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Overview of the System Engineering for Lightweighting of Automotive Structures

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Abstract. Automotive lightweighting represents a core technical pathway for realizing energy conservation, emission reduction, and extending the driving range of new energy vehicles. From the systematic perspective of "materials-processes", this paper comprehensively reviews the application progress and development status of lightweight materials including high-strength steel, aluminum alloy, magnesium alloy and composite materials, as well as advanced manufacturing technologies such as conventional die casting, rheological die casting and integrated die casting. The study indicates that the future development of automotive lightweighting should focus on multi-material collaborative design and the upgrading of manufacturing processes. Nevertheless, the large-scale application of lightweight technologies is still confronted with severe challenges. Firstly, the profitable production of lightweight materials and the establishment of a recycling system covering the entire life cycle are not yet sufficiently developed. Secondly, advanced manufacturing processes are constrained by high equipment investments and industrialization challenges. This article aims to provide a theoretical reference for overcoming the aforementioned bottlenecks and accelerating the widespread dissemination and application of lightweight automotive technologies.

Keywords: Automotive Lightweighting, Automotive Lightweight Materials, Die Casting Process, Multi-material Collaborative Design

1. Introduction

1.1. The industrial context of body lightweighting and integrated structures

At present, foreign research has made important breakthroughs in the development of advanced materials and achieved remarkable results in light structural design. Although domestic research on high-end materials is relatively limited, rapid breakthroughs have been made in recent years, but the demand for high-end materials is still largely dependent on imports. Process and performance are weak and there is a significant gap from the international advanced level. This article provides a systematic review of existing research. In the context of the transformation of the automotive industry towards industrialization, low-carbon practices and electrification, it systematically analyzes the benefits, restrictions and application scenarios of high-strength steel, aluminum alloys, magnesium alloys and composite materials. In addition, it studies the process properties of

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integrated pressure casting, rheocasting,and traditional casting and offers valuable information for the development of lightweight technologies. Extract the key issues of body lightweight and provide corresponding ideas for subsequent researchers, provide clear academic context for field research, and clarify the research direction and reference framework.

1.2. The evolution of automotive structural lightweighting: vehicle weight reduction and cost reduction

Currently, the fear of range around new energy vehicles, particularly battery electric vehicles (BEVs), has imposed a rigid demand for weight reduction. Given the limited improvements in battery energy density, reducing body weight can greatly improve vehicle range. Automotive Lightweighting focuses primarily on optimizing the use of materials and manufacturing processes. There has been a gradual transition from traditional steel to high-strength steel, aluminum alloys, magnesium alloys and composite materials, continuously improving the specific strength and corrosion resistance of materials, to ensure structural safety while reducing weight. On the other hand, traditional die casting, with its mature system, supports the mass production of light components. Rheocasting is an environmentally friendly and effective solution to overcome the pain point of high error rates, while integrated pressure casting achieves a double leap in light weight and production efficiency through structural integration. Figure 1 shows a schematic diagram of the lightening of the automobile construction. The synergistic development of materials and processes together pushes the development of automotive structures towards lighter, more robust and more efficient structures.

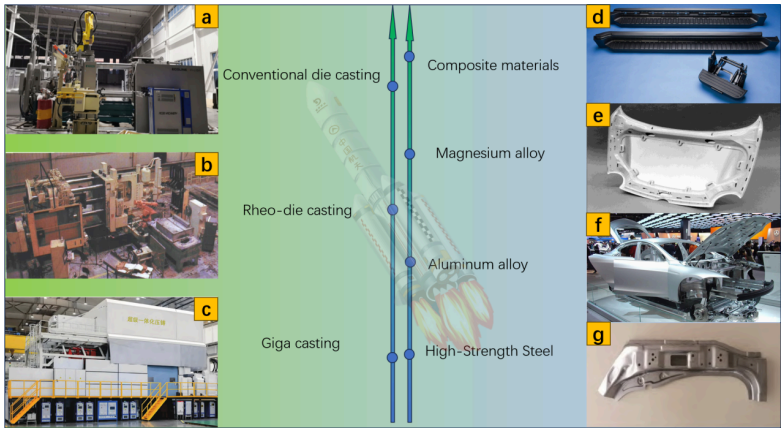


Figure 1. Schematic diagram of material-process evolution for lightweighting of automobiles [1-7]

a: Traditional die casting; b: Rheocasting; c: Integrated die casting; d: Composite material; e: Magnesium alloy; f: Aluminum alloy; g: High-strength steel

1.3. Lightweight of automobile structure:key challenges

At present, the main challenge of lightness in the automotive sector lies in the fact that lightweight materials such as high-strength steel, aluminum alloys, magnesium alloys and composites present all the limits of performance and economic efficiency for practical applications that hinder the lightweight of the body structure.At the process level, techniques such as integrated die casting, rheocasting and traditional pressure casting face equipment limitations, high costs or performance limitations. In addition, considerable difficulties remain for the connection of different materials.

