INVESTIGATION OF MACHINING PERFORMANCE OF COATED CARBIDE BY MURAKAMI SURFACE PRETREATMENT

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A report submitted in partial fulfillment of
The requirements for the award of the degree of
Bachelor of Mechanical Engineering
With Manufacturing Engineering

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ABSTRACT

Tungsten carbide is the most widely used material for cutting tools. Due to extreme demands higher tool life several types of coating have been introduced to prolong the service time which include diamond coating. However cobalt binder in tungsten carbide prevents diamond to adhere well on the substrate and its content at the outer surface should be reduce to below 1%. Pretreatments have been studied by many researchers. But to date poor adhesion of diamond coating still an issue. In this work a murakami pretreatment was used to etch tungsten carbide at the surface of the substrate in order to solve poor adhesion problem. First step with Murakami's reagent 20 minutes and the second step of the process were carried out by etching in a solution of hydrochloric acid (45 seconds). The effect of murakami pretreatments on Co cemented tungsten carbide samples were study in term of surface morphology, surface roughness, and cobalt removal from the surface was examined. Based on the experimental, the following conclusions can be withdrawn. It is found that murakami suface pretreatment affecting the final surface roughness of substrate. Murakami pretreatment able to strengthened the diamond coating adhesion by modifying the surface roughness. The wear resistance of coated tungsten carbide was higher than uncoated tungsten carbide. Cutting tool with coated tungsten carbide produced better work piece’s surface finish as compared to uncoated cutting tool. It was also further improved when pretreatment (murakami) was used.

ABSTRAK

Tungsten karbida adalah bahan yang paling banyak digunakan dalam alat-alat pemotongan. Disebabkan oleh permintaan yang tinggi terhadap alatan pemotong yang berjangka hayat lama, kaedah saduran diperkenalkan untuk meningkatkan masa penggunaannya termasuklah saduran berlian. Walaubagaimanapun, pengikat kobalt di dalam tungsten karbida menghalang berlian daripada melekat dengan sempurna pada substrak dan kandungannya perlu dikurangkan kepada bawah daripada satu peratus. Kaedah langkah pra-rawatan telah dipelajari oleh ramai penyelidik sebelum ini. Tetapi masalah berlian yang tidak melekat dengan baik masih menjadi isu. Didalam kajian ini,pra-rawatan digunakan untuk menghakis tungsten karbida pada permukaan substrak dalam usaha menyelesaikan masalah perekatan yang tidak sempurna ini. Langkah pertama adalah dengan reagen Murakami 20 minit dan langkah kedua dalam proses ini ialah pengakisan menggunakan asid hidroklorik (45 saat). Kesan daripada eksperimen ini terhadap tungsten karbida semen dikaji dari segi morfologi permukaan, kekasaran permukaan dan penyingkiran kobalt dari permukaan. Berdasarkan eksperimen ini, kesimpulannya didapati bahawa pra-rawatan permukaan mempengaruhi kekasaran permukaan akhir substrate.Murakami dapat mengukuhkan lekatan salutan berlian dengan mengubah rintangan permukaan. Tungsten karbida bersalut adalah lebih tinggi daripada tungsten karbida tidak bersalut, alat pemotongan tungsten karbida bersalut menghasilkan kemasan permukaan benda kerja yang lebih baik berbanding alat pemotong tidak bersalut. Ia juga menjadi lebih baik apabila prarawatan (Murakami) telah digunakan.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

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µm	Micrometer
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g/cm^3	Gram per centimeter cube
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Gpa	Giga Pascal
Mpa	Mega Pascal
c	Thermal Expansion Coefficient
K	Kelvin
HV	Hardness Vickers

LIST OF ABBREVIATIONS

CVD	Chemical Vapour Deposition
PVD	Physical Vapour Deposition
Ti-6Al-4V ELI	Titanium alloy alpha-beta Extra Low Interstitial
HF	Hydrofluoric
SEM	Scanning Electron Microscope
WC	Tungsten Carbide

UNIVERSITI MALAYSIA PAHANG
FACULTY OF MECHANICAL ENGINEERING

I certify that the project entitled "*investigation of machining performance of coated carbide by murakami surface pretreatment*" is written by *Khairul Azmi Bin Mohd Mawardzi*. I have examined the final copy of this project and in our opinion; it is fully adequate in terms of scope and quality for the award of the degree of Bachelor of Engineering. I here with recommend that it be accepted in partial fulfillment of the requirements for the degree of Bachelor of Mechanical Engineering with Manufacturing Engineering.

