Donghyuk (Eric) Cho

d.cho@kaist.ac.kr

Computer-Aided Net Shape Manufacturing Lab, KAIST, Daejeon, Korea

EDUCATION

Sep. 2020 ~ Aug. 2025 **Korea Advanced Institute of Science and Technology** Daejeon, Korea
Ph.D. in Mechanical Engineering
Advisor: Professor Jeong Whan Yoon
Ph.D. Dissertation: Characterization and Modeling of Local Mechanical Behavior in Dissimilar Resistance Spot Welds

Mar. 2018 ~ Feb. 2020 **Chung-Ang University** Seoul, Korea
Master of Science in Mechanical Engineering
Advisor: Professor Youngseog Lee
Master's Thesis: Construction of machine learning-based material customized optimum drawing process design platform
(Nominated as the Best Master's Thesis of 2020 by The Korea Society of Mechanical Engineers)

Mar. 2011 ~ Feb. 2018 **Chung-Ang University** Seoul, Korea
Bachelor of Science in Mechanical Engineering

RESEARCH SKILLS

▶ **Research Interest:** Novel material characterization methods, Micro-scale fracture mechanics and plasticity, Material modeling (plasticity, ductile fracture, cohesive zone, multi-scale constitutive behavior), Numerical modeling and simulation (finite element, multi-scale analysis), Dissimilar material joining, Metal forming and process optimization with ML

▶ **Experimental Skills:**

- ✓ Constitutive characterization: Micro-scale tensile/shear test, Micro & Macro scale DIC
- ✓ Fracture characterization: Micro-scale fracture test, weld performance test, ductile fracture test, fractography
- ✓ Metallography: SEM, BSE, EBSD, EDS, OM, grinding, polishing, etching

▶ **Modeling & Computational Skills**

- ✓ Finite Element Analysis: ABAQUS, user subroutine (Fortran), LS Dyna, HyperMesh
- ✓ Fracture & Constitutive Modeling: Cohesive zone, ductile fracture, plasticity models, multi-scale simulations
- ✓ Machine Learning & Data-driven Methods: Python, MATLAB
- ✓ DIC, CAD Tools: GOM correlate , CATIA, SolidWorks

WORK EXPERIENCE

Aug. 2025 ~ Feb. 2026 **Postdoctoral Fellow** *–PRISM-AI Center, KAIST* Daejeon, Korea
PRISM-AI Center

- ✓ *Characterization and modeling of micro-scale mechanical behavior of dissimilar materials*
- ✓ *Publish research papers, draft research proposals and scientific reports, and conduct diverse research projects.*

Aug. 2020 ~ Aug. 2025 **Research Assistant** *–Department of Mechanical Engineering, KAIST* Daejeon, Korea
Computer-Aided Net Shape Manufacturing Lab

- ✓ *Conduct advanced research on constitutive and fracture modeling for dissimilar welds.*
- ✓ *Develop micro-scale testing methods to analyze local constitutive properties and fracture behavior of welds.*
- ✓ *Publish research papers, draft research proposals and scientific report, and conduct diverse research projects.*

Aug. 2020 ~ Aug. 2024 **Teaching Assistant** –*Department of Mechanical Engineering, KAIST* Daejeon, Korea

- ✓ *Supported graduate-level courses including Advanced Mechanics of Solids and Mechanics of Plastic Deformation.*

Jul. 2022 ~ Aug. 2022 **Visiting Scientist** –*General Motors Global R&D* Michigan, USA

- ✓ *Developed key methods for measuring local mechanical properties in welds.*
- ✓ *Collaborated with GM researchers to integrate scientific findings into production processes.*

Nov. 2021 ~ Dec. 2021 **Guest Ph.D. Student**– *Technical University of Denmark* Lyngby, Denmark
Section of Solid Mechanics

- ✓ *Developed a cohesive zone model to simulate the fracture behavior of dissimilar welds.*

Aug. 2014 ~ Jul. 2020 **Research Assistant** –*Department of Mechanical Engineering, Chung-Ang University* Seoul, Korea
Computer Solid Mechanics and Design Lab

- ✓ *Designed and optimized drawing processes using machine learning-based platforms for industrial applications.*
- ✓ *Conducted experiments and developed FE models to evaluate product quality after the drawing process.*
- ✓ *Published papers on machine learning and process optimization techniques.*

Oct. 2016 ~ Apr. 2017 **Internship Engineer** - *thyssenkrupp elevator AG* Essen, Germany
Production system team (Headquarter)

- ✓ *Developed a sampling inspection plan for traction motor components, approved for official use in Neuhausen.*
- ✓ *Designed escalator assembly parts for customer-specific requirements; two designs were productionized.*
- ✓ *Collaborated with R&D, quality, and field teams to optimize manufacturing and quality assurance processes.*

JOURNAL PUBLICATIONS

►PUBLISHED

1. **Donghyuk Cho**, Hassan Ghassemi-Armaki, Blair E. Carlson, and Jeong Whan Yoon. Micro-scale Shear and Tensile Testing for Advanced Localized Characterization of Aluminum-Steel Resistance Spot Welds. *Mechanics Research Communications*
https://doi.org/10.1016/j.mechrescom.2025.104495

2. **Donghyuk Cho**, Ghassemi-Armaki, H., Stoughton, T. B., Carlson, B. E., & Yoon, J. W. (2025). Characterization of Micro-Scale Gradient Material Properties to Visualize the Variations of Stress-Strain Relationships with Digital Image Correlation Method. *Materials Science and Engineering: A*, 148636.
https://doi.org/10.1016/j.msea.2025.148636

3. **Donghyuk Cho**, Ghassemi-Armaki, H., Stoughton, T.B., Carlson, B.E., Sung, H-M., Hwang, J., Legarth, B.N., Jeong Whan Yoon (2024), Fracture mechanisms of Al-steel resistance spot welds: The role of intermetallic compound phases, *Engineering Fracture Mechanics*, https://doi.org/10.1016/j.engfracmech.2024.110520

4. Piemaan Fazily, **Donghyuk Cho**, Hyunsung Choi, Joon Ho Cho, Jongshin Lee, Jeong Whan Yoon. (2023). Formability classifier for a TV back panel part with machine learning. *International Journal of Material Forming*,.
https://doi.org/10.1007/s12289-023-01791-y

