Metoda Taguchi planowania i analizy eksperymentu w zastosowaniu do warstw na bazie TiAlN - przegląd literatury

Literatura do tak zawężonego zakresu jest raczej nieliczna.
Ujęto więc także inne artykuły, interesujące z innych względów

Applied Surface Science 255 (2008) 1865–1869

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Optimization of hybrid PVD process of TiAlN coating

Donghai Yu [a], Chengyong Wang [a,*], Xiaoling Cheng [b], Fenglin Zhang

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Materials and Design 28 (2007) 36–46

Materials & Design

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A hybrid approach to optimise multiple performance characteristics of high-speed computerised numerical control milling tool steels

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Materials and Design 27 (2006) 920–927

Experimental and numerical studies on the determination of twist drill temperature in dry drilling: A new approach

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MATERIALS CHEMISTRY AND PHYSICS

rials Chemistry and Physics 46 (1996) 77–83

The deposition and wear properties of cathodic arc plasma deposition TiAlN deposits

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Received 22 February 1995; accepted 20 December 1995

Przegląd wybranych artykułów

1

- Artykuł 1
  Podejście najbardziej typowe

2

- Artykuł 2
  Ciekawa warstwa bo ciekawą metodą nanoszona

3

- Artykuł 3
  TiAlN i stosunkowo duża ilość zmiennych

4

- Artykuł 4
  Tu autorzy trochę chyba przesadzili

5

- Artykuł 5
  Mimo, że wnioski dość oczywiste to ciekawy

Applied Surface Science 255 (2008) 1865–1869

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Optimization of hybrid PVD process of TiAlN coatings by Taguchi method

Donghai Yu [a], Chengyong Wang [a,*], Xiaoling Cheng [b], Fenglin Zhang [a]

A B S T R A C T

Taguchi method was applied to optimize the performances of TiAlN coatings deposited by hollow cathode discharge ion plating (HCDIP) and medium frequency magnetron sputtering ion plating (MFMSIP) hybrid physical vapor deposition (PVD) coating system. TiAlN coatings prepared by this coating system showed columnar microstructure with the preferred orientation of (1 1 1). The sensitive parameters on microhardness were total deposition pressure and substrate bias voltage, and the sensitive parameter on milling performance was substrate bias voltage. The optimum conditions were total deposition pressure: 0.9 Pa, flowrate of N_2: 250 sccm, substrate bias voltage: −120 V. And the confirming experiment obtained the optimum TiAlN coating with microhardness of 25.8 GPa, and the best TiAlN-coated end mill performed the milling length of 50.8 m.

The substrates used in this experiment were mirror polishe SUS304 stainless steel plates and cemented carbide end mills. Th SUS304 stainless steel plates were used to analysis TiAlN coating structures and microhardness. The cemented carbide end mill (type GM-4E-D4.0S, average WC grain size 0.8 μm, as diameter c 4 mm, four-flute flattened end mills with straight shank) wer used for high-speed milling test.

1

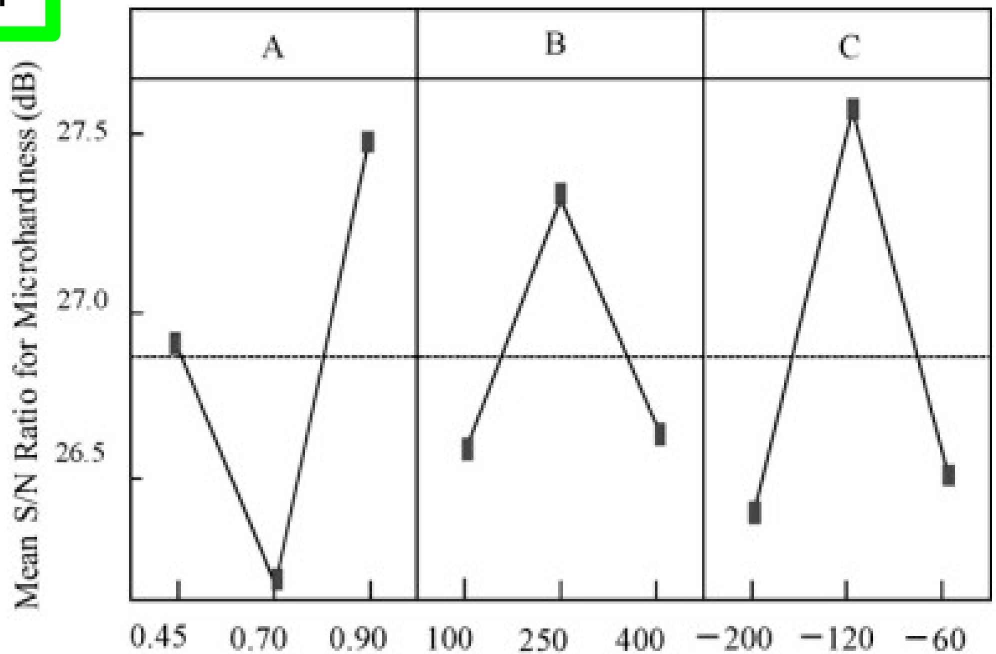

Fig. 4. The mean S/N graph for microhardness.

