JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Comparision of plasma spray and PVD coatings on different cutting tool

K.Suresh kumar[1] Dr.K.R.Dinesh[2]. Dr.K.Veeresh [3] Dr.Jagadish.S.P[4]. 1.Research Scholor VTU-Belagaum Assistant professor Mechanical Dept RYMEC-Ballari 2.Professor Govt.Engg College K.R.Pet Mandya.3.Dr.K.Veeresh Professor Mechanical Dept RYMEC-Ballari 4.Associate professor Mechanical Dept RYMEC-Ballari

Abstract:*In this research work by considering Six different Alloys namely SS316,SS304,SS410, SS440C, Ti-6Al-4V and HSS, plasma spray and PVD coatings is carried out by using different powder particles on these tools to increase the tool hardness life and comparisons made on these tools and from experimental results it is found that HSS and Ti-6Al-4V very good coating properties compared to other tools And comparing the plasma spray and PVD coatings, The PVD coating with TIN shows good results with coating thickness of* ~0.5 µm to ~3 µm. *and increases tool life.*

Keywords: SS316, SS304, SS410, SS440C, Ti-6Al-4V, HSS,physical vapour deposition with sputtering coating process and plasma spray coating

1.1.Introduction:-Generally the cutting tools used to remove or cut material in machining operations .Cuttingtool It is defined as eliminate or withdraw material from the component by using lathe machine.Removal ofmaterial on theworkpiece is done by using singlepoint cutting tool.Typesofcuttingtool:Single/multi pointcuttingtools.Rotarycuttingtools,tapsanddies,milling cuttersetc,[1].

1.1.1. Methods for Measurement of Cutting tool wear

i)using optical micro scope fitted with micrometer ii) using Scanning Electron Microscope (SEM)

iii) Talysurf iv) Grooving and indentation methodetc,

Tool wear:-is take place due to regular usage or operation of tool in machinery.

Figure1.1:No wear of tool [2-55]

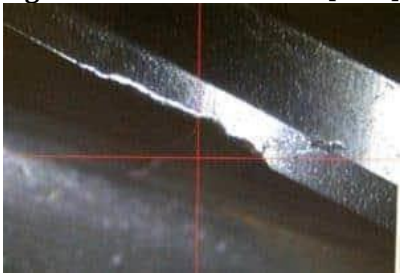


Figure1.2:Excessive wear of a tool [2]

AbrasiveWear:-Duetomechanicalabrasiontakenplacefromtheworkpiecetocutting edgeof thetool.

Figure1.3:Abrasivewear[2]

Thermal Cracking: Due to continuous operation in the lathe or any machine,heat or temperature generated and it reflect the tool failure is called thermal cracking.

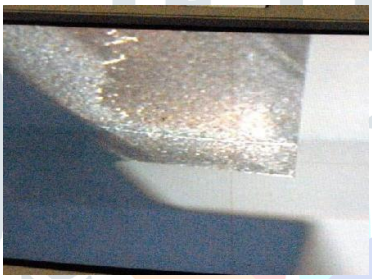


Figure1.4:Thermal Cracking [2]

1.1.2. PVD coating physical vapor deposition (PVD)

PVD -PVD usually uses evaporation and sputtering techniques and does not involve chemical reactions. PVD covering delays apparatus life under similar slicing conditions contrasted with uncoated carbide.
Coating of instruments with sharp edges is conceivable without relaxing or changing the edge nature of the substrate.
As the cycle moves the covering material as a solitary iota or on the sub-atomic level, it can give amazingly unadulterated and elite coatings which for some, applications can be desirable over
different strategies utilized. At the core of each CPU, and semiconductor gadget, solid defensive film, optical focal point, sun based board and numerous clinical gadgets, PVD Coatings give significant execution ascribes to the end result. Regardless of whether the covering should be incredibly slim, unadulterated, tough or clean, PVD gives the arrangement. The two most basic Physical Vapor Deposition Coating measures are Sputtering and Thermal Evaporation.
Types of PVD Coatings:-Different types of PVD Coatings are as follows.
Vacuum vanishing, Sputtering, and Ion plating.
Vacuum evaporation:- Equipment is relatively low-cost and simple; deposition of compounds is difficult; example of coating materials;Ag, Al, Au, Cr, Cu, Mo, W
Sputtering:-Better throwing power and coating adhesion than vacuum evaporation can coat compounds, slower deposition rates, example of coating materials;Al_2O_3, Au, Cr, Mo, SiO_2, Si_3N_4, TiC, TiN
Ion plating.:- Best coverage and coating adhesion of PVD processes, most complex process control, higher deposition rates than sputtering. example of coating materials;Ag, Au, Cr, Mo, Si_3N_4, TiC, TiN
coating materials used in this research work are as follows;Titanium nitride (TiN) and Titanium oxide