5. Roh, Y. H., **Donghyuk Cho**, Choi, H. C., Yang, Z., & Lee, Y. (2021). Process Condition Diagram Predicting Onset of Microdefects and Fracture in Cold Bar Drawing. *Metals*, 11(3), 479. https://doi.org/10.3390/met11030479

6. **Donghyuk Cho,** YC Jang, and Y. Lee. (2019). Evaluation of the prediction ability of ductile fracture criteria over a wide range of drawing conditions. *Journal of Mechanical Science and Technology,* 33(9), 4245-4254. https://doi.org/10.1007/s12206-019-0821-0 ***(Nominated JMST 2nd Best Paper of 2019)***

7. **Donghyuk Cho** and Y. Lee. (2019). Development of a Machine Learning Based Fast Running Model to Determine Rapidly the Process Conditions in Drawing Process, *International Journal of Automotive Technology,* 20(6), https://doi.org/10.1007/s12239-019-0123-7

► IN PREPARATION

1. A Novel Experimental Method for Measuring Local Properties of Cap-to-Can Laser Welds in Prismatic Lithium-Ion Cells, *Target Journal: Materials and Design*

2. High-Temperature Property Measurement and Failure Behavior Analysis of Cap-to-Can Laser Welds in Prismatic Lithium-Ion Cells under Thermal Runaway Conditions, *Target Journal: Journal of Energy Storage*

3. Data Acquisition Methods for Material Properties of Top/Cap Vent Notch in Prismatic Lithium-Ion Cells, *Target Journal: International Journal of Mechanical Sciences*

4. Unearthing a Novel Mechanism in Al-Steel Dissimilar Welds: The Positive Impact of Pre-existing Micro Defects on Dissimilar Weld Performance, *Target Journal: Acta Materialia*

5. Direct Local Constitutive Characterization and Fracture Modeling of 3rd Generation Steel Resistance Spot Welds

Target Journal: International Journal of Mechanical Sciences

6. Effect of Paint Baking on Local Plasticity and Ductility of 3rd Generation Steel Resistance Spot Welds

Target Journal: Journal of Materials Research and Technology

7. Accelerated Automotive Tailgate Stiffness Optimization Process via Active Learning Surrogate Models and Global Search Strategies, *Target Journal: Thin-Walled Structures*

INTERNATIONAL CONFERENCES

1. Hyeonbin Moon, **Donghyuk Cho**, Jeong Whan Yoon, Seunghwa Ryu, (2026). Physics-informed Discovery of Yield Functions in Plasticity using Physics-Informed Neural Networks. *International Conference on Plasticity, Damage, and Fracture 2026, Geelong, Australia.*

2. H. Ghassemi-Armaki, **Donghyuk Cho**, J. Lee, M. Pour, J. Ma, B. Carlson, Jeong Whan Yoon, (2025). Micro-Scale Characterization of Plasticity and Fracture in EV Body and Battery Joints. *NUMISHEET 2025, Munich, Germany*

3. **Donghyuk Cho**, Hassan Ghassemi-Armaki, Blair E. Carlson, Thomas B. Stoughton, Jeong Whan Yoon. (2024). Characterization of constitutive property gradients in Al-steel RSW: A novel method. *International Conference on Plasticity, Damage, and Fracture 2024, Panama City, Panama.*

4. Jeong Whan Yoon, **Donghyuk Cho**, Taekjin Jang, Heonyong Lim, Kwanghyun Yu. (2024). Advances in materials characterization for constitutive and fracture modeling. *International Conference on Plasticity, Damage, and Fracture 2024, Panama City, Panama.*

5. Hyunsung Choi, Yong-Nam Kwon, **Donghyuk Cho**, Piemaan Fazily, Jeong Whan Yoon, Jaekun Kim. (2023). AI Application to the EV Motor Component Manufacturing. *The 14th Asian Workshop on Micro/Nano Forming Technology & The 4th Asian Pacific Symposium on Technology of Plasticity, Gangneung, Korea.*

6. **Donghyuk Cho**, Hassan Ghassemi-Armaki, Thomas B. Stoughton, Blair E. Carlson, Hyun Min Sung, Brian N. Legarth, and Jeong Whan Yoon. (2022). Constitutive and Fracture Modeling of Al-Steel Resistance Spot Welds. *International Welding/Joining Conference 2022, JeJu, Korea*.

7. Hyunsung Choi, Piemaan Fazily, **Donghyuk Cho**, Joon Ho Cho, Jaekun Kim, Jeong Whan Yoon. (2022). Springback Control with Artificial Intelligence for Electric Motor Hairpin. *ESAFORM 2022 - 25th International Conference in Material Forming, Braga, Portugal.*

8. Donghyuk Cho and Y. Lee. (2018). Application of ANN-NSGA-II Hybrid Methodology for the Automation of Die Design in Single-Pass Drawing. *The 14th Asia-Pacific Symposium on Engineering Plasticity and its Applications, Jeju, Korea.*

9. Donghyuk Cho, I.H Baik, H. C. Choi, S. H. Jung, and Y. Lee. (2018). Automatic Design and Optimization of a Drawing Process Based on Artificial Neural Network and Genetic Algorithm. *4th International Conference on Computational Design in Engineering, Changwon, Korea.*

PATENT

1. J Yoon, **Donghyuk Cho,** Battery weld joint mechanical property testing method and apparatus, and jig used therein, (KR 10-2025-0214708), filed Dec. 2025.

2. J Yoon, **Donghyuk Cho**, J Lee, and others, Method for Producing Rib Structure Data and Electronic Device Performing the Method, (KR 10-2024-0174188), filed Nov. 2024.

3. J Yoon, **Donghyuk Cho**, J Lee, and others, Method for Determining Rib Structure and Electronic Device Performing the Method, (KR 10-2024-0174196), filed Nov. 2024.

