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Special Issue Reprint

## Future Trends in Ultra-Precision Machining

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This Reprint highlights recent research advancements in four areas of ultra-precision machining: material removal mechanisms, field-assisted machining, AI-driven process optimization, and intelligent measurement and defect detection. In particular, the nanoscale material removal behavior in ultra-precision machining is investigated through molecular dynamics simulations considering the microstructural characteristics of the workpiece. These studies provide deeper insight into the fundamental mechanisms governing deformation, chip formation, surface generation, and subsurface damage during the machining process. In addition, the influence of external energy fields in field-assisted machining is examined through a combination of numerical simulations and experimental investigations, providing a clearer understanding of how energy-field coupling affects machining performance and material response. This Reprint also presents recent progress in the integration of artificial intelligence with ultra-precision machining, especially in process optimization, measurement, and automated surface defect detection. Collectively, these advanced theories, methods, and technologies provide valuable new perspectives on achieving efficient, high-quality, and low-damage machining. They not only deepen the fundamental understanding of ultra-precision machining processes but also support the development of next-generation manufacturing strategies for advanced materials and high-performance components.



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