2.LITERATURESURVEY:- In this section introduction to Cutting tools and literature survey carried out .

Exhaustive literature survey has been done on the basis of parameters strength, coating, corrosion, wear on Cutting tools on the basis of reputed journals and publications.

[1]Yahya Işık et.al [2010]They investigated that TiAlN single-layered PVD sheathed tools indicates thathigher hardness when compare to CVD coated tools,and alsomachining cost per part using TiAlN CVDis very high comapared toTiAlN PVD.

[3] Fritz Klocke et.al [2011]They investigated that in machining HS 6-5-3 PM resulted in a significantly decreased feed force and enhanced tool life and also In machining HS 4-2-4 PM the feed force increased more sharply with advanced cutting speeds while tool life was tripled in regard to HS 6-5-3 PM.

[4] S.M. Forghania,.et.al [2012]They investigated that TiO2-covered mellow steel micro hardness and plasma coatings up to 878 HV0.3,Be that as it may, by utilizing an elevated level of intensity (40 kW), an unfavorable impact may happen because of the remaining burdens. Number of cycles had no embellishment with a special case for accomplish wanted thicknesses. To put it plainly, the most best boundaries of plasma splashing of TiO2-covered mellow steel with power utilized upto 30 kW along a powder feed 6 g/min, and a filtered with velocity of 0.5 m/s.

[5]**Turgay Kıvak** et.al **[2013]**They investigated thatCVD TiCN/Al2O3-coated carbide tool inserts shows the improve achivement than PVD TiAlN-coated carbide inserts on various cutting tools.

[6] JUNAIDI* et.al. [2015]They investigated that the Cutting process tool HSS With Cast Iron Material Universal Lathe which is commonly found at Analysis cutting Process by some aspects numely Cutting force , Cutting Speed, Cutting Powe r, Cutting Indication Power , Temperature Zone 1 and Temperatur Zone 2. Purpose of this Study was to determine how big the cutting Speed , Cutting Power, electromotor Power, Temperatur Zone 1 and Temperatur Zone 2 that drives the chisel cutting HSS in the Process of tur ning Cast Iron Material .Cutting force obtained from image analysis relationship between the recommended Component Cuting Force with plane of the cut and Cutting Speed obtained from image analysis of relationships between the recommended Cutting Speed Feed rate.

[7] Daniel Johanssona, et.al [2016]They investigated that the current paper researches hardened steel AISI 304 Strong carbide (WC–Co) embeds with steady cutting calculation and with five distinctive PVD coatings were utilized in the machining preliminaries. The outcomes will help limit the measure of work material and test time just as apparatuses expected to get dependable machining information.