4. Y Lee, **Donghyuk Cho** and H.C Choi, Hybrid apparatus and method for wire drawing, (kr 1018085740000), filed Feb. 2016, and issued Dec. 2017

PUBLICATION IN KOREAN JOURNAL

1. Gyuhyeong Kim, **Donghyuk Cho**, Juwon Lee, Sangdeok Kim, Cheolmin Shin, & Jeong Whan Yoon (2023). A Study on the Prediction of Warpage During the Compression Molding of Glass Fiber-polypropylene Composites. Transactions of Materials Processing, 32(6), 367-375. https://doi.org/10.5228/KSTP.2023.32.6.367

2. Y. H. Roh, **Donghyuk Cho**, Kim, S. Seo, J.D. Lee, Y. Lee. (2018). Prediction of Transverse Surface Crack using Classification Algorithm of Neural Network in Continuous Casting Process. Transactions of Materials Processing, 27(2). https://doi.org/10.5228/KSTP2018.27.2.100

CONFERENCES IN KOREA

1. **Donghyuk Cho**, Junjie Ma, Hassan Ghassemi-Armaki, Masoud M. Pour, Blair E. Carlson, Jeong Whan Yoon. (2025). Characterization of Local Mechanical Behavior in EV Battery Cap-Can Laser Welds, The Korean Society for Technology of Plasticity 2025 Fall Conference, Jeju, Korea

2. Juwon Lee, **Donghyuk Cho**, Hassan Ghassemi-Armaki, Masoud M. Pour, B. E. Carlson, Jeong Whan Yoon. (2025). Advanced Characterization and Modeling of Dissimilar Laser Welds for Tabs to Busbar, The Korean Society for Technology of Plasticity 2025 Fall Conference, Jeju, Korea

3. **Donghyuk Cho**, Hassan Ghassemi-Armaki, Thomas B. Stoughton, Blair E., Du-Youl Choi, Jeong Whan Yoon. (2025). Characterization and Modeling of Local Mechanical Behavior in Al-Steel Dissimilar Resistance Spot Welds,

2025 Autumn Conference of the Korean Welding and Joining Society, Daegu, Korea **<Best Paper Awarded>** *[Abstract]*

4. **Donghyuk Cho**, Du-Youl Choi, Jeong Whan Yoon. (2025). Micro-Scale Tensile Characterization of Local Plastic Deformation Behavior in Paint-Baked 3rd Generation Steel Resistance Spot Welds, The Korean Society for Technology of Plasticity 2025 Spring Conference, Changwon, Korea

5. **Donghyuk Cho**, Hassan Ghassemi-Armaki, Thomas B. Stoughton, Blair E., Jeong Whan Yoon. (2024). A Micro-Scale Shear Test for Measuring Localized Mechanical Properties of Resistance Spot Welds under Large Deformation, The Korean Society for Technology of Plasticity 2024 Fall Conference, Jeju, Korea *[Abstract]*

6. **Donghyuk Cho**, Hassan Ghassemi-Armaki, Thomas B. Stoughton, Blair E., Jeong Whan Yoon. (2024). Micro-scale DIC and Experimental Methods for Characterizing Local Mechanical Properties in Resistance Spot Welds, The Korean Society for Technology of Plasticity 2024 Spring Conference, Seoul, Korea **<Best Paper Awarded>** *[Abstract]*

7. **Donghyuk Cho**, Hassan Ghassemi-Armaki, Thomas B. Stoughton, Blair E., Jeong Whan Yoon. (2023). A Novel Method to Characterize Constitutive Property Gradient of Al-Steel Dissimilar Resistance Spot Weld, The Korean Society for Technology of Plasticity 2023 Fall Conference, Jeju, Korea *[Abstract]*

8. Gyuhyeong Kim, **Donghyuk Cho**, Juwon Lee, Sangdeok Kim, Cheolmin Shin, Jeong Whan Yoon(2023). Prediction of Warpages in Glass Fiber/Polypropylene Plain Woven Composite Subjected to Compression Molding, The Korean Society for Technology of Plasticity 2023 Fall Conference, Jeju, Korea *[Abstract]*

9. **Donghyuk Cho**, Hassan Ghassemi-Armaki, Thomas B. Stoughton, Blair E., Jeong Whan Yoon. (2023). Unearthing a Fracture Mechanism in Al-Steel Dissimilar Welds: The Positive Impact of Pre-existing Micro-Defects on Weld Performance, *2023 Autumn Conference of the Korean Welding and Joining Society, Busan, Korea* **<Best Paper Awarded>** *[Abstract]*

10. Piemaan Fazily, **Donghyuk Cho**, Hyunsung Choi, Junho Cho, Jeong Whan Yoon. (2022). Machine learning-based formability analysis with TV back panel. *The Korean Society for Technology of Plasticity 2022 Fall Conference, Jeju, Korea. [Abstract]*

11. **Donghyuk Cho**, Hassan Ghassemi-Armaki, Thomas B. Stoughton, Blair E. Carlson Hyun-Min Sung, Brian N. Legarth, Jeong Whan Yoon. (2022). Constitutive and Fracture Modeling of Al-Steel Dissimilar Resistance Spot Welds. *The Korean Society for Technology of Plasticity 2012 Fall Conference, Jeju, Korea. [Abstract]*

12**. Donghyuk Cho,** Hyunsung Choi, Piemaan Fazily, Jaekun Kim, Jeong Whan Yoon. (2022). Development of AI-based In-situ Real-time Correction Algorithm to Compensate Springback of EV Motor Component. *The Korean Society for Technology of Plasticity 2022 Spring Conference, Yeosu, Korea. [Abstract]*

13. **Donghyuk Cho** and Y. Lee. (2019). Prediction Program for Damage and Surface Defects in Material in Drawing Process Based on Machine Learning. *The Korean Society for Technology of Plasticity 2019 Spring Conference, Daegu, Korea* **<Best Paper Awarded>** *[Abstract]*

14. **Donghyuk Cho** and Y. Lee. (2018). Comparison of reduction limit of single pass drawing for high strength steel according to ductile fracture criterion. *The Korean Society for Technology of Plasticity 2018 Fall Conference, Jeju, Korea. [Abstract]*

15. **Donghyuk Cho**, I. H. Baik, S. B. You, Y. Lee. (2018). Development of Hybrid Drawing Process for Manufacturing of High strength Ultra Fine Grained Wire Rod. *The Korean Society for Technology of Plasticity 2018 Spring Conference, Seoul, Korea.* *[Abstract]*

16. **Donghyuk Cho**, S. J Lee, Y. H Roh, Y Lee. (2018). Development of design parameter prediction program for API centrifugal pump in refinery plant using ANN. *The Korean Society of Mechanical Engineering 2018 Spring Conference, Yeousu, Korea.* *[Abstract]*

