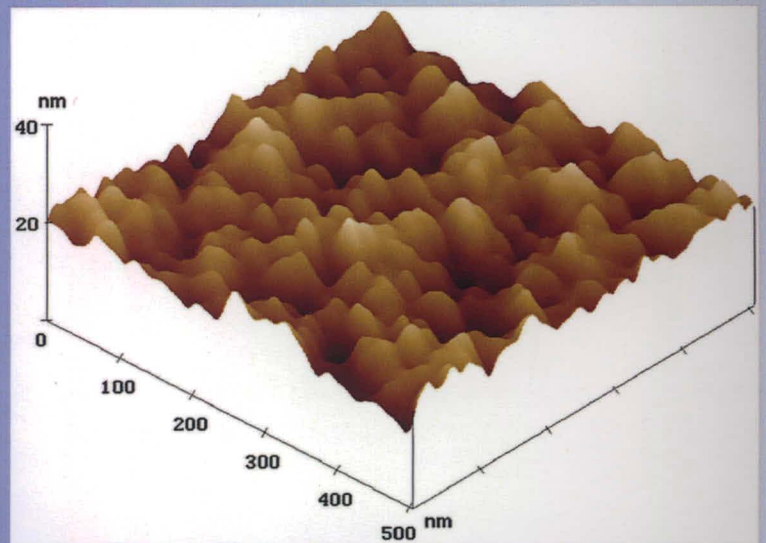
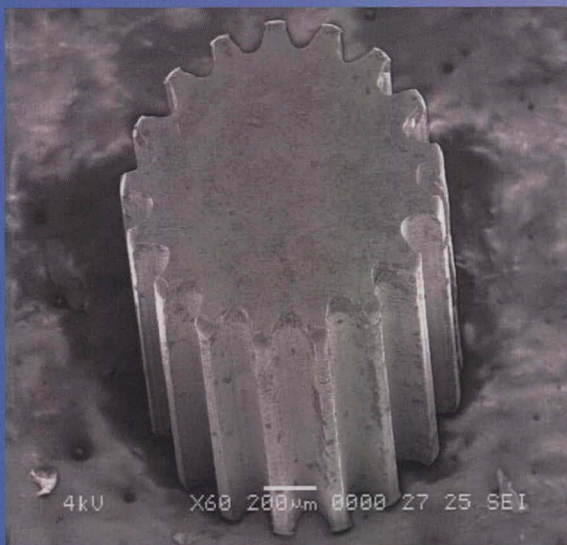
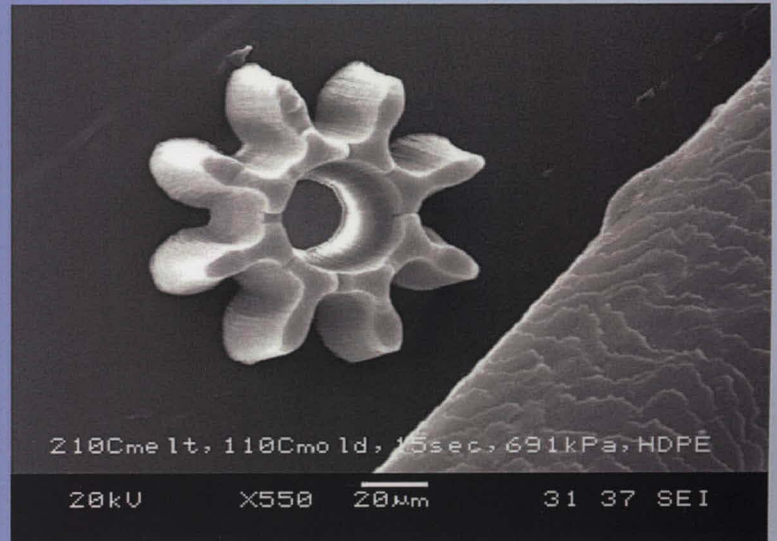
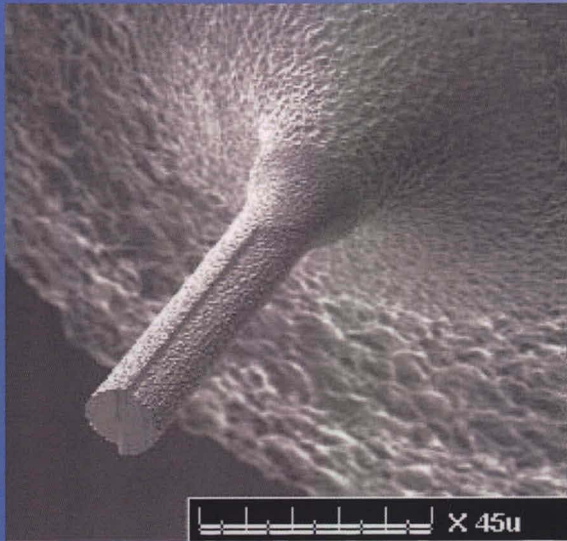