Signature : ……..
Name of Examiner : Dr. Noraini Mohd Razali
Position : Lecturer
Date :

SUPERVISOR'S DECLARATION

I hereby declare that I have checked this project and in my opinion, this project is adequate in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering with Manufacturing Engineering.

Signature : ……..
Name of Supervisor :Dr. Siti Rabiatull Aisha Idris
Position :Lecturer
Date :

STUDENT'S DECLARATION

I hereby declare that this report entitled "*investigation of machining performance of coated carbide by murakami surface pretreatment*"is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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Signature : ……..
Name : Khairul Azmi Bin Mohd Mawardzi
ID Number : ME 08068
Date : 22th of June 2012

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Machining process play an important role in product making and widely use in manufacturing industries. Machining is the process of removing materials from excess and unwanted stock by use of machine tools and converting them into a usable parts. All of these related to the metal cutting. Therefore the characteristic of cutting tools need to be consider during in machining operation in order to get a good quality of product in time, and can reduce the production cost. Cemented tungsten carbide is the most widely used material for cutting tools. Due to extreme demands higher tool life several types of coating have been introduced to prolong the service time which include diamond coating. The study of CVD diamond coatings can be expected to significantly prolong the lifetime of coated tools during cutting and milling. The Co in the hard metal binder phase can Influence the chemical vapour deposition of diamond. Co vapour pressure, surface migration, and carbon solubility are the main parameters influencing diamond nucleation and growth and coating adhesion. Pre-treatment procedures are usually aimed at decrease the Co in the substrate surface by select chemical etching**.** In this paper the special surface pre-treatment procedure reported in the patent was investigated. After small amounts of WC are removed from the hard metal substrate surface by etching with Murakami solution ($K_3[Fe(CN)_6]$ n KOH), the remaining Co binder network is treated with H_2SO_4/H_2O_2 solution. The effects of this surface treatment with respect to diamond growth rate, morphology and adhesion of the deposited coating on the substrates were investigated.

1.2 PROBLEM STATEMENT

Performance of turning machine almost depending in how fast the machine can cut the work piece, its meant more faster the turning machine process material more finish product are produce in a period of time and the productivity of the machine are high. High productivity needed high rate of metal removal, so it will reduce manufacturing cost and operation time. Although the faster process is needed, it did not guarantee the quality of the produce good in term of surface roughness. Customer always prefer to a quality product and the quality of work piece machined surface and its integrity are most depend on tool wear and it directly depend on life of the tool. Moreover, despite having the target of achieving optimum finishing with the shortest possible time one must take into account the consideration the quality of surface roughness, so that the complete finishing operation can be carried out with just one tool, avoiding the intermediate stops in order to change the tool due to its wear. Eventually, sudden failure of cutting tools lead to loss of productivity, rejection of parts and consequential economic losses. Selection of cutting tools and cutting conditions represents. Plus tool wear/tool life is an important aspect commonly considered in evaluating the performance of a machining process. In this research, the main objective is to study the effect and performance of coated cutting tools with Murakami surface pretreatment in order to get the best quality of work piece surface roughness while using turning machine.

1.3 OBJECTIVE OF THE RESEARCH

These are the objectives for this research:

(a) To determine the effect of the murakami pretreatment onto tungsten carbide‘s surface morphology prior to coating.

(b) To determine the effect of machining performance of tungsten carbide on titanium (focusing on size and shape of the chip).

(c) To evaluate the effect of tungsten carbide's wear resistance using coated and uncoated tungsten carbide.

1.4 SCOPE OF PROJECT

The scope of this research can be divided into three main parts:

a) Murakami surface pretreatment of the cutting tools
   -The tungsten carbide cutting tools will be etched (soaked) in murakami solution.

b) Coating the cutting tools
   -The cutting tools will be coated by chemical vapor deposition (CVD) technique.

c) Machining (testing the cutting tools)
   -The cutting tools will be testing by using turning machine with titanium workpiece based on the specified parameters.