17. **Donghyuk Cho**, K.K Kim, J.T Oh, Y.N Park, H.K Choi, Y. Lee. (2017). Multi-objective optimal design of bar drawing process base on Artificial Neural Network and Genetic Algorithm. *The Korean Society for Technology of Plasticity 2017 Fall Conference, Jeju, Korea.* *[Abstract]*

18. **Donghyuk Cho**, T. Y. Kim, H. S. Kang, S. M. Byon, Y. Lee. (2016). Cause Analysis of Fracture in Outer Ring in Mill Stand in Hot Rod (or Bar) Rolling Process. *The Korean Society for Technology of Plasticity 2016 Spring Conference, Andong, Korea.* *[Abstract]*

AWARDS AND HONOR

2025 KWJS Best Presentation Award [Certificate]
-Nominated as the best paper at *Korean Welding and Joining Society Conference*

2024 Best Paper Award by The Korean Federation of Mechanical Engineering Societies [Certificate]
-Nominated as the best paper at *The Korean Society for Technology of Plasticity Conference*

2023 KWJS Best Presentation Award [Certificate]
-Nominated as the best paper at *Korean Welding and Joining Society Conference*

2022 Best Teaching Assistance Award [Certificate]
-Course: Advance Mechanics of Solids (Lecturer: Prof. Seyoung Im)

2021 Best Teaching Assistance Award [Certificate]
-Course: Mechanics of Plastic Deformation (Lecturer: Prof. Jeong Whan Yoon)

2020 Best Master's Thesis in Mechanical Engineering [Certificate]
- Nominated as a best master's thesis in the field of CAE and Applied Mechanics in 2020 by KSME

2019 JMST Second Best Paper Award [Certificate]
- Nominated as the best paper of *Journal of Mechanical Science and Technology* in 2019 by the Editorial Board

2019 KSTP Best Presentation Award [Certificate]
-Nominated as the best paper at *The Korean Society for Technology of Plasticity Conference*

2018 Grand Prize of Technical Solution and Idea for Steels [Certificate]
- Nominated as the best technical idea for steels. Sponsor: POSCO

Korea Government Scholarship (Sep.2021-Aug.2024)
-Full-tuition scholarship and living expenses for exceptional graduates in South Korea

CAU Graduate Research Scholarship (Mar. 2018 – Feb. 2020)

-Full-tuition scholarship for exceptional graduates at Chung-Ang University

PARTICIPATION IN RESEARCH PROJECTS

1. Methods for Acquiring Notch Material Property Data and Development of a Plasticity Material Model (*May. 2025-Present*) Sponsor: *LG Energy Solution*

1. Micro-scale Characterization of Cup to Can Laser Welding for Electrical Vehicle Prismatic Battery (*May. 2024-Present*) Sponsor: *General Motors Global R&D*

2. Measurement of Local Mechanical Properties and Fracture Modeling of Spot Welds in Giga Steel (*Jan. 2024-Present*) Sponsor: *POSCO Global R&D*

3. Advanced Characterization and Modeling of Dissimilar Laser Welds for Tabs to Busbar(*Sep. 2023-Present*) Sponsor: *General Motors Global R&D*

4. Development of Lower Protection panel for EV battery pack using optimal design based on Machine Learning and Polypropylene/Glass fiber Fabric composites (*Apr. 2022-Dec. 2023*), Sponsor: *Ministry of Trade, Industry and Energy*

5. Development of Plastic Tailgate using Inner panel applying Polypropylene Composite/Glass fiber composite and Poly(lactic acid)/Glass fiber Composite based on Compounding and Outer Panel applying Nonpainting Plastic (*June. 2022-Dec. 2025*), Sponsor: *Ministry of Trade, Industry and Energy*

6. Constitutive and Fracture Modeling of Al-Steel Dissimilar RSW(*Mar.2021-Present*) Sponsor: *General Motors Global R&D*

7. Establishment of Geometrical Standards to Minimize Thermal Distorsion of Aluminum Large Clamshell Hoods (*Mar. 2022-Present*) Sponsor: *HYUNDAI Motors*

8. A Study on the Investigation of the Specific Causes of Magnetization of Shipbuilding Steel Materials and Solutions (*Jul. 2021-Oct. 2021*) Sponsor: S*amsung Heavy Industry*

9. Intelligent Hairpin Forming - Algorithm Development (*Mar. 2021-Jul. 2021*) Sponsor: *LG Electronics*

10. A method that predicts in real-time the wear profile change of work rolls and determines the compensation value of roll gap and roll rpm using the current of the mill motor in caliber rolling *(Jan. 2018-Jan. 2020)* Sponsor: *NRF*

11. Development of fatigue life prediction technology of rolling mill spindle based on fatigue failure *(Jan. 2018-Dec. 2018)* Sponsor: *POSCO*

LIST OF COURSES TAKEN AT GRADUATE SCHOOL

① Advanced Mechanics of Solids, ② Fracture Mechanics, ③ Mechanics of Plastic Deformation, ④ Joining Engineering, ⑤ Finite Element Analysis of Structures, ⑥ Optimal Design, ⑦ Automobile Special Topics in Mechanical Engineering, ⑧ Deformation, Fracture and Strength of Materials, ⑨ Advanced Engineering Design, ⑩ Machine Learning for AI, ⑪ Materials for Mechanical Engineering, ⑫ Advanced and Intelligent Manufacturing, ⑬ Scientific Writing

LIST OF TEACHING COURSES (AS A TEACHING ASSISTANCE)

① Advanced Mechanics of Solids, ②Mechanics of Plastic Deformation, ③ Basic Mechanical Practice, ④Mechanism Design, ⑤Foundation of Stress Analysis, ⑥ Advanced and Intelligent Manufacturing

LANGUAGE CAPACITY

Korean Native
English Fluent, with strong proficiency in academic writing and communication.

