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PREFACE

Preface for Feature Topic on Environmentally Benign Automotive Lightweighting

Junying Min[1] · A. Erman Tekkaya[2] · Yongbing Li[3] · Yannis P. Korkolis[4] · Ying Zhao[5]

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To address the pressing energy and environmental challenges and accelerate the realization of the "Carbon Net Zero" concept, the role of Environmentally Benign Automotive Lightweighting is crucial. Among the various technologies available, automotive lightweighting technologies not only contribute to the "Carbon Net Zero" process, but also extend the range of electric and hybrid-powered vehicles. Moreover, the implementation of environmentally-friendly technologies greatly improves the safety and overall performance of automobiles. The advancement of lightweighting technologies has led to the adoption of novel materials like advanced high-strength steels (AHSS), aluminum and magnesium alloys, fiber-reinforced polymers, and hybrid metal-polymer composites. These materials, combined with innovative structures such as architected cellular structures, and advancements in forming and joining processes, have propelled the field forward.

We organized this Feature Topic and expect it will promote the development of environmentally benign automotive lightweighting technologies and contribute to the "Carbon Net Zero" process. We would also like to take this opportunity to commemorate the Honorary and Founding Executive Editor-in-Chief Professor Fangwu (Mike) Ma for his contributions to eco-driving and for his dedicated support in the publication of the previous Special Issue on Automotive Lightweight in 2020 (https://link.springer.com/journal/42154/volumes-and-issues/3-3).

This Feature Topic comprises eight papers that showcase the latest advances in the pursuit of lightweighting in automotive applications. The core contributions of these articles are summarized below.

1 Highlights of Articles in the Feature Topic

(1) The paper titled "Environmentally Responsible Lightweight Passenger Vehicle Design and Manufacturing" by Glenn S. Daehn et al. addresses the urgent challenges of climate change and greenhouse gas emissions in personal transportation. It explores a comprehensive approach to significantly reduce greenhouse gas emissions by emphasizing longevity, utilization, shared ownership, lightweight design, aerodynamic efficiency, comfort, and electric power. This innovative model has the potential to revolutionize automotive manufacturing by reducing material consumption and enhancing per-mile efficiency.

(2) The paper "Hybrid Additive Manufacturing of Forming Tools" by A. Erman Tekkaya et al. showcases the integration of additive manufacturing (AM) with classical forming technologies. It presents three applications demonstrating the advantages of AM, including reduced temperatures, increased production speed, complex geometries, lower carbon footprint, and enhanced efficiency in the hot stamping process. This study highlights the potential of hybrid additive manufacturing in advancing tooling design for various forming applications.

(3) The paper "Low-Carbon-Emission Hot Stamping: A Review from the Perspectives of Steel Grade, Heating Process, and Part Design" by Junying Min et al. provides an overview of advancements in hot stamping

✉ Junying Min
junying.min@tongji.edu.cn

1 School of Mechanical Engineering, Tongji University, Shanghai 201804, China

2 Institute of Forming Technology and Lightweight Components, TU Dortmund University, 44227 Dortmund, Germany

3 Shanghai Jiao Tong University, Shanghai 200240, China

4 Department of Integrated Systems Engineering, The Ohio State University, 1971 Neil Avenue, Columbus, OH 43210, USA

5 College of Engineering and Technology, Southwest University, Chongqing 400715, China

technology, with a focus on carbon emission reduction in the automotive industry. It discusses steel grades, heating processes, and part design techniques that promote material efficiency and lightweighting. This review offers valuable guidance for sustainable hot stamping solutions to researchers, engineers, and policymakers.

(4) The paper "Mechanical Performance Evaluation of Multi-Point Clinch-Adhesive Joints of Aluminum Alloy A5052-H34 and High-Strength Steel JSC780" by Yunwu Ma et al. investigates the influence of the clinching process on adhesive layer performance in joining high-strength steel and aluminum alloy. The study examines stack-up orientations and clinching points, identifying factors affecting bonding strength. Valuable insights for optimizing clinch-adhesive joint performance are provided, contributing to the development of efficient and reliable joining techniques for vehicle body manufacturing.

(5) The paper "Soft Sensors for Property-Controlled Multi-Stage Press Hardening of 22MnB5" by Juri Martschin et al. presents the development of two soft sensors for measuring and controlling product properties during multi-stage press hardening. These sensors enable feedback control and optimization of product properties, such as temperature distribution and phase fractions. They offer significant potential for improving the efficiency and accuracy of multi-stage press hardening processes.

(6) The paper "Non-Associated and Non-Quadratic Characteristics in Plastic Anisotropy of Automotive Lightweight Sheet Metals" by Myoung-Gyu Lee et al. investigates the plastic behavior of lightweight sheet metals using a non-associated flow rule approach. The study highlights the importance of considering non-quadratic characteristics in plasticity modeling, particularly for aluminum alloys, and provides valuable insights for accurate finite element analysis of lightweight sheet metals in automotive applications.

(7) The paper "Review of Crashworthiness Studies on Cellular Structures" by Ying Zhao et al. offers a comprehensive overview of innovative cellular structures for energy absorption in vehicle collisions. The review discusses different application forms, design concepts, and manufacturing techniques, emphasizing the exceptional crashworthiness and potential for improving vehicle safety and energy efficiency. It also identifies key challenges in the field and provides valuable guidelines for researchers and engineers working on lightweight cellular structures.

