Preface

Since the last decade, the major research challenges and developments around the globe are to manufacture microcomponents with high accurate of microfeatures which have geometrical dimensions even less than tens of microns. It is obvious that the demand of microcomponents is diversely increasing day by day in the field of aviation, automotive, biomedical, optical, electronics, and energy sectors. This wide range of applications of microcomponents brings the necessity to develop promising micromachining technologies which can yield high degree of precision, improved machining rate with accurate geometrical dimensions, reliability, flexibility, and after all environment friendly. Moreover, the developments of material science provide materials which have enormous material properties especially in their machinability and hardness. In this situation, it is the task of manufacturer engineers to develop micromachining processes, both traditional and non-traditional, which can fulfill the demands of microproduct having several micro- and nanofeatures.

In the area of non-traditional micromachining processes, few books are available. These books mostly describe numerical and experimental research details at different stages. However, it is the most important task at this stage to gain the fundamental knowledge about different non-traditional micromachining processes. Not only that, but it is also important to be acquainted with the capabilities and applications of these micromachining processes in various product manufacturing. Moreover, several hybrid micromachining processes have also been developed to improve the surface integrity, geometrical accuracy, and machining efficiency. The present book entitled "Non-traditional Micromachining Processes—Fundamentals and Applications" will definitely fulfill the gap between the demand of microfeatured components and successful micromachining of these products.

This book starts with introduction of various micromachining processes, especially, non-traditional, with recent research and developments in each processes. Further, mechanical type micromachining process such as micro-USM is presented with mechanism of material removal, types and technologies of micro-USM and recent research advancements. Then, electro-thermal processes such as micro-EDM, wire-EDM, micromachining using laser beam (micro-turning,

micro-cutting, etc) were discussed. Further, electrochemical micromachining process was discussed for micromachining and micro fabrication of various complex and high accuracy profiles. Then, hybrid type micromachining such as micro electrochemical discharge machining processes were presented. Chapter 1 gives an overview of various micromachining processes including various hybrid and nanofinishing processes with their applications, working principles, challenges in scaling down a macro machining process to a micromachining process, and some recent developments in each category of process. Chapter 2 describes the overview of microultrasonic machining process with brief description of process parameters, system details, and recent development and research challenges for micromachining of intricate parts with high degree of accuracy and surface profile. Chapter 3 describes the overview of EDM and micro-EDM process with details of significant process parameters and experimental investigation with analysis of microhole machining process utilizing some novel machining strategies such as microtool rotation, polarity changing, utilization of deionized water as dielectric, implementation of boron carbide additives into dielectrics. In Chap. 4, a brief introduction of microwire electrical discharge machining (MWEDM) is presented with details of micromachining system, wire failure prevention, detailed analysis of charging and discharging circuits, and details of wire lag and vibration phenomena during micromachining of complex geometrical components. Chapter 5 deals with the experimental investigation and analysis on pulsed Nd:YAG laser microturning process of aluminum oxide ceramics. This process is new in the category of laser micromachining process, and a lot of research and developments are still needed for exploring the capabilities of pulsed Nd:YAG laser for obtaining high precision microparts with required surface finish. In Chap. 6, the overall concept of fiber laser micromachining and influence of machining process parameters on geometrical accuracy of microparts is presented. The chapter also describes various micromachining processes such as microcutting, microdrilling, engraving, and marking using fiber laser systems on wide range of materials from polymer to ceramics. In Chap. 7, in-depth experimental study and analysis are carried out during laser beam cutting of Inconel 625 superalloy at dry condition to explore the influence of various process parameters on kerf width utilizing pulsed Nd:YAG laser micromachining system. In Chap. 8, fundamental of anodic dissolution of microelectrochemical machining is presented with brief overview of significant process parameters and important techniques for improving the machining accuracy and reliability by implementing novel geometry of microtool and its insulation during microchannel formation using EMM process. Chapter 9 presents a detailed overview of electrochemical micromachining of titanium and its alloy and the effect of process parameters on feature profile during maskless and through mask EMM. Chapter 10 provides the fundamental aspect of microelectrochemical discharge machining process and description of machining system and process parameters. The chapter also describes the research and development carried out around the globe in microdrilling and microcutting using micro-ECDM. Chapter 11 presents the overview of travel wire electrochemical spark machining (TWECSM), the development of micromachining setup, brief discussion of process parameters, and

parametric effect on machining rate and spark gap width during machining of glass fiber epoxy composite.

This book offers a comprehensive treatment of various non-traditional micromachining techniques and future directions representing a valuable reference to engineers and R&D researchers involved in micromachining. The present book can also be used as a research book for final undergraduate engineering course or as a topic on micromachining processes at the postgraduate level. Also, this book can serve as a useful reference for academics, researchers, mechanical, manufacturers, industrial and materials engineers, professionals in micromachining processes and related industries. The scientific interest in this book is evident from many important centers of the research, laboratories, universities as well as industries. Therefore, it is hoped that this book will inspire and enthuse others to undertake research in non-traditional micromachining processes.

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