Advanced Machining Process



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>
PART 1: ELECTRO DISCHARGE MACHINING	1
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
Mohamed Konneh, Khairunnisa Ahmad and Rose Fazleen

Chapter 31 172
Precision Grinding of Silicon Carbide using 46 µm Grain Diamond
Cup Wheel
Mohamed Konneh and Ahmad Fauzan

Chapter 32 178
Precision Grinding of Silicon Carbide using 76 µm Grain Diamond
Cup Wheel
Mohamed Konneh and Mohd Shukur Zawawi

Chapter 33 184
Precision Grinding of Silicon Carbide using 107 µm Grain Diamond
Cup Wheel
Mohamed Konneh and Mohd Fadzil

Chapter 34 190
Investigation of Surface Integrity during Precision Grinding of
Silicon Carbide using Diamond Grinding Pins
Mohamed Konneh, Mohamad Lutfi and Mohamad Shahrilnizam

Chapter 35 196
A Comparative Study on Flank Wear and Work Surface Finish during
High Speed Milling of Cast Iron with Different Carbide Tools
Ahsan Ali Khan, Zuraida Aman Nor Rasid and Izausmawati Yusof

Micro Wire Electrical Discharge Machining of Tungsten Carbide: Analysis of Surface Roughness

Mohammad Yeakub Ali¹, Ahmad Chaaban Elabtah and Musab Jamal Alrefaie
 Department of Manufacturing and Materials Engineering
 Faculty of Engineering, International Islamic University Malaysia
 P.O. Box 10, 50728 Kuala Lumpur, Malaysia
 ✉ : mmyalita@iiu.edu.my

Keywords: Micro WEDM, Tungsten carbide, Surface roughness

Abstract. This chapter presents a experimental study to develop mathematical model for machined surface roughness that relate the machining parameters. The basic objective is to achieve lowest possible surface roughness. A micro wire electro discharge machine is used on tungsten carbide workpiece. The electrode material was also tungsten. Taguchi method is used to formulate the experimental layout, to analyze the effect of each parameter on the machining characteristics, and to predict the optimal level of parameter values using Design Expert Version 6.0.8. It is found that these parameters have a significant influence on surface roughness. Mathematical model has been developed and the model is found to be adequate.

Measurements of Surface Roughness

The surface produced by EDM process consists of a large number of craters that are formed from the discharge energy. The quality of surface mainly depends upon the energy per spark. The roughness of the machined surface increases as the energy of the pulse increases. In other words, at higher pulse energy, the surface will be rough. The pulse energy is a function of the capacitance and the working voltage of the circuit. Therefore, by varying these two parameters fine (smoother) surface could be obtained. The surface produced by this process consists of micro-craters. Low energy discharges that leave small craters are necessary for fine surface finish. However, MRR is the low in order to get a low surface roughness.

The EDM surface is made up of three distinctive layers consisting of white layer/recast layers, heat effected zone and unaffected parent metal. EDM surface is dependent on the solidification behaviour of molten metal after the discharge cessation and subsequent phase transformation. The thickness of the recast layer formed on the workpiece surface and the level of thermal damage suffered by the electrode can be determined by analyzing the growth of the plasma channel during sparking. In addition, the EDM surface has a relatively high micro hardness, which can be explained by the emigration of carbon from the oil dielectrics to the workpiece surface forming iron carbides in the white layer. There are several numbers of useful techniques for measuring surface roughness:

Fast and repeatable, the NT1100 utilizes white light interferometer for high resolution 3D surface measurements, from sub – nanometre roughness to millimetre- high steps. On super smooth or rough surfaces, the versatile NT1100 provides repeatable surface measurement for R&D, wear and failure analysis, and process control. Figure 1 shows the WYKO NT1100 machine. The result for the surface roughness obtained by the machine and after taking the