[8] Xuchao et.al [2020] They have investigated that To achieve a better performance, a novel cutting tool has been developed with micro-grooves on its rake face. Such tools have great potential in manufacturing. However, micro-grooves of improper directions and shapes may adversely affect cutting tools. This paper investigates the performance of newly designed cemented carbide (WC/Co) cutting tools with micro-grooves on the rake face in the machining of titanium alloy Ti-6A1-4V using finite element (FEM) simulation. The objectives are to explore the influence of the directions and geometrical shapes of micro-grooves on the performance of cutting tools in dry turning of the titanium alloy and to compare it with conventional cutting toolspecifically, the following aspects are compared: cutting temperature, cutting force, chip morphology, and stress distribution. It is found that these micro-grooved cutting tools generate lower cutting force and cutting temperature and increase chip curling

[9]Yu Zhou a, et.al.[2022]They investigated that the study reported a strategy of three-stage heat treatment to simultaneously improve yield strength (YS), ultimate tensile strength (UTS) and elongation (EL) of laser melting deposited (LMDed) Ti-6Al-4V titanium alloy. After the three-stage heat treatment, the basketweave microstructure consisting of acicular α laths in the as-built sample was transformed to a multiscale-α microstructure consisting of the coarse-plate α, fine-plate α and ultrafine α in the heat-treated sample. The effect of microstructure on the tensile properties was revealed via in-situ tensile test combined with the analysis of the deformation and fracture mechanism. Although the coarse-plate α in heat-treated sample is larger than the acicular α in as-built sample, the combination of multiscale α grains with a certain relative content aroused an increment of the YS from 879 ± 28 MPa in as-built sample to 973 ± 9 MPa in heat-treated sample.

3.OBJECTIVES AND SCOPE OF THE PRESENT RESEARCH WORK:-

Now a days, Due to various reason cutting tools fails and tool wear takes place, due to improperor negligence utilization of cutting tool in various industry, Due to this wear or damage or fracture of cutting tools takes place. In this context to increase the lifeof the cutting tool the different Heat Treatment process and coating on different singlepoint cutting tool is carried out. And also, it leads to investigations of single point cuttingtools material which is having low density and good Hardness properties, to withstand Wear property.

4.SELECTION OF MATERIALS AND METHODOLOGY:-

In this chapter the SS316, SS304, SS410, SS440C, HSS and Ti-6Al-4V six different alloy materials are selected to conduct the coating to improve the hardness, to improve the Wear properties and strength on these specimens. PVD and Plasma spray coating carried out for comparison of these alloys is carried out.

4.1.Different Coating Techniques Used to Coat on Cutting Tool

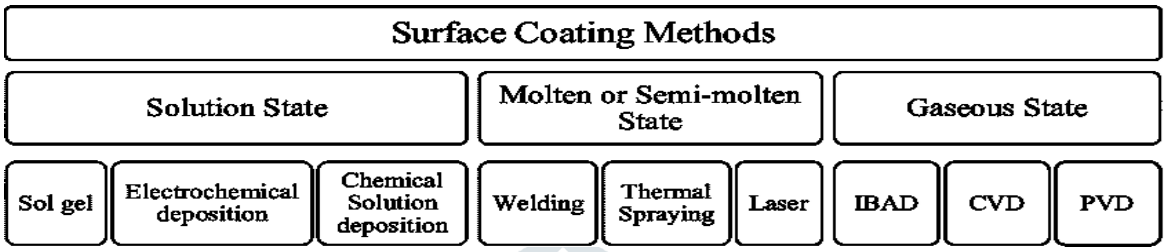


Figure4.1:Types of surface coating methods

Coating on Cutting Tool By Using Plasma Spray Technique:-

Titanium Oxide powder Coating on S1, S2, S3, S4, S5 and S6 specimens is carried out by using plasma spray coating technique, the plasma spray coating method, which is used as efficient and economical, applied in all the specimens.

Procedure: A high temperature plasma stream is created by non-transferred plasma arc within the torch. Many gases may be ionized this way, organ or nitrogen with small additions of hydrogen and helium are popular choices. In anionized gas, free electrons are stripped from the atoms and recombination releases significant thermal energy. The plasma stream can reach temperatures of 10,000 -50,000 degrees Fahrenheit and then started the coating process and coated on S1, S2, S3, S4, S5 and S6specimensis 150-250 microns achieved.

