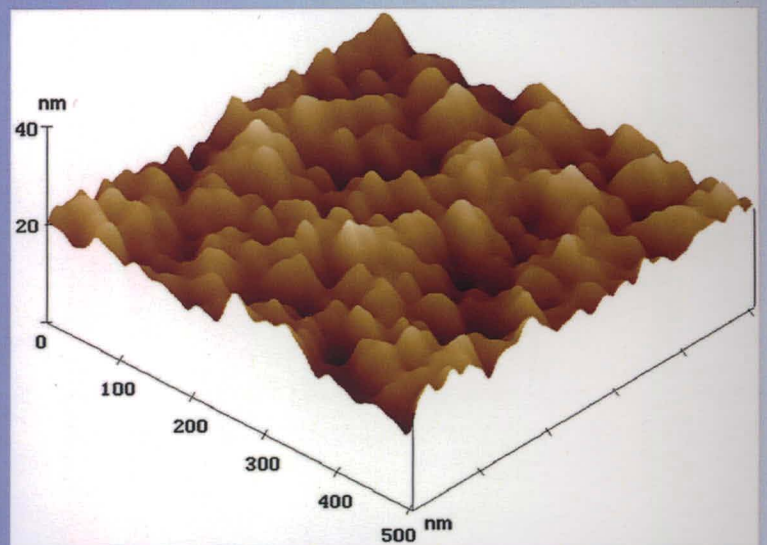
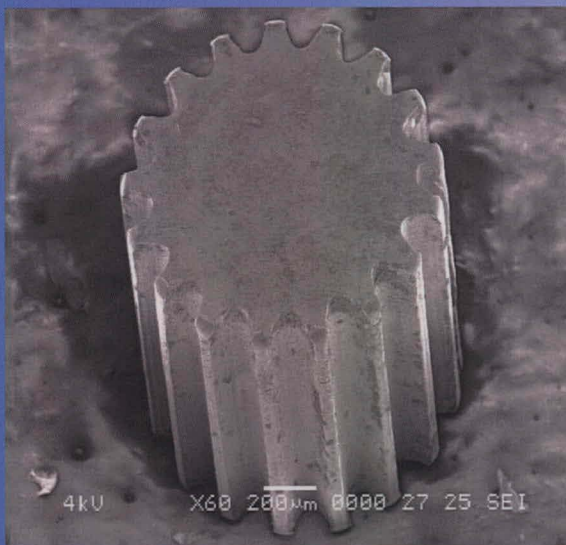
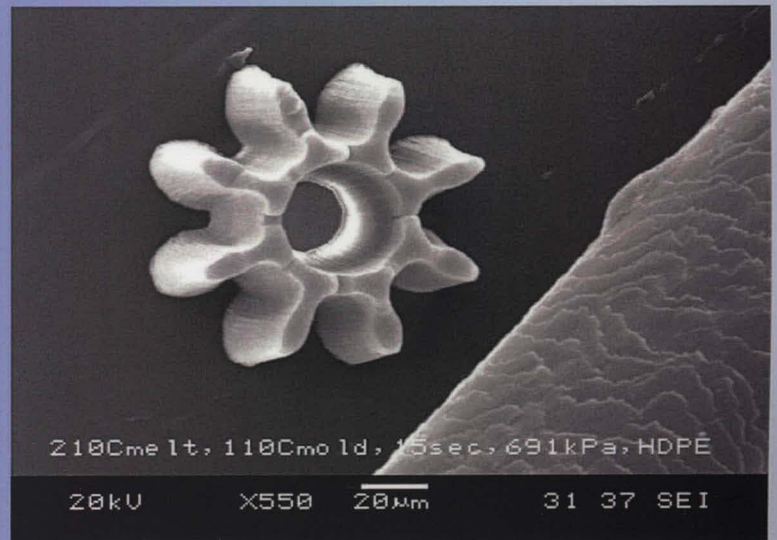
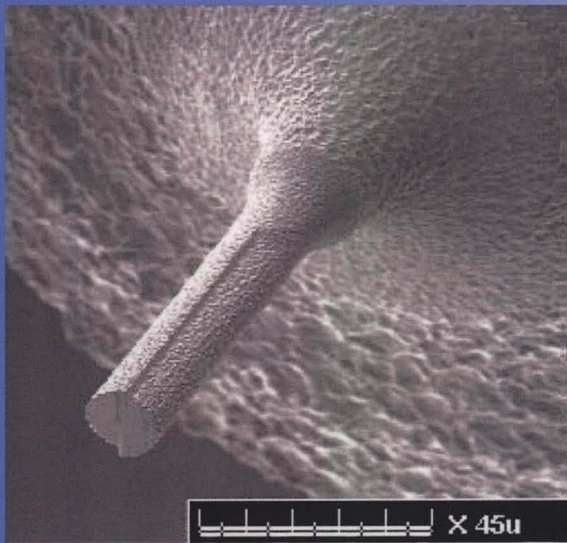