REFERENCE

Professor Jeong Whan Yoon
Position: Professor
Institution: Korea Advanced Institute of Science and Technology (KAIST),
Department: Department of Mechanical Engineering,
E-mail: j.yoon@kaist.ac.kr
Relation: Ph.D. Advisor, Advised since Sep. 2021

Professor Youngseog Lee
Position: Professor
Institution: Chung-Ang University
Department: Department of Mechanical Engineering,
E-mail: ysl@cau.ac.kr
Relation: Master Advisor, Advised since July 2014

Dr. Hassan Ghassemi-Armaki
Position: Staff Researcher
Institution: General Motors
Department: Materials & Manufacturing Systems Research
E-mail: hassan.ghassemi-armaki@gm.com
Relation: Collaborator, Cooperated since Jan. 2021

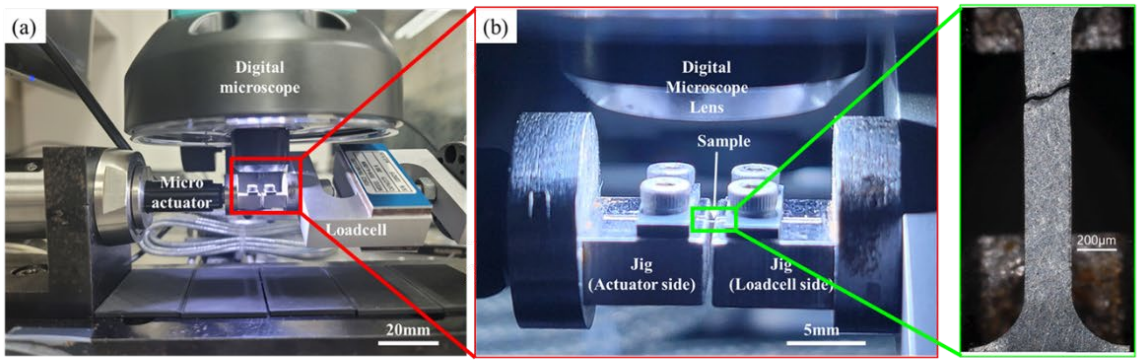
Professor Brian Nyvang Legarth
Position: Associate Professor
Institution: Technical University of Denmark (DTU)
Department: Department of Civil and Mechanical Engineering
E-mail: bnle@dtu.dk
Relation: Collaborator, Cooperated since Nov. 2021

Dr. Duyoul Choi
Position: Senior Researcher
Institution: POSCO
Department: POSCO Global R&D Center
E-mail: ctoto88@posco.com
Relation: Collaborator, Cooperated since Dec. 2022

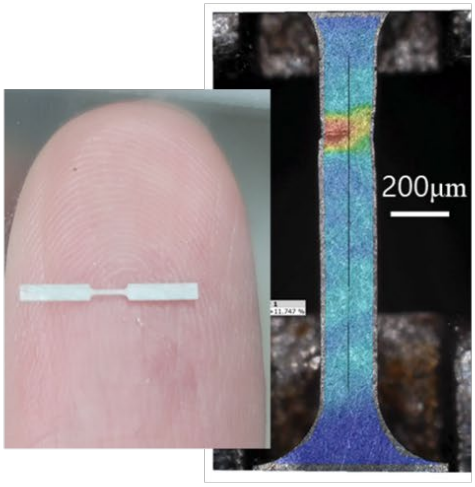
KEY RESEARCH CONTRIBUTIONS

Micro-scale Material Characterization and Modeling

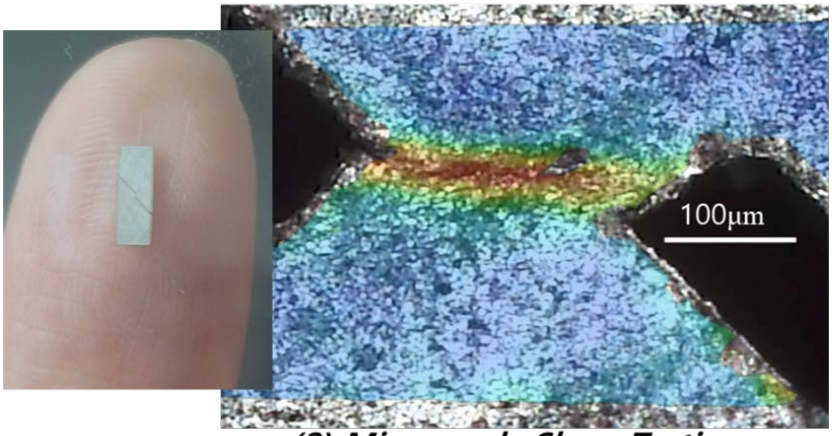
Traditional techniques struggled to capture localized mechanical properties in small welds, such as resistance spot welds and laser welds, particularly at the micro-scale. To address this, a method was developed to measure localized properties, overcoming challenges in sample fabrication, experimental system development, and μDIC. This involved designing and building a micro-scale testing system, establishing precise sample fabrication protocols, and developing μDIC-based data processing methods for three tailored tests: *(1) micro-scale tensile testing, (2) micro-scale shear testing*, and (3) *micro-scale gradient testing*. These efforts enabled the measurement of local mechanical properties at tens to hundreds of microns, significantly enhancing the understanding of GM's Al-Steel RSW, battery laser welds, and POSCO's 3rd generation steel RSW.