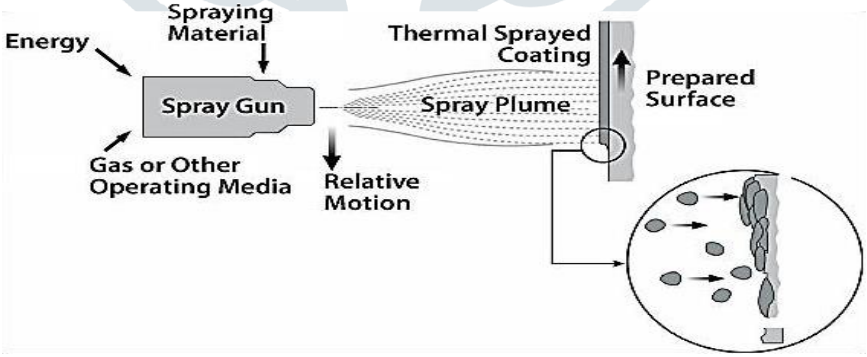


Figure4.2:Plasmaspray processonS1,S2,S3, S4,S5 andS6

Table4-1:Specification of Plasma Spray coating machine

Sl.No.	Description	Details

1	Gun	3mb
2	Nozzle	GH
3	ArgonPressure	100 to150 psi
4	FlowRate	80 to 90 lpm
5	HydrogenPressure	50psi
6	FlowRate	15 to 18 lpm
7	Temperature	500 ^{o}c
8	Voltage	65 to 70 v
9	PowderFeed	50 to 65g/min
10	SprayDistance	2to 4inches

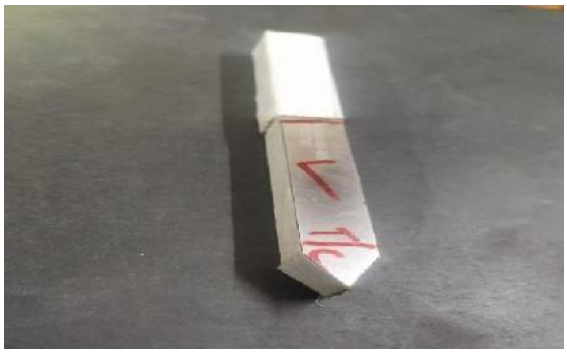
4.2.DifferentPowder Particles Used for Coating

Different Powder Particles used for Coating are(a)TitaniumNitrade (b)TitaniumOxide

Fig. 4.3 (a)

Fig.4.3 (b)

Figure4.4:Different Powder Particles used for Coating (a)Titanium Nitrade (b)Titanium Oxide.



