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Editorial

Editorial for the Special Issue on Precision Engineering

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Precision engineering has developed from its original literal meaning of "making things precisely" into a sub-discipline of electrical engineering, software engineering, electronics engineering, mechanical engineering, and optical engineering that is concerned with designing machines, fixtures, and other structures that have exceptionally high tolerances, are repeatable, and are stable over time. In advanced research on precision engineering, the behavior of an experimental system remains fully predictable, even including micro/nanoscale motions. Micro/nano-scale phenomena introduce a wide spectrum of unknown fields and promising applications that have driven researchers to dedicate themselves to work in molecular electronics, biomedical applications, picosecond lasers, nanometric fabrication, and micro/nano devices.

The development of a special issue on such newly developing topics is timely, prompted by current global research and engineering efforts in precision engineering. This issue is devoted to the latest achievements in precision engineering research that have great significance in terms of high-value manufacturing and product quality. A series of eight articles written by 32 authors illustrate the state of the art in this field on the following topics:

(1) **Fundamental research on high-precision manufacturing.** The level of manufacturing directly contributes to the progress of related industries. "Advances in molecular electronics: A brief review" reviews novel works in developing electrical-equivalent molecular components such as molecular transistors, capacitors, diodes, and wires. The durability and stability of molecular devices should be kept in mind when fabricating molecular components. On the nanometric level, "Fabrication of periodic nanostructures using AFM tip-based nanomachining: Combining groove and material pile-up topographies" presents an atomic force microscopy (AFM) tip-based nanomachining method to fabricate periodic nanostructures. This method combines the topography generated by machined grooves with the topography that results from the accumulated pile-up of material on the side of these grooves. The optical effect that is induced as machined periodic nanostructures produce surface colorization is investigated for potential applications in the fields of anti-counterfeiting and metal sensing. In "Engineered functional surfaces by laser microprocessing for biomedical applications," laser micro-processing is introduced as an advanced method to enhance the surface-related properties of biomaterials. This work demonstrates the capability of laser micro-processing for biomedical metallic materials including magnesium alloy and titanium alloy, with potential applications in cell adhesion and liquid biopsy. Microdevices have become a hot research topic, and "Ultra-short pulsed laser manufacturing and surface processing of microdevices" stresses the multifold advantages of the utilization of ultra-short laser pulses for materials processing. The direct-writing process of high-performance three-dimensional (3D) structured multilayer micro-supercapacitors on polymer substrates demonstrates the attractive potential of the ultra-short pulsed laser for surface precision manufacturing. Hierarchical two-dimensional (2D) arrays are becoming a new structure of interest in a variety of experimental applications. In "Picosecond laser surface texturing of a Stavax steel substrate for wettability control," a picosecond laser is employed to fabricate surface textures on a Stavax steel substrate, including periodic sub-micron ripples, a hierarchical 2D array of micro-bumps, and micro-pits with nano-ripples. The described process holds the potential to improve the performance of fabricated plastic products in terms of wettability control and easy cleaning.

(2) **Advanced applications of high-precision measurement.** The feedback of measured data is essential for revealing and sensing changes in systems and the effects of variables. The acquisition of data is a significant component of measuring and evaluating. "Dual-comb ranging" reviews an emerging tool that exploits phase resolution and frequency accuracy for rapid high-precision distance measurement. The tool is shown to be promising for various professional applications in absolute distance measurement, which is a fundamental technique in large-scale manufacturing and in future tight-formation-flying satellites. Many approaches are employed in optics and machine vision to improve the accuracy of geometric measurement. "Performance analysis and evaluation

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of geometric parameters in stereo deflectometry" presents a novel geometric parameter analysis in stereo deflectometry with a screen and two cameras. An error of less than 0.1 μm global measurement accuracy was achieved in obtaining form information on freeform specular surfaces. The reconstruction of measured data assists in the recognition and evaluation of the subject. "A dual-platform laser scanner for 3D reconstruction of dental pieces" focuses on an integrative method for data collection and a hybrid algorithm for data processing. A dual-platform scanner has been established that provides an effective way to achieve the 3D reconstruction of dental pieces, as well as of objects in engineering fields with irregular shapes.

We have been deeply inspired by the research in this special issue. However, as the work in this issue reveals, there is still considerable room for growth in various research dimensions, including precision structure design and fabrication, actuation and control, sensing and perception, and advanced applications. We would like to thank all the authors for their contributions to this special issue, which represents the current development of the emerging field of precision engineering.