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2. Automotive lightweight materials

2.1. High-strength steel

High Strength Steel (HSS) is a powerful metallic material, which has been developed into traditional steel through composition optimization and process innovation and is currently the most widely used lightweight metallic material. Advanced High Strength Steel (AHSS) research remains a challenge. Liu et al. [8] designed a new ultra-high strength steel (0.25C-2Cr-10Ni-8Co-2Mo-2Al), which exhibits outstanding tensile strength, achieving superior yield strength and shock resistance, and a balance between strength, plasticity, and strength, which was difficult to achieve with traditional high strength steel. Lyu et al. [9] studied the mechanical performance of high-strength steel multi-screw joints through experiments and digital simulations and proposed an ultimate high-precision front strength model. Despite its excellent performance, high strength steel has a relatively low weight reduction rate, which makes it difficult to fully achieve the lightness goals in the automotive sector.

2.2. Aluminum alloys

Aluminum alloys are, due to their high specific strength, excellent energy absorption capacity and significant weight reduction effects have become one of the basic materials in the field of automotive similarity. Vázquez et al. [10] studied the fatigue-braking behavior of Al7075-T651 alloy through digital experiments and simulations and demonstrated that digital methods - in particular the ΔK 1* maximum method and the SWT maximum method - offer high prediction accuracy and can accurately reproduce the pathways of crack propagation and offer high-precision theoretical tools for technical construction. Yan et al. [11] manufactured graphene-nanoplate reinforced aluminum matrix composite materials by powder metallurgy and achieved a 50% increase in Dehnung. This study breaks the long-standing barrier to balance strength and plasticity in aluminum alloys and provides critical support for the development of Automotive Materials. This shows that aluminum alloys balance strength and plasticity while offering considerable lightness potential.

2.3. Magnesium alloys

Magnesium alloys are currently the lightest metals in industrial applications, offering high strength per unit weight while retaining excellent rigidity during weight reduction and thus playing a decisive role in the Lightness process in the automotive sector. Lu et al. [12] studied the fracture behavior and Crack initiation mechanisms of AZ91 magnesium alloy under tensile and impact stress and concluded that there are differences between the fracture behaviors under tensile and percussion, with different fracture morphologies being observed in different regions under percussion pressure. Wu et al. [13] studied the mechanisms of improving the ductility of magnesium alloys and established a predictive theory that demonstrates, that specific diluted solvents can promote dislocation unfolding and multiplication, while preventing their transformation into stationary structures, which improves ductility. In recent years, research has mainly focused on improving the performance of magnesium alloys, which has significantly increased their lightweight potential.

2.4. Composite materials

Composite materials offer excellent corrosion resistance and have great design flexibility. Due to its significantly lower density compared to steel, aluminum and magnesium far exceed those of metals

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in their mechanical performance per unit weight and offer exceptional lightness effects. As such, they currently represent the automotive materials with the greatest weight reduction potential. Ying et al. [14] studied the effect of density on punching behavior and showed that the model could accurately reproduce the punching process, providing an accurate modeling tool for efficient manufacturing and performance optimization of carbon fiber-reinforced composite materials. Wang et al. [15] studied the influence of carbon fiber volume fraction and other factors on traction properties and hybrid effects. After optimization, the strength and toughness of the composites have been significantly improved. Thanks to their extremely low density and high reliability, composite materials are the ideal choice for lightweight applications in the automotive sector.