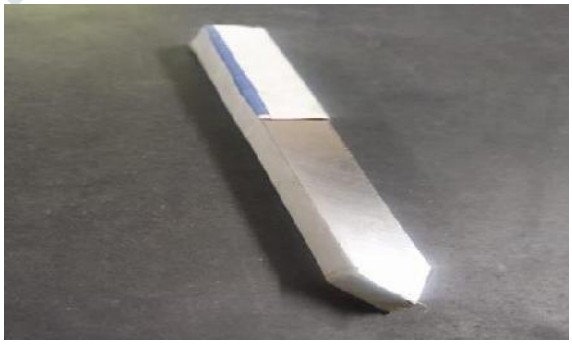


Figure4.5:Single point cutting tools before coating

Figure4-6:Sand blasting for CuttingTool

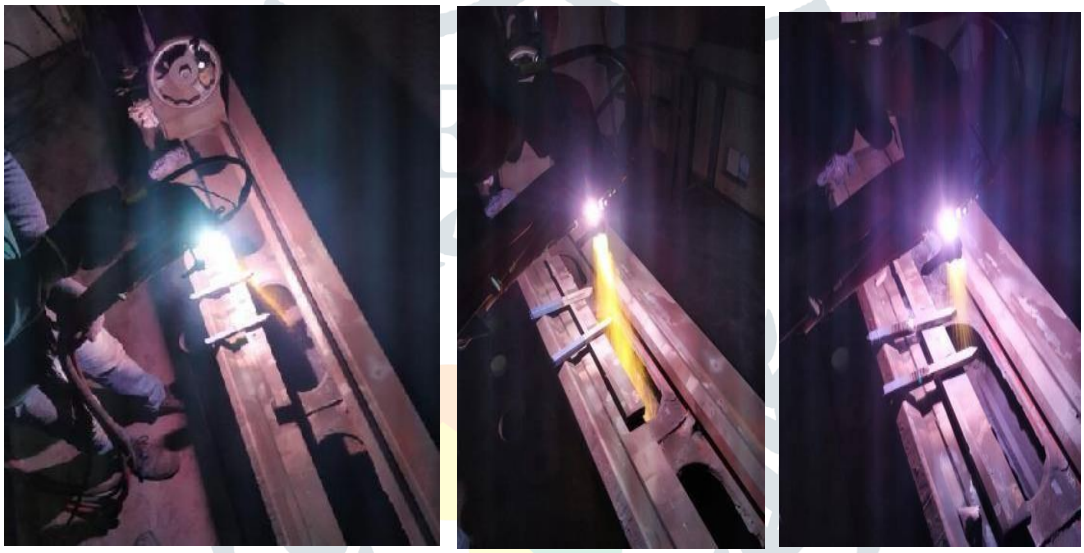


Figure4-7: Plasma ArcWelding

4.8 (a) 4.8(b)

Figure 4.8: Different coated tools (a) Titanium Nitride powder coated on tools (b)Titanium Oxidepowdercoated on tools

4.3.Coating on cutting tool by Physical Vapor Deposition (PVD):

Physical Vapor Deposition (PVD) Coating :PVD covering delays apparatus life under similar slicing conditions contrasted with uncoated carbide.

Coating of instruments with sharpedges is conceivable without relaxing or changing the edge nature of the substrate.As the cycle moves the covering material as a solitary or on the sub-atomic level, it give amazingly unadulterated and elite coatings, which are desirable over different strategies utilized. At the core of each CPU semiconductor gadget, solid defensive film, optical focal point, sun based board and numerous clinical gadgets,PVD Coatings give ssignificant execution ascribes to the end result. Regardless of whether the covering should be incredibly slim, unadulterated, tough or clean, The two basic Physical Vapor Deposition Coating measures are Sputtering and Thermal Evaporation.
Types of PVD Coatings:Different types of PVD Coatings are as follows.

Vacuumevaporation: Equipment is relatively low cost and simple;deposition of compounds is difficult;ex:powder ;Ag, Al,Au, Cr,Cu, Mo, W
Sputtering: Better throwing power and coating adhesion than vacuum evaporation cancoat compounds, slower deposition rates, example of coating materials; Al_2O_3, Au, Cr,Mo,SiO_2, Si_3N_4, TiC, TiN.
Ionplating:bestcoverageandcoatingadhesionofPVDprocesses,mostcomplexprocess control, higher deposition rates than sputtering. ex; Ag,Au, Cr, Mo, Si_3N_4, TiC, TiN coating materials and also powders are used in this research work are as follows;Titaniumnitride (TiN)and Titanium oxide.

Sputtering:
On the off chance that the outside of a strong (or fluid) is besieged by nuclear particles ofadequatelyhighenergy,singularmoleculesofthesurfacemaysecureenoughforcebecause of the crash that they are launched out from the surface by move of energy. Thisis the cycle known as faltering. The most helpful type of high energy molecule is anionized gas, for example, argon, stimulated methods for anelectric field to frame aplasma. As a PVD cycle, faltering includes barrage of the cathodic covering material with argon particles (Ar+), making surface iotas get away and afterward besave donto asubstrate,shaping a dainty film on the substrate surface.

