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Editorial

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Editorial

Advancing Injection Molding: Innovations in Process, Materials and Applications

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This Special Issue on Advances in Injection Molding: Process, Materials and Applications presents a curated collection of papers highlighting the dynamic evolution of this fundamental manufacturing technology. From intricate medical devices to everyday consumer products, injection molding plays a pivotal role across industries. As the demand for sustainable, efficient, and high-performance solutions grows, so does the requirement for innovation.

The contributions presented in this issue explore a wide spectrum of challenges and breakthroughs, offering fresh insights and practical solutions that push research boundaries in the field.

Materials and Sustainability

In terms of materials and sustainability, in the paper by Gao et al. [1], the authors present a critical analysis of the embodied energy across different grades of injection-molded polypropylene, providing valuable data for environmentally conscious manufacturing. In detail, they investigate the correlation between polymer melt viscosity, tensile properties, and injection molding energy consumption for three grades of polypropylene, a virgin grade, a recycled grade, and a modified recycled grade, providing guidelines and estimation techniques to support sustainable design for manufacturing practices. Carrasco et al. [2] also address a practical challenge by evaluating the performance of purging compounds, exploring shear viscosity, activation energy behavior in the torque rheometer, and energy consumption in the injection molding process for two polyolefin-based purging compounds: one on polypropylene (PP) and another on polyethylene (PE).

Process Control and Optimization

The control and optimization of the molding process itself are a key focus. Baruffa et al. [3] introduce a novel transfer learning-based neural network to predict weld line formation, a common defect, through process simulations and molding trials. Their results demonstrate transfer learning's efficacy in reducing the amount of data required for training predictive models, with simulations proving to be a cost-effective alternative to experimental data, thus optimizing the injection molding process and reducing manufacturing costs. In addition, Saeedabadi et al. [4] investigate the impact of molding parameters on the acoustic properties of materials. The authors demonstrate that the injection molding parameters offer precise control over acoustic parameters and therefore enable engineering of the polymer sample toward the desired acoustic properties. Lastly, Arioli et al. [5] delve into the underlying principles of the process, using operando Small-Angle X-ray Scattering to observe real-time complex crystallization behavior in plastics. The design of

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their equipment enabled the evaluation of the structure and morphology in different parts of the mold cavity, additionally identifying prospects in terms of novel mold heating and cooling systems.

Precision and Metrology

While accuracy is always central, it is particularly critical for micro-products, where measurement uncertainty can significantly impact quality assessments. Bellantone et al. [6] investigate this challenge by addressing the experimental uncertainty in optical measurements of micro-injection molded components. Their research highlights the importance of meticulous uncertainty estimation, which is essential for correctly evaluating quality, meeting tight tolerances, and accurately setting up both the process and measurement equipment.

Tooling and Application

Some of the authors of the included papers explore innovations in tooling and applications. Souza et al. [7] investigate the thermal contact resistance between mold steel and additively manufactured inserts, which is key for designing efficient conformal cooling channels. The authors aim to fill the gap in the literature with respect to experimental studies on thermal contact resistance in mold/insert contact interfaces, particularly for additively manufactured inserts. Brag et al. [8] present a novel application: the development of artificial test swarf to study wear behavior in engine components. The main goal of this paper is to elaborate on a draft that defines standardized test particles in Micro Powder Injection Molding. Lastly, Abbas et al. [9] explore the crystallization and aging behavior of PEEK in rapid tooling and rubber molding, revealing new opportunities for high-performance materials. In this era of short product life cycles, additive manufacturing and rapid tooling are important methods to make tool development and manufacturing more efficient, and the findings of this study contribute to a better understanding of thermal aging. In fact, the entire process chain of Fused Filament Fabrication and rapid tooling using PEEK is highlighted therein.

This collection of papers represents a significant step forward in the field of injection molding. They offer both foundational research and practical innovations that contribute to the development of this technology. It is our hope that this Special Issue inspires further exploration and development in this exciting domain.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Gao, P.; Nieduzak, Z.; Krantz, J.; Sobkowicz, M.J.; Masato, D. Analysis of the Embodied Energy of Different Grades of Injection-Molded Polypropylene. *J. Manuf. Mater. Process.* **2024**, *8*, 182. [CrossRef]
2. Carrasco, M.; Guerrero, J.; Lazo, M.; Adrián, E.; Medina-Perilla, J.A.; Rigail-Cedeño, A. Evaluation of Processing Conditions in the Performance of Purging Compounds for Polypropylene Injection Molding. *J. Manuf. Mater. Process.* **2023**, *7*, 31. [CrossRef]
3. Baruffa, G.; Pieressa, A.; Sorgato, M.; Lucchetta, G. Transfer Learning-Based Artificial Neural Network for Predicting Weld Line Occurrence through Process Simulations and Molding Trials. *J. Manuf. Mater. Process.* **2024**, *8*, 98. [CrossRef]
4. Saeedabadi, K.; Lickert, F.; Bruus, H.; Tosello, G.; Calaon, M. Impact of Injection Molding Parameters on Material Acoustic Parameters. *J. Manuf. Mater. Process.* **2023**, *7*, 222. [CrossRef]
5. Arioli, M.; Massano, A.P.; da Silva, D.P.; Gameiro, F.A.; Carreira, P.; Malfois, M.; Matias, J.; Pascoal-Faria, P.; Mateus, A.; Mitchell, G.R. Time and Spatially Resolved Operando Small-Angle X-ray Scattering Measurements during Injection Moulding of Plastics. *J. Manuf. Mater. Process.* **2023**, *7*, 176. [CrossRef]
6. Bellantone, V.; Surace, R.; Fassi, I. Experimental Uncertainty Evaluation in Optical Measurements of Micro-Injection Molded Products. *J. Manuf. Mater. Process.* **2024**, *8*, 21. [CrossRef]
7. Souza, A.; Capela, P.; Lopes, V.; Prior, F.; Puga, H.; Soares, D.; Teixeira, J. Thermal Contact Resistance between Mold Steel and Additively Manufactured Insert for Designing Conformal Channels: An Experimental Study. *J. Manuf. Mater. Process.* **2022**, *6*, 99. [CrossRef]

8. Brag, P.; Piotter, V.; Plewa, K.; Klein, A.; Herzfeldt, M.; Umbach, S. Development and Production of Artificial Test Swarf to Examine Wear Behavior of Running Engine Components—Geometrically Derived Designs. *J. Manuf. Mater. Process.* **2022**, *6*, 100. [CrossRef]
9. Abbas, K.; Balc, N.; Bremen, S.; Skupin, M. Crystallization and Aging Behavior of Polyetheretherketone PEEK within Rapid Tooling and Rubber Molding. *J. Manuf. Mater. Process.* **2022**, *6*, 93. [CrossRef]

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