The trade-off between performance and cost-effectiveness of lightweight materials is a central consideration in their technical application. characterized in that the corresponding cost-performance map is shown in Table 1:

Table 1. Performance and cost comparison of automotive lightweight materials [16,17]

Material type	Weight reduction rate	Density(kg/m^3)	Specific strength(MPa*cm^3/g)	Relative cost vs. mild steel(times)
AHSS	15%-25%	7.8	100-200	1-1.5
Aluminum alloys	40%-60%	2.7	110-180	1.5-3
Magnesium alloys	60%-75%	1.8	120-200	1.5-2.5
CFRP	50%-60%	1.5	500-1000	2-10+

High strength steel achieves increased strength by reinforcement processes, but does not overcome the density bottleneck. Overall, high-strength steel is therefore suitable for both use in automotive parts and for pressure molds. Aluminum alloys, with their relatively low density, find a balance between strength, plasticity and cost, so they can be used for components such as engine supports and shock absorber turrets that are manufactured by integrated die casting. Magnesium alloys and carbon fiber compounds represent the technological direction of the "ultimate lightweight", even though the operating costs are higher. Magnesium alloys offer high strength per unit weight and can be used in automotive interiors and small components. Composite materials have high corrosion resistance, construction flexibility, great structural integration and excellent shock and safety resistance, making it suitable for body panels, structural reinforcements and auxiliary materials. The four types of lightweight materials are shown in Figure 2.

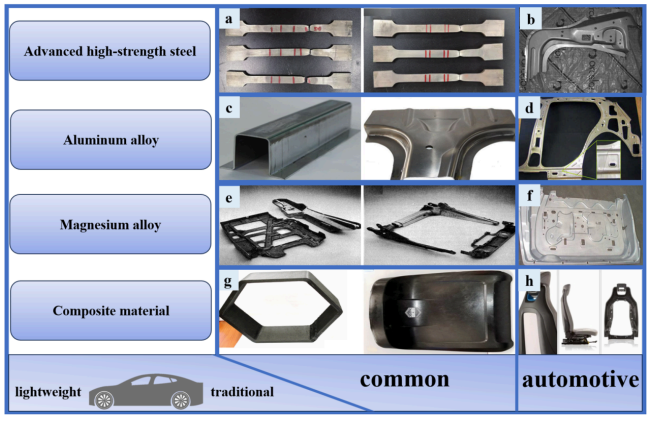


Figure 2. Automotive lightweight materials [18-25]

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a: Commonly used high-strength steel materials diagram; b: Diagram of automotive high-strength steel materials; c: Commonly used aluminum alloy materials diagram; d: Diagram of automotive aluminum alloy materials; e: Commonly used magnesium alloy materials diagram; f: Diagram of automotive magnesium alloy materials; g: Commonly used composite materials diagram; h: Diagram of automotive composite materials

3. Automotive lightweighting technology

3.1. Traditional die casting

Traditional pressure casting offers high production efficiency and measurement accuracy and is capable of forming complex thin-walled structures. Niu et al. [26] studied the effects of treatment parameters on flowability. The defects and mechanical properties of Al-Si-Mg alloy high-pressure die casting components suggested the concept of effective flow length to assess castability. Mielke et al. [27] identified critical processing windows by optimizing process parameters and characterizing interfaces. Thanks to the inclusion of a locking mechanism, they increased the total bonding strength of the aluminum-steel interface to 25 MPa. Its research effectively overcomes the challenges of low adhesion and poor stability and offers a reliable process solution for lightweight in the automotive sector.

3.2. Rheological die casting

Rheocasting offers considerable improvements over conventional die casting in terms of form quality, mechanical properties, process efficiency, costs and safety. Kopper et al. [28] have developed an on-demand reforming process that allows direct preparation of sludge from liquid aluminum alloy and recycling of waste, which reduces porosity and reduces cycle times, thereby overcoming the high cost barriers and recycling difficulties of materials associated with thixoforming. Qi et al. [29] developed the ACSR-rheocasting high pressure casting process that enables thermal conductivity, greatly increased the strength and corrosion resistance of heat dissipation components, and addressed the problems of high porosity and coarse secondary phases, which are common in traditional high pressure casting.Rheocasting develops towards a balance between carbon neutrality and increased strength and positions it as a critical process in the field of lightweight in the automotive sector.

3.3. Integrated die casting

Integrated die casting offers a high degree of structural integration, which greatly improves the mechanical properties and structural rigidity of the body. At present, this process has become a core technology for lightweight. Dong et al. [30] studied the shape laws and error control strategies for large integrated thin-walled aluminum alloy die castings and achieved improved performance. Zhao et al. [31]. conducted single-factor simulations, multi-parameter optimization studies, and structural modification to address the problem of shrinkage porosity in integrated pressure casting. Through process optimization and fault control, they have advanced the application of integrated die casting in precision components in the automotive sector. Integrated die casting significantly reduces weight and improves performance, positioning it as a critical process for lightweight in the automotive sector.