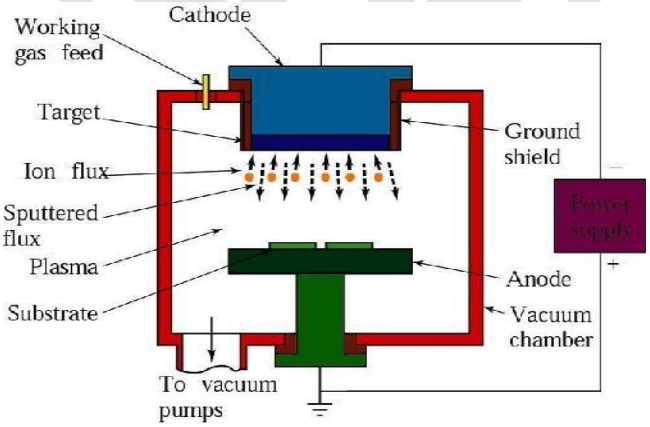
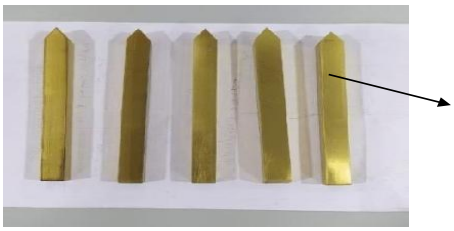


Figure4.9:PhysicalVaporDeposition (PVD) coatingsetupimage

The substrate should be put near the cathode and is typically warmed to improve holding of the covering particles.Though vacuum vanishing is restricted to metals, faltering can be applied to almost any material metallic and nonmetallic material components;composites,pottery,and polymers. Movement of amalgam sand

mixes can be faltered without changing their synthetic structures. Movement of substance mixes can likewise be stored by utilizing responsive gases that structure oxides, carbides ornitrides with the faltered metal.



Titanium nitride (TiN)coating

Figure4.55:Titaniumnitride(TiN) sputteringPVDcoating

Conclusion:-Coating is carried out on all specimens and found that in plasma thermal spray coating process the Titanium Oxide powder shows very good bonding with coating thockness 0.5-1 µm or adhesive property on all the specimens compare to titanium nitrate powder.

Coating is carried out on all specimens by using TiN (Titanium Nitrate) PVD coating-sputtering method it is found that Titanium Nitrate coating shows very good bonding with coating thickness of ~0.5 µm to ~3 µm. or adhesive property on all the specimens and it is found that HSS (S6) and Titanium alloy (Ti-6Al-4V) (S5) shows better coating strength compare to other specimens.From experimental results it is found that TiN (Titanium Nitrate) PVD coating-sputtering method is very good coating process compare to plasma spray coating process.

References:-

[1] **Tool life and performance comparison of coated tools in metal cutting** Yahya IşıkDepartment of Technical Science,Vocational School of Higher Education,Uludag University,16059 Görükle, Bursa, TurkeyInt. J. Materials and Product Technology, Vol. 39, Nos. 3/4, 2010 Işık, Y. (2010) 'Tool lifeand performance comparison of coated tools in metal cutting', Int. J. Materials and Product Technology, Vol. 39, Nos. 3/4, pp.252–262.

[2]https://wikipedia.com

[3] **Characterization of ToolWear in High-SpeedMilling of Hardened PowderMetallurgical Steels Fritz Klocke, Kristian Arntz, Gustavo Francisco Cabral,Martin Stolorz, andMarc Busch** *Fraunhofer Institute for Production Technology IPT, Steinbachstraße 17, 52074 Aachen, Germany* Correspondence should be addressed to Marc Busch, marc.busch@ipt.fraunhofer.de Received 30 June 2011; Accepted 29 August 2011 Academic Editor: Alexander Tsouknidas Hindawi Publishing Corporation Advances in Tribology Volume 2011, Article ID 906481, 13 pages doi:10.1155/2011/906481

