Seungwoo Kim

- Ph.D course
- Department of Mechanical Engineering
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- Research interest: Power device thermal management, ANN based optimization

Education:

Korea Advanced Institute of Science and Technology (KAIST): Ph.D (2022.09 – Present)

Korea Advanced Institute of Science and Technology (KAIST): Researcher (2021.06 – 2022.08)

Kyung Hee University (KHU): M.S. (2021.03 – 2022.08)

Kyung Hee University (KHU): B.S. (2015.03 – 2021.02)

Journal Publications:

1) Seokkan Ki, Jooyoung Lee, **Seungwoo Kim**, Jeongmo Sung, Jaehwan Shim, Seungtae Oh, Sumin Cho, Soosik Bang, Donghyun Seo, Joongnyon Kim, Youngsuk Nam “An energy-efficient battery thermal management system incorporating a porous metal-based multiscale flow manifold”, *Energy Conversion & Management*, Vol. 269, pp. 116147 (2022)

2) Jaehwan Shim, Seungtae Oh, **Seungwoo Kim**, Donghyun Seo, Subeen Shin, Haeseung Lee, Younghwan Ko, Youngsuk Nam "Long-lasting ceria-based anti-frosting surfaces", *International Communications in Heat and Mass Transfer*, Vol. 140 pp.106550 (2023)

3) **Seungwoo Kim**, Seokkan Ki, Soosik Bang, Sanghyung Han, Junyong Seo, Chulmin Ahn, Suhyeon Maeng, Bong Jae Lee, Youngsuk Nam "Optimizing Energy-Efficient Jet Impingement Cooling Using an Artificial Neural Network (ANN) Surrogate Model for High Heat Flux Semiconductors", *Applied Thermal Engineering*, Vol. 239 pp. 122101 (2023)

4) Soosik Bang, **Seungwoo Kim**, Seokkan Ki, Junyong Seo, Jaechoon Kim, Bong Jae Lee and Youngsuk Nam "Artificial neural network (ANN)-based multi-objective optimization of the vapor chamber with liquid supply layer for high heat flux applications", In review

Patent Publications:

Conference Presentations:

1) **<u>Seungwoo Kim</u>**, Seokkan Ki, Soosik Bang, Chulmin Ahn, Choongyeop Lee and Youngsuk Nam, "Direct cooling system based on multi-objective optimization to improve high heat flux chip cooling efficiency", *KSME Spring Conference*, Korea, April 20-22, 2022.

2) Seokkan Ki, Jooyoung Lee, **<u>Seungwoo Kim</u>**, Joongnyon Kim and Youngsuk Nam, "Battery thermal management system using manifold flow channels combined to porous metal layer", *KSME Spring Conference*, Korea, April 20-22, 2022.

3) Soosik Bang, **<u>Seungwoo Kim</u>** and Youngsuk Nam, "Numerical analysis on heat transfer characteristics of ultra-thin vapor chamber with liquid supply layer based on multi-objective optimization", KSME Fall Conference, Jeju, Korea, November 9-12, 2022

4) **<u>Seungwoo Kim</u>**, Seokkan Ki, Soosik Bang, Chulmin Ahn, Choongyeop Lee and Youngsuk Nam, "The Optimization of a Jet Impingement and Micropost Hybrid Cooling System for High Heat Flux Semiconductors", *8th Thermal and Fluids Engineering Conference (TFEC)*, USA, March 26-29, 2023.

5) Hyunho Cho, Insik Lee, **<u>Seungwoo Kim</u>**, Soosik Bang, Jaechoon Kim and Youngsuk Nam, "Multi-objective design optimization of direct liquid cooling system for multi-chip semiconductor package using active learning", KSME Spring, Busan, Korea, Apr 19-22, 2023

6) Hyunho Cho, Insik Lee, **<u>Seungwoo Kim</u>**, Soosik Bang, Jaechoon Kim and Youngsuk Nam, "An active learning approach to performance optimization of jet array impingement-based cooling module for chiplet semiconductor package", KSFM Summer Conference, Pyeongchang, Korea, July 5-7, 2023

7) **<u>Seungwoo Kim</u>**, Seokkan Ki, Soosik Bang, Sanghyung Han, Junyong Seo, Chulmin Ahn, Suhyeon Maeng, Youngsuk Nam, "Thermal Management in EV Inverters: Optimizing Jet Impingement Cooling with Micropost Integration", The 21th International Symposium on Microelectronics and Packaging (ISMP 2023), Korea, October 25-27, 2023

8) Hyunho Cho, Insik Lee, **<u>Seungwoo Kim</u>**, Soosik Bang, Jaechoon Kim and Youngsuk Nam, "Optimization of thermal management performance of direct liquid cooling module for chiplet packages using active learning and hierarchical exploration", KSFM Winter Conference, Jeju, Korea, Nov. 29-Dec. 1, 2023