Cost is also an inevitable factor in the development of lightweight in the automotive sector. The comparison of process performance to cost is shown in Table 2:

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Table 2. Performance and cost comparison of automotive lightweighting processes [32-39]

Process type	Tensile strength (Mpa)	Hardness(HB)	Elongation(%)	Relative cost vs. conventional die casting (times)
Conventional die casting	180-220	95-100	2-3	1
Rheological die casting	240-285	115-120	10-15	1.05-1.1
Integrated die casting	221-312	90-105	8-12	0.8-0.9

Traditional die casting, characterized by its mature process, high mass production capability, and excellent material adaptability, has laid the core foundation for automotive lightweighting. Furthermore, rheocasting, through innovative slurry preparation processes and the development of specialized alloys, has reduced material defects and achieved a green and environmentally friendly process upgrade, solving the pain point of high porosity inherent in traditional die casting. Integrated die casting, in turn, achieves a balance between lightweighting and production efficiency, establishing itself as the core direction for new energy vehicle lightweighting. Three casting processes are shown in Figure 3:

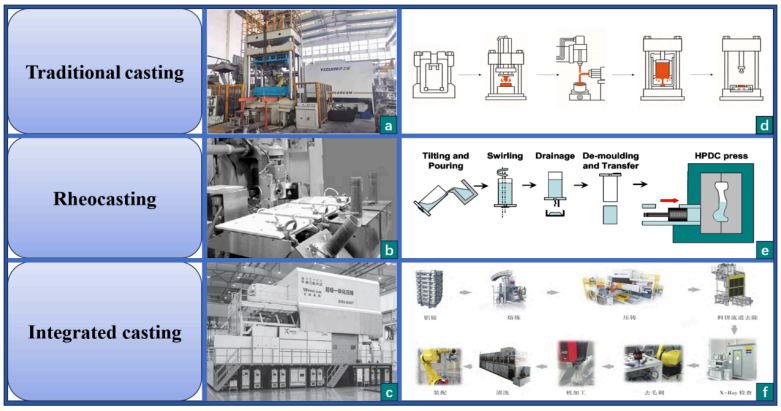


Figure 3. Automotive lightweighting process schematic [40-43]

a: Conventional die casting equipment; b: Rheocasting equipment; c: Integrated die casting equipment; d: Conventional die casting process; e: Rheocasting process; f: Integrated die casting process;

4. Outlook and opportunities for the future: automotive lightweight technology

4.1. Multi-material collaborative design

Collaborative multi-material design represents a decisive direction for the future development of lightweight technologies in the automotive sector. Its fundamental principle is the integrated application of different materials – including high-strength steel, aluminum alloys, magnesium alloys and composite materials – depending on the load requirements and operating conditions of different body components, achieving a balance between performance and cost. Supported by advanced moulding processes such as integrated die casting and rheo casing, collaborative design with multiple materials promotes the transformation of body structures from simple weighing to light weighing coupled to multiple materials. Thanks to the complementary properties of different materials, it fully exploits the structural strength of hard alloys and simultaneously exploits the lightness potential of Low-Density Materials. This approach enables synergistic improvements in

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terms of lightness, mechanical properties, conformability and shock safety and offers a key technological path for the structural lightness of future new energy vehicles.

4.2. Process upgrade drives lightweight design

Process modernization is one of the key ways to promote lightweight design. The technological evolution from conventional pressure casting to Rheocasting and then to integrated pressure casting shows a gradual improvement in lightness. Thanks to its delicate filling process with semi-resistant sludge, Rheocasting effectively improves density and overall mechanical properties compared to conventional pressure casting. casting, which allows the components to obtain the strength while being thinner and more compact. Integrated die casting, on the other hand, represents a transformative leap in structural integration, grouping several discrete parts into a single large-scale integrated component, which greatly increases structural rigidity and production efficiency become. Together, this pioneering development forms a solid process basis for the advancement of lightweight in the automotive sector.