Advanced Machining Process



Editors

Mohammad Yeakub Ali

AKM Nurul Amin

Erry Yulian Triblas Adesta

IIUM PRESS

INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA



Advanced Machining Process

Editors

**Mohammad Yeakub Ali
AKM Nurul Amin
Erry Yulian Triblas Adesta**



IIUM Press

Published by:
IIUM Press
International Islamic University Malaysia

First Edition, 2011
©IIUM Press, IIUM

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without any prior written permission of the publisher.

Perpustakaan Negara Malaysia

Cataloguing-in-Publication Data

Mohammad Yeakub Ali, AKM Nurul Amin & Erry Yulian Triblas Adesta: Advanced Machining Process

ISBN: 978-967-418-162-8

Member of Majlis Penerbitan Ilmiah Malaysia – MAPIM
(Malaysian Scholarly Publishing Council)

Printed By:
IIUM PRINTING SDN.BHD.
No. 1, Jalan Industri Batu Caves 1/3
Taman Perindustrian Batu Caves
Batu Caves Centre Point
68100 Batu Caves
Selangor Darul Ehsan
Tel: +603-6188 1542 / 44 / 45 Fax: +603-6188 1543
EMAIL: iiumprinting@yahoo.com

Advanced Machining Process

Table of Contents

<i>Preface</i>	<i>ii</i>
<i>Acknowledgement</i>	<i>iii</i>
<i>Copyright</i>	<i>iv</i>
<i>PART 1: ELECTRO DISCHARGE MACHINING</i>	<i>1</i>
Chapter 1	2
Tool Wear rate during Electrical Discharge Machining (EDM) with Eccentric Electrode <i>Ahsan Ali Khan, Affendi Bin Saad and Mohd Zulfadli Isma Bin Mohd Isa</i>	
Chapter 2	7
Wear Ratio and Work Surface Finish during Electrical Discharge Machining (EDM) with Eccentric Electrode <i>Ahsan Ali Khan, Affendi Bin Saad and Mohd Zulfadli Isma Bin Mohd Isa</i>	
Chapter 3	12
Role of Current, Voltage and Spark on-time on Electrode Material Migration during EDM <i>Ahsan Ali Khan, Nurul Shima Mohd Noh</i>	
Chapter 4	18
A Study on Material Removal Rate during EDM with Tantalum Carbide-Copper Compacted Electrode <i>Ahsan Ali Khan, Mohammad Azhadi Bin Mohammad Hambiyah and Mohd Faiz Bin Nazi Nadin</i>	
Chapter 5	23
Features of EDM of Mild Steel with Ta-Cu Powder Compacted Electrodes <i>Ahsan Ali Khan, Mohammad Azhadi Bin Mohammad Hambiyah and Mohd Faiz Bin Nazi Nadin</i>	
Chapter 6	28
Relationship between Machining Variables and Process Characteristics during Wire EDM <i>Ahsan Ali Khan, M. B. M. Ali and N. B. M. Shaffiar</i>	