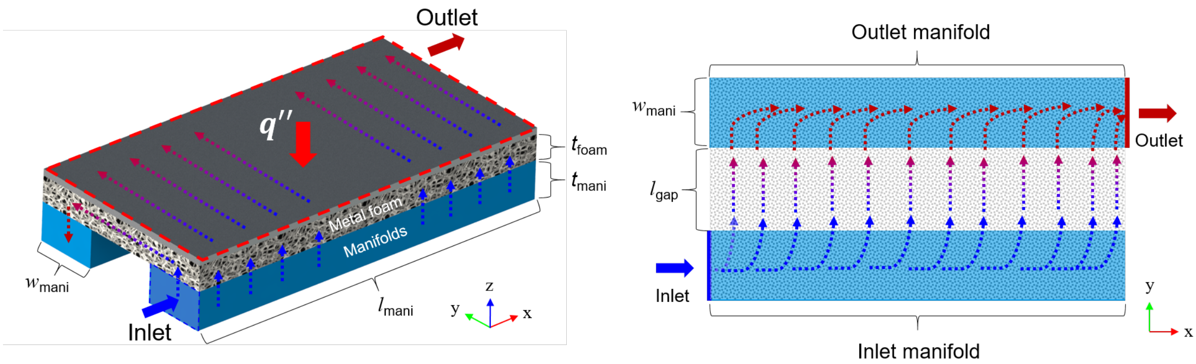
Award:

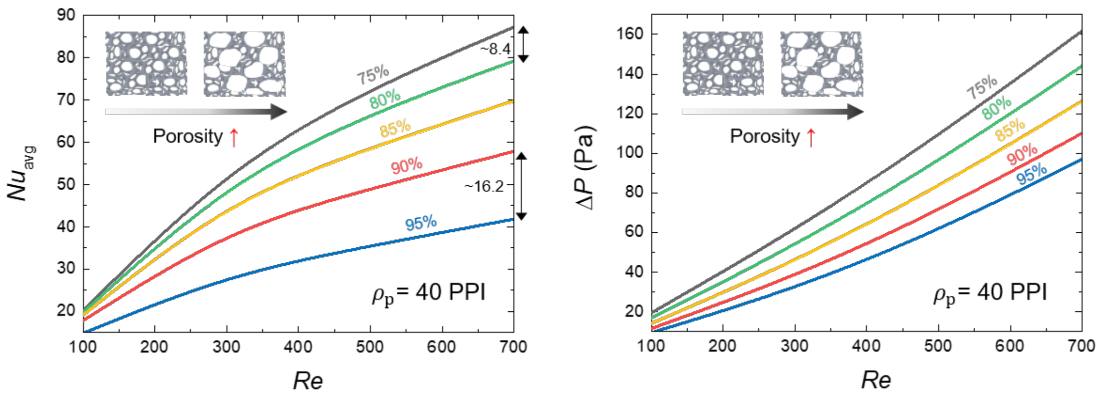
1) "Outstanding TA award" from *KAIST*, Korea, March 30, 2023.

2) “Young Scientist Award” at ISMP 2023 conference, Korea, October 27, 2023.