5. Conclusion

5.1. From materials to processes and performance: the relationship between the three

When it comes to lightweight design, materials, processes and performance develop in synergy. Materials often determine the lightness potential, while processes not only determine whether this potential can be fully realized, but also contribute to structural weight reduction through integrated construction. Fatigue resistance and service are key criteria for determining whether weight reduction is achievable. Optimizing molding processes reduces internal defects, increases density and improves fatigue resistance. Implementation of large-area integrated components through integrated die casting minimizes connections and voltage concentration and improves service performance Weight reduction. Only a synergistic harmonization of materials, processes and performance ensures structural safety and reliability when reducing weight.

5.2. Automotive lightweighting issue: current shortcomings

At present, lightweight in the automotive industry still faces significant shortcomings, with a remarkable contradiction between cost and scale. Advanced processes such as integrated die casting rely heavily on large-area devices, which poses significant implementation challenges for small and medium-sized automotive companies and creates significant barriers to lightweight technology. The manufacturing of magnesium alloys is energy-intensive and highly polluting, while composite material recycling systems are not yet well established and remain expensive. Thus, very light materials cannot reach a cyclic life cycle. Future lightweight research in the automotive sector should focus on low-cost preparation technologies for lightweight materials and efficient recycling processes, reducing costs while preserving mechanical properties. Studies on advanced processes such as integrated die casting should aim to lower the threshold for plant investments and improve the accessibility of superior manufacturing technologies. In-depth research on collaboration with multiple materials should be followed, with progressive development towards composite material solutions. In summary, light weight in the automotive industry should move from simple material exchange to systematic integration of materials, processes and performance, to support low-carbon transformation and qualitative development of solid automotive industry.

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References

[1] Tian-hao, D. (2025). Post-processing Equipment and Layout for the Integrated Die-casting Unit. Foundry Equipment And Technology(06), 49–54. https: //doi.org/10.16666/j.cnki.issn1004-6178.2025.06.009

[2] Sebastian, W., Dröder, K., & Schumann, S. (2001). Properties and Processing of Magnesium Wrought Products for Automotive Applications. Advanced Engineering Materials, 3(12), 602–608.

[3] Stewart, R. (2009). Lightweighting the automotive market. Reinforced Plastics, 53(2), 14, 18, 21–16, 19, 21.

[4] Zhang, Q., Cao, M., Zhang, D., Zhang, S., & Sun, J. (2014). Research on integrated casting and forging process of aluminum automobile wheel. Advances in Mechanical Engineering, 6, 870182.

[5] Bing, J. E. S. F. N. (2026). Discussion on feasibility of producing automotive steel sheet via the full-scrap EAF smelting process. Iron and Steel. https: //doi.org/1010.13228/j

[6] Roberto Boni, W. J. (2009). Idra Semi-solid Rheocasting Technology. Special Casting & Nonferrous Alloys, 29(2), 2.

[7] Shizhong, L. (2020). Research on HPDC Technology and Mechanical Performance Analysis of Automobile Aluminum Alloy Shock Tower Jilin University].

[8] Liu, T., Cao, Z., Wang, H., Wu, G., Jin, J., & Cao, W. (2020). A new 2.4 GPa extra-high strength steel with good ductility and high toughness designed by synergistic strengthening of nano-particles and high-density dislocations. Scripta Materialia, 178, 285–289. https: //doi.org/10.1016/j.scriptamat.2019.11.045

[9] Lyu, Y.-F., Li, G.-Q., Wang, Y.-B., Li, H., & Wang, Y.-Z. (2020). Bearing behavior of multi-bolt high strength steel connections. Engineering Structures, 212. https: //doi.org/10.1016/j.engstruct.2020.110510

[10] Vázquez, J., Carpinteri, A., Bohórquez, L., & Vantadori, S. (2019). Fretting fatigue investigation on Al 7075-T651 alloy: Experimental, analytical and numerical analysis. Tribology International, 135, 478–487. https: //doi.org/10.1016/j.triboint.2019.03.028

[11] Yan, S. J., Dai, S. L., Zhang, X. Y., Yang, C., Hong, Q. H., Chen, J. Z., & Lin, Z. M. (2014). Investigating aluminum alloy reinforced by graphene nanoflakes. Materials Science and Engineering: A, 612, 440–444. https: //doi.org/10.1016/j.msea.2014.06.077

[12] Lu, Y. Z., Wang, Q. D., & Zeng, X. Q. (2000). Fracture behavior of AZ91 magnesium alloy. Materials Letters, 44(5), 265–268.