Chapter 7		33
	Influence of Machining Parameters on Surface Roughness during EDM of Mild Steel	
	<i>Ahsan Ali Khan, Erry Y.T. Adesta and Mohammad Yeakub Ali</i>	
Chapter 8		38
	Machining of Ceramic Materials: A Review	
	<i>Abdus Sabur, Md. Abdul Maleque and Mohammad Yeakub Ali</i>	
Chapter 9		44
	Formation of Micro-cracks and Recast Layer during EDM of Mild Steel using Copper Electrodes	
	<i>Ahsan Ali Khan, Erry Y.T. Adesta and Mohammad Yeakub Ali</i>	
Chapter 10		49
	Features of Electrode Wear during EDM of Mild Steel with TaC-Cu Powder Compacted Electrodes	
	<i>Ahsan Ali Khan, Mohd Faiz Bin Nazi Nadin and Mohammad Azhadi Bin Mohammad Hambiyah</i>	
Chapter 11		54
	Influence of Current, Spark On-time and Off-time on Electrode Wear during EDM of Mild Steel	
	<i>Ahsan Ali Khan, Mohd Faiz Bin Nazi Nadin and Mohammad Azhadi Bin Mohammad Hambiyah</i>	
Chapter 12		59
	A Comparative study on Work Surface Hardness EDMed by Ta-C Powder Compacted and Copper Electrodes	
	<i>Ahsan Ali Khan, Mohd Faiz Bin Nazi Nadin and Mohammad Azhadi Bin Mohammad Hambiyah</i>	
Chapter 13		65
	An Introduction to Electrical Discharge Machining	
	<i>Ahsan Ali Khan and Mohammed Baba Ndaliman</i>	
Chapter 14		70
	Developments in EDM Process Variables	
	<i>Ahsan Ali Khan, Mohammed Baba Ndaliman and Mohammad Yeakub Ali</i>	

PART 2: MICROMACHINING	76
Chapter 15	77
Focused Ion Beam Micromachining: Technology and Application <i>Israd Hakim Jaafar, Nur Atiqah, Asfana Banu, Mohammad Yeakub Ali</i>	
Chapter 16	83
Finish Cut of Titanium Alloy using Micro Electro Discharge Milling for Nano Surface Finish <i>Mohammad Yeakub Ali, Muhamad Faizal, Asfana Banu, and Nur Atiqah</i>	
Chapter 17	89
Investigation of MRR for Finish Cut of Titanium Alloy using Micro Electro Discharge Milling <i>Mohammad Yeakub Ali, Mohd Saifuddin, Nur Atiqah, and Asfana Banu</i>	
Chapter 18	95
Investigation of TWR for Finish Cut of Titanium Alloy using Micro Electro Discharge Milling <i>Mohammad Yeakub Ali, Mohd Saifuddin, Nur Atiqah, and Asfana Banu</i>	
Chapter 19	101
Investigation of Chip Formation and Minimum Chip Thickness in Micro/Meso Milling: Methodology and Design of Experiment <i>Mohammad Yeakub Ali, Noor Adila Mansor and Siti Hamizah Mass Duki</i>	
Chapter 20	107
Micro/Meso Milling of Aluminium Alloy 1100: Analysis and Modelling of Minimum Chip Thickness <i>Mohammad Yeakub Ali, Noor Adila Mansor and Siti Hamizah Mass Duki</i>	
Chapter 21	113
Effect of Micro End Milling Tool Diameter on Minimum Chip Thickness <i>Mohammad Yeakub Ali, Noor Adila Mansor and Siti Hamizah Mass Duki</i>	
Chapter 22	119
Micro Wire Electrical Discharge Machining of Tungsten Carbide: Methodology and Procedure <i>Mohammad Yeakub Ali, Ahmad Chaaban Elabtah and Musab Jamal Alrefaie</i>	
Chapter 23	124
Micro Wire Electrical Discharge Machining of Tungsten Carbide: Analysis of Surface Roughness <i>Mohammad Yeakub Ali, Ahmad Chaaban Elabtah and Musab Jamal Alrefaie</i>	
Chapter 24	130
Micro Wire Electrical Discharge Machining of Tungsten Carbide: Analysis of Material Removal Rate <i>Mohammad Yeakub Ali, Musab Jamal Alrefaie and Ahmad Chaaban Elabtah</i>	
Chapter 25	136
Micro Electro Discharge Machining of Micro Pillar Array: Process	

Chapter 25		136
	Micro Electro Discharge Machining of Micro Pillar Array: Process Development	
	<i>Mohammad Yeakub Ali, Wan Emira Azaty and Nor Suriza</i>	
Chapter 26		142
	Micro Electro Discharge Machining of Micro Pillar Array: Analysis of Surface Finish	
	<i>Mohammad Yeakub Ali, Wan Emira Azaty and Nor Suriza</i>	
Chapter 27		148
	Micro Electro Discharge Machining of Micropillar Array: Analysis of Material Removal Rate	
	<i>Mohammad Yeakub Ali, Nor Suriza and Wan Emira Azaty</i>	
Chapter 28		154
	Vibration Issue in Micro End Milling	
	<i>Mohammad Yeakub Ali, Muhamad Lutfi and Mohamad Ismail Fahmi</i>	
Chapter 29		159
	Fabrication of Micro Filter by Electro Discharge Machining	
	<i>Abdus Sabur and Mohammad Yeakub Ali</i>	