Major Research Topics

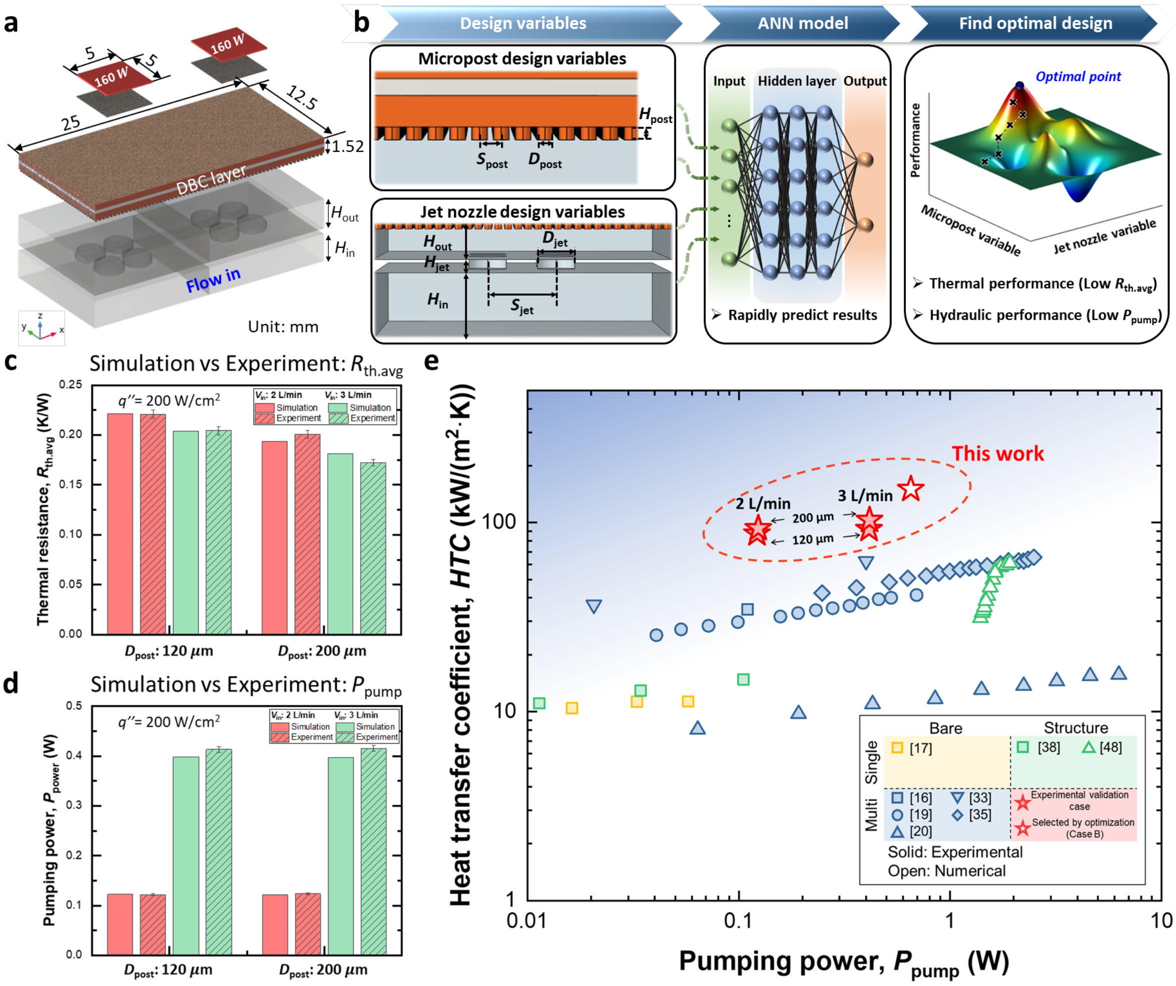
1) Development of compact cooling module for battery pack using metal foam: unit geometry





We propose an alternative cooling module which can control the high energy density multiple heat sources by combines the advantages of a manifold structure with a low initial pressure drop to obtain a high mass flow rate through the fluid path, and the advantage of porous materials to achieve efficient heat transfer through the uniform coolant distribution. In this study, we have defined a unit geometry for the manifolds-metal foam (MMF) configuration, where the physical properties of metal foam and geometrical parameters of flow channels were investigated. Also we can find the optimized geometry and metal foam porosity by low computational cost. Based on these results, a full scale battery thermal management system (BTMS) was developed.

2) Development of energy-efficient Jet impingement cooling for semiconductor thermal management utilizing surrogate model based multi-objective optimization



This study presents the optimization of two high-heat flux (865.8 W/cm2) semiconductor thermal management systems targeting an EV inverter. The cooling system employs a jet impingement integrated with microposts. The thermal resistance ($R_{th.avg}$) and pumping power (P_{pump}) were evaluated through computational fluid dynamics (CFD) simulations by varying the jet nozzle parameters, micropost variables, and volume flow rate. To ensure the accuracy of the CFD model, experimental validation was also conducted, demonstrating less than a 5% error. Then a surrogate model predicting $R_{th.avg}$ and P_{pump} was developed using the artificial neural network (ANN) method. The sensitivity analysis subsequently identified the primary influencing factors of the system, and the Pareto optimal fronts were determined via the elitist non-dominated sorting genetic algorithm (NSGA-II). Through optimization, the approach provided multiple optimal designs for a broad spectrum of P_{pump} values, which was feasible within a brief period (less than 200 seconds) due to the rapid estimations by the ANN-based surrogate model. The experimentally validated design achieved a 65% improvement in heat transfer coefficient (~102.96 kW/(m2·K)) at similar pumping power levels (~0.42 W) compared to previously reported jet impingement studies. Moreover, the design chosen through the optimization (Case B) projected a 140% enhancement in heat transfer coefficient (~150.2 kW/(m2·K)) with only a 63% rise in P_{pump} (~0.65 W). By exploring a more diverse range of multi-jet and micropost configurations, we were able to achieve higher performance. This study highlights the potential of combining jet impingement cooling with microposts as a highly attractive strategy for thermal management in high heat flux and multi-hot spot applications.