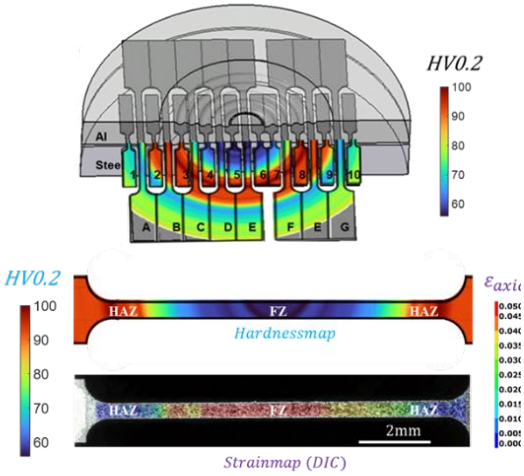
μ scale tensile testing system

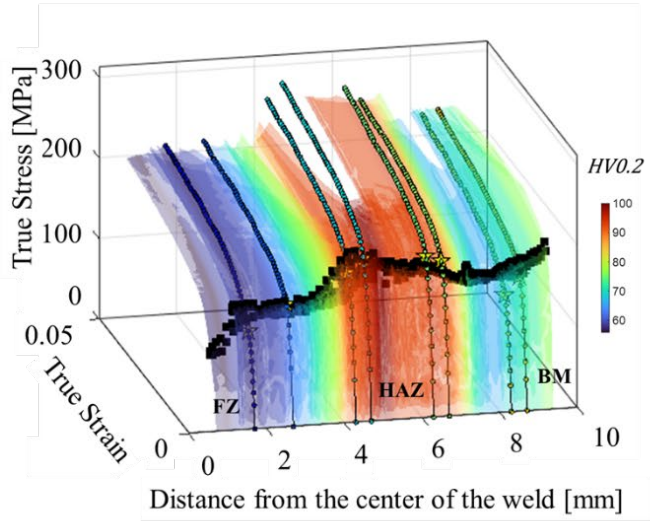


(1) Micro-scale tensile testing



(2) Micro-scale Shear Testing



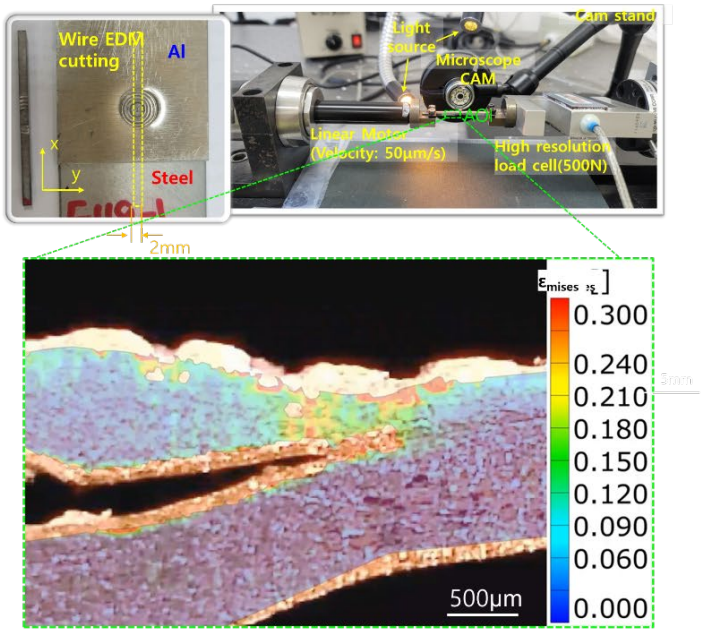


(3) Micro-scale Gradient Testing

Fracture Characterization

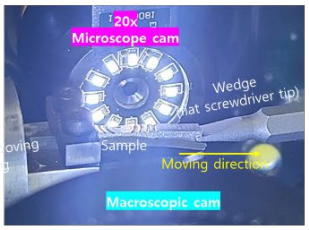
The fracture behavior of Al-Steel dissimilar welds presented unique challenges, particularly due to the competition between ductile Al fusion zones and IMC phases during crack initiation and propagation. Investigations focused on understanding the role of property gradients, defects, and IMC phase transitions in influencing crack paths and weld strength. To achieve this, three micro-scale fracture testing methods were developed: (*1) Miniature Lap-Shear Test, (2) Micro Wedge Test*, *and (3) Micro-scale IMC Fracture Test*, allowing in-situ observation of fracture mechanisms on diverse scales. This work directly revealed key fracture mechanisms, uncovering unknown phenomena. These findings provided strategies to enhance the strength and reliability of dissimilar welds.

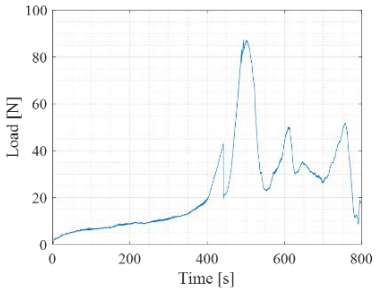
1) Miniature Lap-shear Test



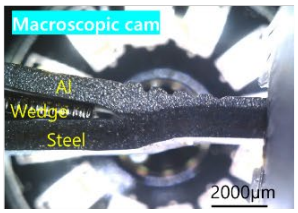
<IMC phase dependent crack path observation>

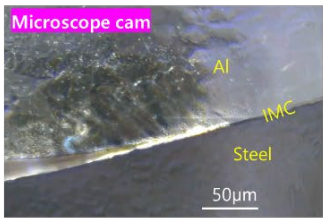
2) Micro Wedge Test

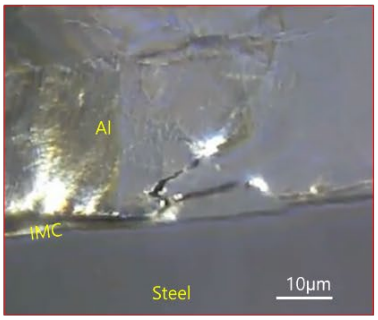




In-situ Load fluctuation

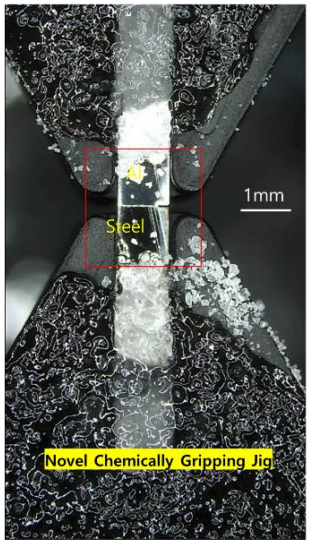




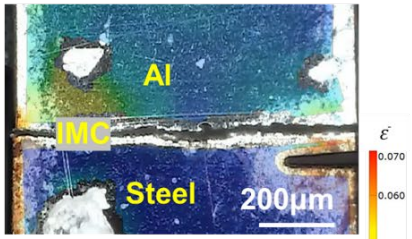


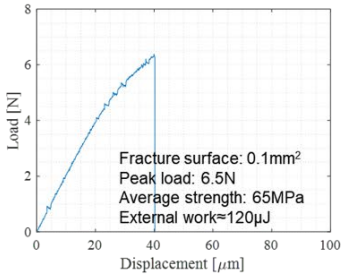
<Crack path change at the micro-defects>