[13] Wu, Zhaoxuan, Ahmad, Rasool, Yin, Binglun, Sandloebes, Stefanie, Curtin, & W. (2018). Mechanistic origin and prediction of enhanced ductility in magnesium alloys. Science.

[14] Ying, Z., Sun, X., Wu, Z., Peng, L., Cheng, X., Zhu, F., & Chen, F. (2025). High-Precision Parametric Modeling and Needling Process Mechanism of Carbon Fiber Needled Preforms. Applied Composite Materials, 32(6), 2879–2909. https: //doi.org/10.1007/s10443-025-10358-w

[15] Wang, A., Liu, X., Yue, Q., & Xian, G. (2023). Tensile properties hybrid effect of unidirectional flax/carbon fiber hybrid reinforced polymer composites. Journal of Materials Research and Technology, 24, 1373–1389. https: //doi.org/10.1016/j.jmrt.2023.03.078

[16] Wu, R., Dai, W., Luo, J., Li, M., Liu, Y., & Li, H. (2025). Aluminum Alloy Hot Stamping and Forming Technology: A Review. Materials, 18(8). https: //doi.org/10.3390/ma18081694

[17] Zhang, S., Song, H., Xu, L., & Cai, K. (2022). Application Research on the Lightweight Design and Optimization of Carbon Fiber Reinforced Polymers (CFRP) Floor for Automobile. Polymers, 14(21). https: //doi.org/10.3390/polym14214768

[18] Songtao, L., Chunfu, G., Chen, Y., Yupeng, Z., Chen, Y., & Haiyan, W. (2026). Analysis of microstructure and properties of multi-layer and multi-bead double-wire submerged arc welding of Q355ND high-strength steel. Transactions Of Materials And Heat Treatment, 47(01), 227–236. https: //doi.org/10.13289/j.issn.1009-6264.2025-0288

[19] Bouaziz, O., Zurob, H., & Huang, M. (2013). Driving Force and Logic of Development of Advanced High Strength Steels for Automotive Applications. steel research international, 84(10), 937–947. https: //doi.org/10.1002/srin.201200288

[20] Hirsch, J. (2014). Recent development in aluminium for automotive applications. Transactions of Nonferrous Metals Society of China, 24(7), 1995–2002. https: //doi.org/10.1016/s1003-6326(14)63305-7

[21] Jaśkiewicz, K., Skwarski, M., Kaczyński, P., Gronostajski, Z., Polak, S., & Trzpis, P. (2022). Warm sheet metal forming of energy-absorbing elements made 7075 aluminum alloy in the hardened state T6. The International Journal of Advanced Manufacturing Technology, 119(5-6), 3157–3179. https: //doi.org/10.1007/s00170-021-08549-3

[22] Liu, B., Yang, J., Zhang, X., Yang, Q., Zhang, J., & Li, X. (2023). Development and application of magnesium alloy parts for automotive OEMs: A review. Journal of Magnesium and Alloys, 11(1), 15–47. https:

DOI: 10.54254/2755-2721/2026.BJ32751

//doi.org/10.1016/j.jma.2022.12.015
[23] Luo, A. A. (2005). Wrought Magnesium Alloys and Manufacturing Processes for Automotive Applications. Sae Technical Papers, 1.
[24] Taub, A., De Moor, E., Luo, A., Matlock, D. K., Speer, J. G., & Vaidya, U. (2019). Materials for Automotive Lightweighting. Annual Review of Materials Research, 49(1), 327–359. https: //doi.org/10.1146/annurev-matsci-070218-010134
[25] Fatima, N., Alam, S., Islam, M. N., Hasan, M. M., & Sany, M. Z. I. (2025). Lightweighting the Future: A Comprehensive Review of Materials in Automotive Design.
[26] Niu, Z., Liu, G., Li, T., & Ji, S. (2022). Effect of high pressure die casting on the castability, defects and mechanical properties of aluminium alloys in extra-large thin-wall castings. Journal of Materials Processing Technology, 303. https: //doi.org/10.1016/j.jmatprotec.2022.117525
[27] Mielke, F., Sulik, D., & Fang, X. (2025). Influence of high-pressure die casting parameters on bonding characteristics of aluminium-steel hybrid-castings for automotive lightweight structures. Journal of Manufacturing Processes, 143, 351–368. https: //doi.org/10.1016/j.jmapro.2025.04.032
[28] Kopper, A., Donahue, R., Olson, D., & Midson, S. (2006). Case Studies of Large Components Produced by High-Pressure Die Casting and Slurry-on-Demand Casting. SAE World Congress,
[29] Qi, M., Kang, Y., Xu, Y., Wulabieke, Z., & Li, J. (2020). A novel rheological high pressure die-casting process for preparing large thin-walled Al–Si–Fe–Mg–Sr alloy with high heat conductivity, high plasticity and medium strength. Materials Science and Engineering: A, 776. https: //doi.org/10.1016/j.msea.2020.139040
[30] Dong, J., Jiang, J., Wang, Y., Qin, T., Huang, M., Cui, J., Zhang, X., Kong, L., & Chen, J. (2025). Research on numerical simulation and integrated die casting process of large complex thin-walled aluminum alloy automobile rear floor. Results in Engineering, 26. https: //doi.org/10.1016/j.rineng.2025.105399
[31] Zhao, S., Ye, H., Gu, R., Xing, H., Xie, J., & Liu, Z. (2025). Numerical Simulation and Process Parameter Optimization of High-Pressure Socket for Automobile Based on Integral Die Casting. International Journal of Metalcasting, 19(5), 2903–2917. https: //doi.org/10.1007/s40962-024-01506-2
[32] Zhifeng, F. Y. X. J. G. Z. Z. (2017). Simulated and Experimental Study on Rheo-Diecasting Process of 7075 Aluminum Alloy. Chinese Journal Of Rare Metals, 41(11), 1180–1187. https: //doi.org/10.13373/j.cnki.cjrm.xy16032807
[33] HOU Wenjun, T. J., LIU Jinchuan. (2009). Research and Development of Semi solid Rheo-diecasting Process. Foundry Technology, 30(01), 91–94.
[34] L, T. J.-b. L. Z.-m. L., & jun, i. x. G. L.-i. (2010). Influence of pouring length on rheo-die casting microstructures and properties of AlSi^{9}Mg. Journal of Hebei University of Science and Technology, 31(06), 568–571.
[35] Basner, T. (2000). Rheocasting of Semi-Solid A357 Aluminum. Foundry Technology, 1.
[36] Heng, L., Nan, W., Xingyu, T., Zhen, C., Xiaoyong, Z., & Yucheng, W. (2024). Design and Optimization of Casting System for Integrated Longitudinal Beam and Tower Package Based on Al-Si Alloy. Advances in Science and Technology Research Journal, 18(3), 111–122. https: //doi.org/10.12913/22998624/186012
[37] Wen, T., Liu, L., Wang, X., Zheng, Y., Yang, F., & Zhou, Y. (2022). Zinc-based alloy rapid tooling for sheet metal forming reinforced by SLM steel inlays. The International Journal of Advanced Manufacturing Technology, 122(2), 761–771. https: //doi.org/10.1007/s00170-022-09937-z
[38] Zhai, Q., Liu, Z., & Zhu, P. (2025). A transfer learning enhanced physics-informed neural network for predicting fatigue life of megacasting alloy with limited data sizes. International Journal of Fatigue, 200. https: //doi.org/10.1016/j.ijfatigue.2025.109129
[39] Zhai, Q., Tang, R., Liu, Z., & Zhu, P. (2025). A novel method for predicting mechanical properties of megacasting alloy based on the modified GTN model and machine learning. Engineering Failure Analysis, 174. https: //doi.org/10.1016/j.engfailanal.2025.109536
[40] Langlais, J., & Lemieux, A. (2006). The SEED Technology for Semi-Solid Processing of Aluminum Alloys: A Metallurgical and Process Overview. Solid State Phenomena, 116-117, 472–477. https: //doi.org/10.4028/www.scientific.net/SSP.116-117.472
[41] Yangxin. (2022). Numerical Simulation And Properties Of High Pressure Die Casting Car Cross Beam Using Magnesium Alloy Hebei University of Technology].
[42] Pan Fei, P. S., Tian Zhengfang. (2025). Research on Application of Integrated Die-Casting Process in Automotive Flooring. Automobile Technology & Material(5).
[43] Ye Yuanzhu, F. Z. (2025). Development and Application of Automotive Components and Cutting-Edge Technologies. Trend & Summary.