(8) The paper "Analysis and Suppression of End Flare in AHSS Roll-Formed Seat Rail" by Dayong Li et al. addresses the issue of end flare, a shape error affecting the forming accuracy of roll-formed parts, using advanced high-strength steel (AHSS). The study analyzes the mechanism of end flare, develops finite element models to predict its occurrence, and proposes effective strategies for its mitigation. The findings highlight the primary factors causing end flare, the benefits of multiple bending processes, and the positive impact of homogenizing longitudinal residual stress on dimensional accuracy.

The collective insights presented in these eight papers contribute to the advancement of environmentally benign automotive lightweighting. We extend our sincere appreciation to all the authors, reviewers, and editors of Automotive Innovation for their dedicated efforts in bringing this Feature Topic to fruition. We hope that this compilation of research stimulates scientific ideas, encourages further exploration, and fosters impactful research in the field of automotive lightweighting.

Prof. Junying Min is the professor/vice dean of the School of MechanicalEngineering, Tongji University. His research interests include advancedforming processes, mechanical characterization and constitutive modeling, andhybrid components and processes, of lightweight materials. He was a postdocat the University of Hawaii and University of Michigan from 2013 to 2014. Heconducted research at the Ruhr University Bochum from 2015 to 2017 as anAlexander von Humboldt fellow. He is a member of the expert committee ofChina Auto Ligh tweight Technology Innovation Strategy Alliance. To date hehas published more than 150 peer reviewed papers and 3 monographs with his co authors and has over20 invention patents filed/granted.

Prof. A. Erman Tekkaya is a professor at TU Dortmund University in Dortmund, Germany and director of the Institute of Forming Technology and Lightweight Components (IUL). He studied mechanical engineering in Ankara, Turkey and completed his doctoral studies in Stuttgart, Germany. His research interests cover fundamentals and technology of novel metal forming processes as well as material characterization for modelling plastic deformations. He is a visiting professor at the Ohio State University, USA and honorary professor at the Xi'an Jiao Tong University, China. Prof. Tekkaya is a member of acatech German Academy of Science and Engineering

fellow of the International Academy for Production Engineering (CIRP) and editor of Advances in Industrial and Manufacturing Engineering (AIME).

Prof. Yongbing Li is a distinguished professor in Mechanical Engineering at Shanghai Jiao Tong University and director of Shanghai Key Laboratory of Digital Manufacturing for Thin walled Structures. He earned his Bachelor's and Master's degrees in Materials Processing from Xi'an Jiao Tong University in 1998 and 2001, respectively, before obtaining his PhD in Automotive Engineering from Shanghai Jiao Tong University in 2005 He was a visiting postdoctoral fellow at The University of Michigan (2006–2007) and a visiting scholar at Oak Ridge National Laboratory in 2014. Prof. Li is a member of the Standing Committee of Welding Branch of China Mechanical Engineering Society, as well as the American Welding Society and American Society of Mechanical Engineers. He has received numerous awards and recognitions for his research in magnetic assisted spot welding process, hybrid riveting process, and real time monitoring and adaptive control of weld quality. He has published over 140 journal papers and granted 43 patents for inventions.

Prof. Yannis P. Korkolis is an Associate Professor, Integrated Systems Engineering, at the Ohio State University. Prior to joining the Ohio State University, he has been a faculty member at the University of New Hampshire for 8.5 years. He has also held visiting appointments at Kyoto University and Tokyo University of Agriculture and Technology in Japan. He has two years of experience in industry and the military. He has p ublished 3 book chapters, over 65 peer reviewed journal papers and has delivered over 160 conference papers, presentations, posters and invited talks. Prof . Korkolis' research is at the interface of constitutive modeling, formability and ductile fracture, and manufacturing processes. His particular approach involves multiaxial experiments, oftentimes using unique, custom built equipment, combined with the use of recent advanced material and numerical models. Prof . Korkolis is the recipient of numerous awards, including the 2018 Ralph R. Teetor Educational Award from the Society of Automotive Engineers, the 2012 Best Reviewer Award from the ASME Journal of Manufacturing Science and Engineering, and a 2012 NSF Faculty Early Career Development (CAREER) Award f rom the National Science Foundation. He is the Chair of the Steering Committee of the Numerical Methods for Industrial Forming Processes (NUMIFORM) series of conferences, and in 2019 he was the organizer of the 13 th Edition of the conference in Portsmouth, New Hampshire.

Dr. Ying Zhao received her PhD degree in the field of vehicle engineering from Jilin University, China, in June 2019 and worked as a research scholar at University of Michigan from October 2016 to September 2018. Until present, Dr. Zhao has been working as an assistant professor at Southwest University since July, 2019. Her research interests mainly focus on cellular structures and materials of vehicles, the impact performances of auxetic structures, and optimization algorithms. She algorithms. She was recognized as was recognized as a a Young Talent of China Association for Young Talent of China Association for Science and Technology in 2022. Dr. Zhao also serves as editor of Automotive Science and Technology in 2022. Dr. Zhao also serves as editor of Automotive Innovation (AUIN). She has published one academic book titled "AInnovation (AUIN). She has published one academic book titled "Arrchitected chitected Cellular Materials Cellular Materials-The Ultimate Solutions of The Ultimate Solutions of Vehicle Lightweight" as the first Vehicle Lightweight" as the first author, and more than 30 peerauthor, and more than 30 peer-reviewed articles have also been published, and reviewed articles have also been published, and she holds over 40 invention patents. She holds over 40 invention patents.