3) Micro-scale IMC test

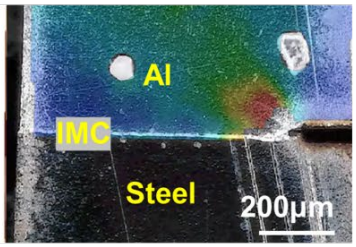


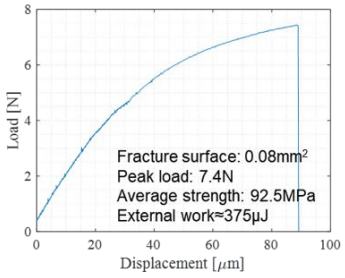
- **Pre-Notch in steel**

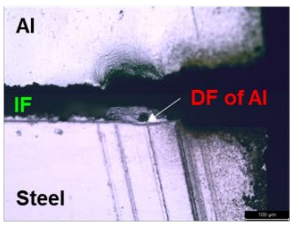




- **Pre-Notch on interface**



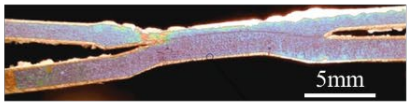




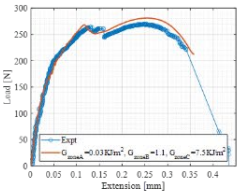
Fracture Modeling

Understanding fracture mechanisms in Al-Steel dissimilar welds required addressing knowledge gaps regarding IMC phase transitions, material property gradients, and micro-defects. To address these challenges, fracture models were developed at three scales: *(1) macro-scale to analyze IMC phase changes, (2) multi-scale to evaluate the impact of defects on crack paths, and (3) micro-scale to assess how defects influence local toughness*. Using FE analysis and experimental data, these models accurately predicted fracture behavior and revealed the role of micro-scale factors in determining crack paths and weld performance. The findings informed welding industries, enabling actionable recommendations that improved weld strength and toughness in collaborations with GM and POSCO.

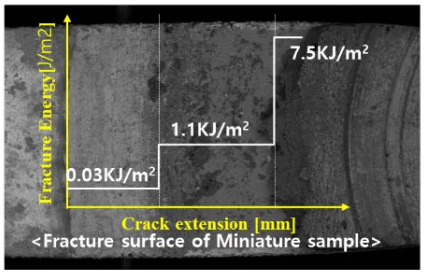
(1) Macro-scale fracture model



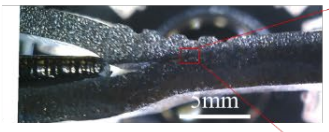
Test Results (μ DIC)



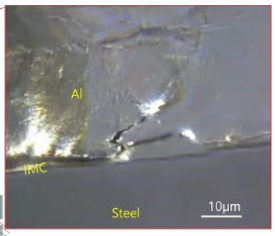
FE Model (CZM with variable fracture energy)

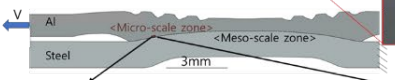


(2) Multi-scale fracture model

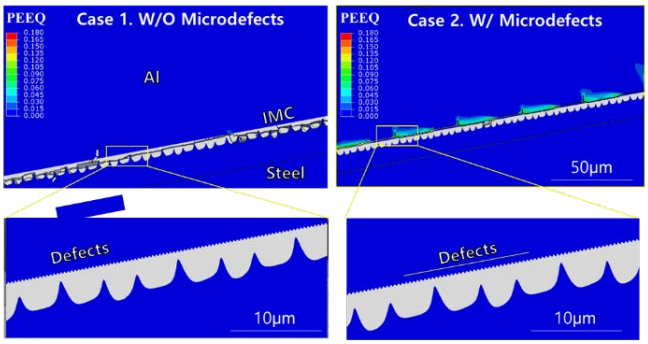


<Test Results>

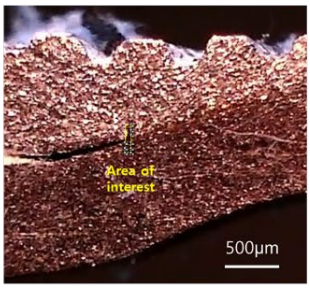


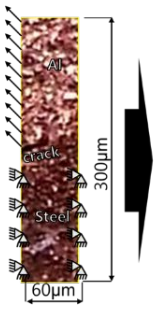


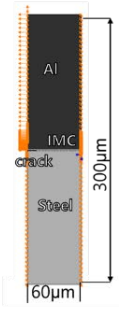
FE Model (Multi-scale model with micro-defects)