[4].Effects of plasma spray parameters on TiO2-coated mild steel using design of experiment (DoE) approach S.M. Forghania, M.J. Ghazalia,n, A. Muchtara, A.R. Daudb, N.H.N. Yusoffc, C.H. Azharia aDepartment of Mechanical & Materials Engineering, Faculty of Engineering & Built Environment, National University of Malaysia, 43600 UKM, Bangi, Selangor, Malaysia bSchool of Applied Physics, Faculty of Science & Technology, National University of Malaysia, 43600 UKM, Bangi, Selangor, Malaysia cMaritime Technology Divison, Science and Technology Research Institute For Defence (STRIDE), c/o KD MALAYA 32100 Pangkalan TLDM, Lumut, Perak, Malaysia Received 5 September 2012; received in revised form 27 September 2012; accepted 27 September 2012 Available online 8 October 2012www.elsevier.com/locate/ceramint0272-8842/$ - see front matter & 2012 Elsevier Ltd and Techna Group S.r.l. All rights reserved. http://dx.doi.org/10.1016/j.ceramint.2012.09.092 Available online at www.sciencedirect.com Ceramics International 39 (2013) 3121–3127

[5]Optimization of surface roughness and flank wear using the Taguchi method in milling of Hadfield steel with PVD and CVD coated inserts, Turgay Kıvak Duzce University, Faculty of Technology, Department of Manufacturing Engineering, 81620 Duzce, TurkeyMeasurement 50 (2014) 19–28

Contents lists available at ScienceDirectReceived 2 March 2013 Received in revised form 4 November 2013 Accepted 12 December 2013 Available online 27 December 2013 Measurement journal homepage: www.elsevier.com/ locate/measurementT. Kıvak / Measurement 50 (2014) 19–28

[6]ANALYSIS CUTTING TOOL HIGH SPEED STEEL (HSS) WITH CAST IRON MATERIAL FROM UNIVERSAL LATHE JUNAIDI* ,DARMAWATI** ,AHMAD YANIE*** Article · January 2015 See discussions, stats, and author profiles for this publication at: https://www.researchgate.net/publication/330934895 Department Mechanical Engineering Sekolah Tinggi Teknik Harapan Medan JL.H.M.Joni No.70-C.MEDAN Email: junaidi413@yahoo.com ABSTRACT Cutting tool is the tools lathe .

[7] **Tool life in stainless steel AISI 304: applicability of Colding's tool life equation for varying tool coatings** Daniel Johanssona, Tõnu Leemetb*, Jaanus Allasb, Marten Madissoob,Eron Adobergc, and Fredrik Schultheissaa Division of Production and Materials Engineering, Lund University, 221 00 Lund, Swedenb Institute of Technology, Estonian University of Life Sciences, Fr. R. Kreutzwaldi 56-A213, 50408 Tartu, Estoniac Faculty of Mechanical Engineering, Tallinn University of Technology, Ehitajate tee 5, 19086 Tallinn, EstoniaReceived 19 October 2015, revised 26 January 2016, accepted 10 February 2016, available online 22 March 2016 Proceedings of the Estonian Academy of Sciences,2016, **65**, 2, 172–176doi: 10.3176/proc.2016.2.13Available online at www.eap.ee/proceedings Article *in* Proceedings of the Estonian Academy of Sciences · January 2016DOI: 10.3176/proc.2016.2.13

[8] Numerical analysis of performance of different micro-grooved tools for cutting titanium alloy Ti-6Al-4V November 2020 The International Journal of Advanced Manufacturing Technology 111(3-4):1-18 DOI:10.1007/s00170-020-06134-8Xuchao MiaoXu ZhangXin LiuQianxi Yu

[9]**Simultaneous improvement of strength and elongation of laser melting deposited Ti-6Al-4V titanium alloy through three-stage heat treatment** Yu Zhou a, Ke Wang a,*, Zhonggang Sun b, Renlong Xin a a *International Joint Laboratory for Light Alloys (MOE), School of Materials Science and Engineering, Chongqing University, Chongqing 400044, PR China* b *Tech Institute for Advanced Materials, College of Materials Science and Technology, Nanjing Tech University, Nanjing 210009, PR Chin* Contents lists available at ScienceDirect Journal of Materials Processing Tech. journal homepage: www.elsevier.com/locate/jmatprotec Available online 27 April 2022 0924-0136/© 2022 Elsevier B.V. All rights reserved.