

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EDUCATION

The Pennsylvania State University   State College, United States
Ph.D. in Mechanical Engineering   *2025 - 2030 (Expected)*

Shanghai Jiao Tong University   Shanghai, China
M.S. in Energy and Power Engineering   *2022 - 2025*

Beijing Jiaotong University   Beijing, China
B.S. in Energy and Power Engineering   *2018 - 2022*

RESEARCH INTEREST

- Battery Performance & Degradation Mode Prediction
- Battery Fault Diagnostics & Aging Mechanisms
- Physics-Based Modeling & Data-Driven Methods

RESEARCH EXPERIENCE

A. Master Phase (2022 - 2025)

Thesis: Experimental and Kinetic Modeling Investigation on Gas Generation Dynamics of Lithium-ion Batteries During Thermal Runaway at Various Abusive Conditions
Advisor: Dong Han
Description: We conducted a comprehensive investigation combining experimental research with modeling analysis to study the thermal runaway (TR) characteristics and gas generation mechanisms of lithium-ion batteries under various abusive conditions. Using experimental data, we developed a gas generation kinetic model based on the Chemical Reaction Neural Network (CRNN), which allows us to predict gas generation during TR at different states of charge (SOCs). Additionally, we calculated the explosion limits of gas generation during TR at various SOCs and performed a chemical reaction kinetic analysis.

B. Undergraduate Phase (2019 - 2022)

Thesis: Effects of Temperature and Pressure Fluctuations on Exergy Loss Characteristics of Hydrogen Auto-ignition Processes
Advisor: Zuoyu Sun
Description: We numerically studied the effects of amplitude and frequency of temperature and pressure fluctuations on the energy conversion of hydrogen auto-ignition processes in an adiabatic constant-volume system, using the second law of thermodynamics. A parametric study was performed by varying the fluctuation amplitude and fluctuation amplitude frequency. Further, employing chemical kinetic analysis, the underlying mechanisms for how temperature fluctuation decreases the exergy loss were revealed.

RESEARCH SKILLS

A. Battery Experiments

- Thermal Runaway Testing (e.g., Thermal, Electrical, Mechanical Abuse)
- Material Characterization (e.g., SEM, XPS)
- Engineering Design (e.g., AutoCAD, CATIA, SolidWorks, LabVIEW)

B. Battery Simulation

- Programming & Data Analysis (e.g., Python, MATLAB, C/C++, Linux, LaTeX)
- Data-Driven Methods (e.g., ML, LLMs)
- Physics-Based Modeling

PUBLICATIONS

Google Scholar | Corresponding author = *

6. **Shaoyan Liu**, Qianzhen Guo, Jiabo Zhang*, Zhen Huang, Dong Han*. Investigation on Thermal Runaway Behaviors and Gas Generation Dynamics of Lithium-ion Batteries Induced by Electrical Abuse at Low Pressure Conditions. *Journal of Energy Storage*, 125, 116855 (2025). [DOI] [PDF]

5. Jiabo Zhang*, Changsheng Ma, Shuaiqi Liu, Qianzhen Guo, **Shaoyan Liu**, Peng Han, Zhen Huang, Dong Han*. Chemical Reaction Neural Networks to Map Lithium-ion Battery Thermal Runaway Gas Generation. *Cell Reports Physical Science*, 6(5), 102563 (2025). [DOI] [PDF]

4. Qianzhen Guo, **Shaoyan Liu**, Jiabo Zhang*, Zhen Huang, Dong Han*. Effects of Charging Rates on Heat and Gas Generation in Lithium-ion Battery Thermal Runaway Triggered by High Temperature Coupled with Overcharge. *Journal of Power Sources*, 600, 234237 (2024). [DOI] [PDF]

3. Jiabo Zhang, Qianzhen Guo, **Shaoyan Liu**, Chao Zhou, Zhen Huang, Dong Han*. Investigation on Gas Generation and Corresponding Explosion Characteristics of Lithium-ion Batteries During Thermal Runaway at Different Charge States. *Journal of Energy Storage*, 80, 110201 (2024). [DOI] [PDF]

2. **Shaoyan Liu**, Jiabo Zhang*, Zuoyu Sun, Dong Han*. Effects of Temperature and Pressure Fluctuations on Exergy Loss Characteristics of Hydrogen Auto-ignition Processes. *International Journal of Hydrogen Energy*, 48(97), 38484-38495 (2023). [DOI] [PDF]

1. Zuoyu Sun*, **Shaoyan Liu**. A Comparative Study on the Turbulent Explosion Characteristics of Syngas Between CO-Enriched and H_2-Enriched. *Energy*, 241, 122941 (2022). [DOI] [PDF]

CONFERENCE POSTERS AND PRESENTATIONS

4. Construction of Lithium-ion Battery Thermal Runaway Gas Generation Chemical Kinetic Mechanism using Chemical Reaction Neural Networks. *2024 China National Symposium on Energy Utilization*. Xiamen, China. (oral presentation, 12/2024)

3. Gas Generation Dynamics of Lithium-ion Batteries under Electrical Abuse at Low-Pressure Conditions. *2024 China National Symposium on Combustion*. Hangzhou, China. (poster, 10/2024)

2. Gas Evolution and Thermal Runaway Behavior of Lithium-ion Batteries under Electrical Abuse at Low-Pressure Conditions. *The 2nd National Doctoral Forum on Energy Storage*. Beijing, China. (oral presentation, 09/2024)

1. Effects of Temperature Fluctuations on Exergy Loss During Hydrogen Auto-Ignition. *2022 China National Symposium on Combustion*. Shanghai, China. (poster, 12/2022)

SELECTED HONORS AND AWARDS

- Graduation with the highest distinction, Shanghai Jiao Tong University   2025
- First Prize Baillie Gifford Scholarship, Shanghai Jiao Tong University (2 out of ~80)   2023

- First Prize Academic Scholarship, Shanghai Jiao Tong University   2023
- First Prize Academic Achievement Award, Beijing Jiaotong University (top 10%)   2020, 2021
- Excellence Award, Formula Student Electric China, with BJTU Formula Student Team   2019

TEACHING EXPERIENCE

Teaching Assistant

- Fall 2025: Machine Learning in Mechanical Engineering (ME 459, Instructor: Prof. Xiang Yang)

SERVICE

Journal Reviewers

- Journal of Energy Storage