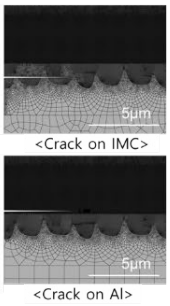


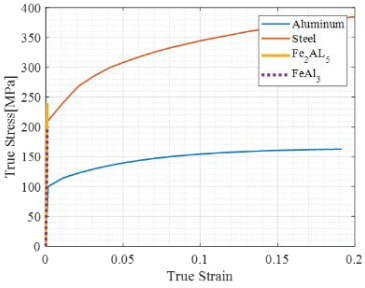
(3) Micro-scale fracture model



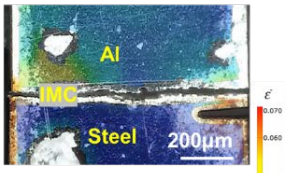




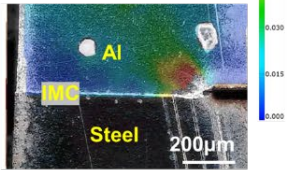


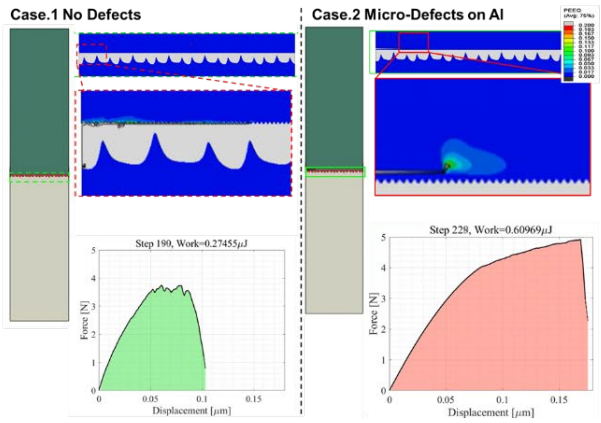


- **Pre-Notch in steel**



- **Pre-Notch on interface**



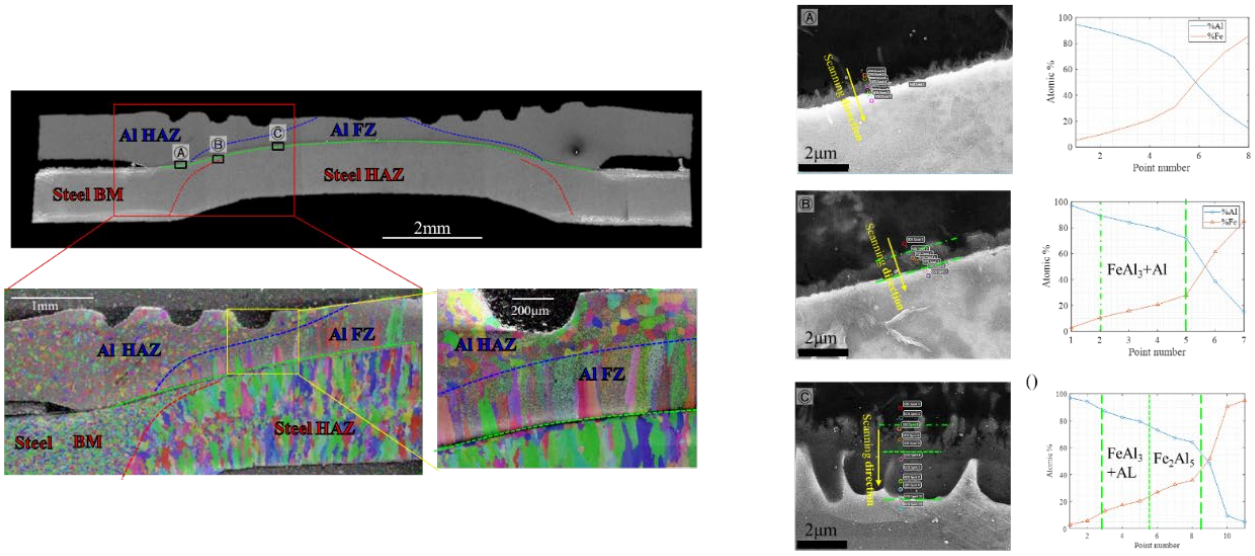


Test Results

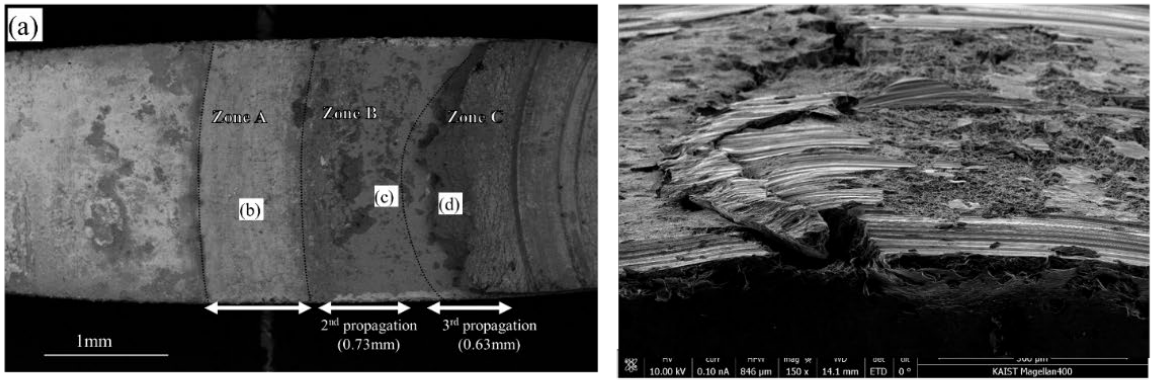
FE Simulation

Metallography and Fractography Analysis

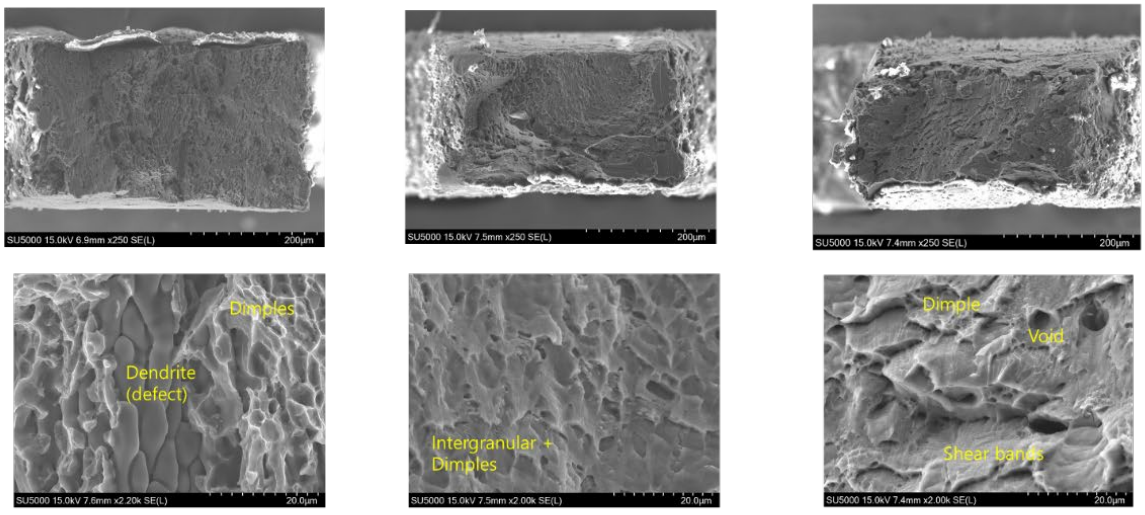
The relationship between microstructural features, local mechanical properties, and fracture mechanisms in Al-Steel dissimilar welds was investigated through comprehensive metallographic and fractographic analyses, incorporating SEM, BSE, EBSD, EDS, and micro-scale testing. This study deepened the understanding of how microstructural variations influence local mechanical properties and fracture behaviors. The findings provided practical solutions to strengthened weld reliability, shaping industry standards through collaborations with POSCO and GM.



SEM, EBSD, and EDS for metallographically characterizing Al-Steel Dissimilar Weld



BSE, EDS to characterize fracture mode of Al-Steel dissimilar weld



Fractography of different weld zones to identify fracture characteristics