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Special issue: Ultra-precision machining

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This special issue in *Frontiers of Mechanical Engineering* contains seventeen papers contributed by prestigious experts from five countries, including one prospect paper, four research papers and twelve review papers. These papers cover a broad area of the ultra-precision machining, and focus on the recent advances on a wide variety of machining methods, such as precision molding, figuring, milling, lapping and diamond machining, to illustrate how various materials in the macro-scale or micro-scale can be machined with high precision, low surface/subsurface damage and ultra-smooth surfaces to meet the demands of numerous application areas, including high-power laser systems, consumer electronics, flexible devices, etc. Some other hot topics, such as the measurement and simulation technology in the ultra-precision machining field, are also covered to provide the readers with a more comprehensive view.

Fengzhou Fang's prospective paper points out the fundamental theory of "Manufacturing 3.0" is based on new principles and theories at the atomic and/or close to- atomic scale, and obtaining a dominant role at the international level is a strategic move for China's progress.

Precision molding was intensively discussed by four review papers to identify the recent advances. Liangchi Zhang and Weidong Liu discuss some of the central issues in precision glass molding (PGM) processes and provide a method based on a manufacturing chain consideration from mold material selection, property and deformation characterization of optical glass to process optimization. Tianfeng Zhou et al. present a detailed review of optical microstructure fabrication through glass molding and highlights the applications of optical microstructures in mold fabrication and glass molding. The glass-mold interface friction and adhesion are also discussed and the latest advancements in glass molding technologies are detailed. Shaohui Yin et al. give a systematical discussion on the key technical factors affecting the quality of the glass lens molding process to solve the existing technical bottlenecks and problems, as well as to predict the potential applicability of glass lens molding in the future. In the review of Hui Li et al., first ultraprecision machine design and machining processes such as slow tool and fast too servo are described and then both compression molding and injection molding of polymer optics are discussed. They valued the importance of numerical modeling using finite element method as a critical part of the precision optical manufacturing process by molding to ensure high product quality.

Four papers are focused on micro- and nano-machining technologies. Shang Gao and Han Huang review the recent advances in micro- and nano-machining technologies, including micro-cutting, micro-electrical-discharge machining, laser micro-machining, focused ion beam machining, and compared to their machining capabilities. Xibin Wang et al. design a micro-ball-end mill in accordance with the non-instantaneous-pole envelope principle and manufactured by grinding based on the profile model of the helical groove and the mathematical model of the cutting

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edge curve. Shaolin Xu et al. provide a review of the state of art of ultrasonic-assisted machining technologies used for fabrication of micro/nano-textured surfaces to address the limitations of conventional diamond machining methods at machinable structures and machining efficiency. Wenbin Huang et al. summarize the status and the limitations of current nano-patterning techniques for scalable and flexible functional devices in terms of working principle, resolution, and processing speed.

Two papers discuss the ultra-precision of soft-brittle crystals due to the imperious demands and great machining difficulties. The paper of Hang Gao et al. reviews the research progress of soft-brittle crystals processing, presents the characteristics and machining difficulties of soft-brittle crystals, and introduces the latest research progress of novel machining technologies and their applications for softbrittle crystals. Feihu Zhang et al. investigate the anisotropic machinability of KDP and the forming reasons of the typical surface errors in ultra-precision fly-cutting of the material in their paper. And the structures of the fly-cutting machine as well as the present processing parameters have been optimized for improving the machined surface quality.

Some other ultra-precision methods are also presented in this special issue. Ming Feng et al. report their progress on employing a spiral V-groove plate method in processing high-precision ceramic balls. Kinematic analysis was used to study this method theoretically. Experimental results demonstrate that ceramic balls with G3-level accuracy have been achieved. The study of Mingjin Xu et al. proposes a multi-pass IBF approach with different beam diameters based on the frequency filtering method to improve the machining accuracy and efficiency of CPPs during IBF.

MD and FEM are powerful tools to investigate the mechanisms of ultra-precision machining. Xiaoguang Guo et al. review the molecular dynamics simulation of ultra-precision machining of hard and brittle materials to clarify the theoretical mechanisms underlying ultra-precision. A Davoudinejad et al. propose a 3D finite element modeling (3D FEM) approach for the micro end-milling of Al6061-T6 to obtain realistic numerical predictions of chip flow, burr formation, and cutting forces. Dede Zhai et al. present a review on self-referenced measurement algorithms which aim to bridge lateral shearing interferometry and multi-probe error separation. They conclude that the reconstruction principle in lateral shearing interferometry is similar to the two-point method in error separation on the condition that no yaw error exists.

At the end of this editorial, I would like to express our deep appreciation to all the authors who have submitted their work for this special issue. I am also grateful to all reviewers for their service and commitment to the journal through their rigorous reviews, timely response to the tight schedule, insightful and constructive comments that helped shape the outcome. Special thanks go to the journal's administrative support team that made the issue possible.

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