PART 3: PRECISION MACHINING	165
Chapter 30	166
High Speed Milling of Mould Steel using 1.5mm-diameter End-mills <i>Mohamed Konneh, Khairunnisa Ahmad and Rose Fazleen</i>	
Chapter 31	172
Precision Grinding of Silicon Carbide using 46 μm Grain Diamond Cup Wheel <i>Mohamed Konneh and Ahmad Fauzan</i>	
Chapter 32	178
Precision Grinding of Silicon Carbide using 76 μm Grain Diamond Cup Wheel <i>Mohamed Konneh and Mohd Shukur Zawawi</i>	
Chapter 33	184
Precision Grinding of Silicon Carbide using 107 μm Grain Diamond Cup Wheel <i>Mohamed Konneh and Mohd Fadzil</i>	
Chapter 34	190
Investigation of Surface Integrity during Precision Grinding of Silicon Carbide using Diamond Grinding Pins <i>Mohamed Konneh, Mohamad Lutfi and Mohamad Shahrilnizam</i>	
Chapter 35	196
A Comparative Study on Flank Wear and Work Surface Finish during High Speed Milling of Cast Iron with Different Carbide Tools <i>Ahsan Ali Khan, Zuraida Aman Nor Rasid and Izausmawati Yusof</i>	

An Introduction to Electrical Discharge Machining

Ahsan Ali Khan[✉] and Mohammed Baba Ndaliman
Faculty of Engineering – International Islamic University Malaysia
✉ : mbndaliman@yahoo.com

Keywords: Electrical discharge machining (EDM), Electrode, Dielectric Fluid, dry EDM, Wire-cut EDM, Micro-EDM.

Abstract. The fundamental features of electrical discharge machining (EDM) were discussed in this chapter. The machining principle and its outcomes were highlighted in this chapter. The input variable of EDM presented here are electrical and non-electrical ones. The output of EDM process are given in terms of the material removal rate (MRR), tool wear rate (TWR) and the surface integrity. This chapter is concluded with a discussion on types of EDM. The various types presented here include: the die sinking type, the wire-cut, micro and the dry EDM.

Introduction

Electrical discharge machining (EDM) is one of the non traditional machining processes used to machine hard materials that were hitherto difficult-to-machine. It is a thermal process that involves melting and vaporisation of the pair of workpiece and electrode. The erosive effect of electrical discharge machining was invented by Joseph Priestly, a 1770 English scientist. The Lazarenkos in 1943 were credited to being the first duo to work on what becomes EDM today [1]. Since then, a refined and controlled machining process becomes established through removal of the destructive effects associated with electrical discharges.

The EDM Process

The EDM process uses electrical discharges to remove material from the workpiece, with each spark producing a temperature of between 10,000-20,000°C. A typical electrical discharge machine is shown in Fig. 1. The basic principle is the conversion of electrical energy into thermal energy through a series of discrete electrical discharges occurring between the electrode (tool) and workpiece immersed in a dielectric fluid. The insulating effect of the dielectric used in EDM process is very important as it prevents the electrolysis of the electrodes during the process. Spark is initiated when high voltage is applied between the electrode and workpiece at small gap as shown in Figs. 2a and b. Materials start to melt and get eroded from both the tool and workpiece surfaces. After each discharge, the capacitor is recharged from DC source through a resistor, and the spark that follows get transferred to the next narrowest gap. At the end, sparks spread over the entire workpiece surface leading to its erosion, or machining to a shape that is mirror image of the electrode. As a consequent to this high temperature operation, the workpiece is subjected to a heat affected zone (HAZ) the top layer of which comprises recast material (Fig. 3). The thickness, composition and condition of this layer depend on the discharge energy, the workpiece material, tool electrode and dielectric fluid. Both hard and soft surface layers can be produced despite perceived thinking that the recast layer is always hard. With ferrous workpiece materials, the recast layer