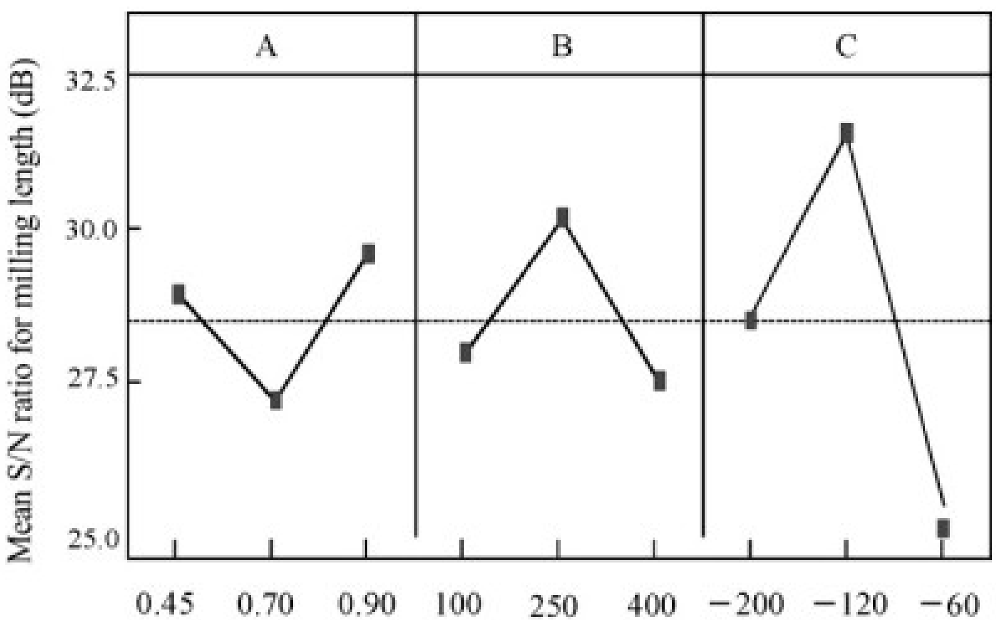

Fig. 5. The mean S/N graph for cutting length.

Pamiętać należy, że optymalizowane parametry nie są jedynymi, które wpływają na własności warstw. Innymi słowy, założono milcząco, że procedura jak niżej jest optymalna czyli „poza Taguchim”

Before deposition, the substrates were degreased in an ultrasonic cleaning line and undergone ultrasonic cleaning progressively in acetone and ethanol and then dried by compress air. After loading, the substrates were gradually heated to 430 °C. Meanwhile, the coating chamber was evacuated to a back vacuum of less than 3×10^{-4} Pa to increase the purity of the coatings. All specimens were first etched in an argon-ion-etching process for 10 min to clean and remove native surface oxides. In a second etching step the substrates were bombarded with Ti ions to activate the surface. In both etching phases the substrates were biased with voltage of −800 V. To achieve better adhesion between coating and substrate, a thin TiN adhesive layer was deposited for 10 min using hollow cathode deposition (HCD) by evaporating Ti metal at a pressure of 0.4 Pa and DC bias voltage of −200 V. Then the TiAlN coating was deposited by HCDIP and MFMS hybrid

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Surface & Coatings Technology 200 (2005) 704 – 707

SURFACE & COATINGS TECHNOLOGY

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Tribological properties of a CrN coating containing carbon nanoparticles

S. Luridiana, S. Mutti*

Abstract

CrN is well known to be one of the most performing tribological coatings, with excellent wear and corrosion resistance and good toughness. These last two properties could make CrN a promising base for the development of coatings for high pressure contacts in lubricated conditions. Unfortunately, like most other nitrides, its dry friction coefficient is not very low. In this work we present the results of a series of experiments aimed at investigating the effect of the incorporation of carbon nanoparticles (nC) on the tribological properties of CrN, in order in particular to check the possibility of achieving a lower dry friction coefficient. Taguchi DoE technique was used to define the set of experiments to be performed; the analysis shows that only minor changes in both dry and lubricated friction coefficient can be obtained within the range of deposition parameters investigated while microhardness is sensitive to variations of the deposition pressure.

Table 1
First L9 Taguchi array developed to study elasticity and friction as response variables

Run	PMCS discharge repetition rate (Hz)	Bias duty cycle (%)	Bias tension (V)	Substrate temperature (°C)
1	4	15	60	
2	4	80	120	
3	4	100	150	
4	7	15	120	
5	7	80	150	
6	7	100	60	
7	10	15	150	
8	10	80	60	
9	10	100	120	

PMCS - Pulsed Microplasma Cluster source

2

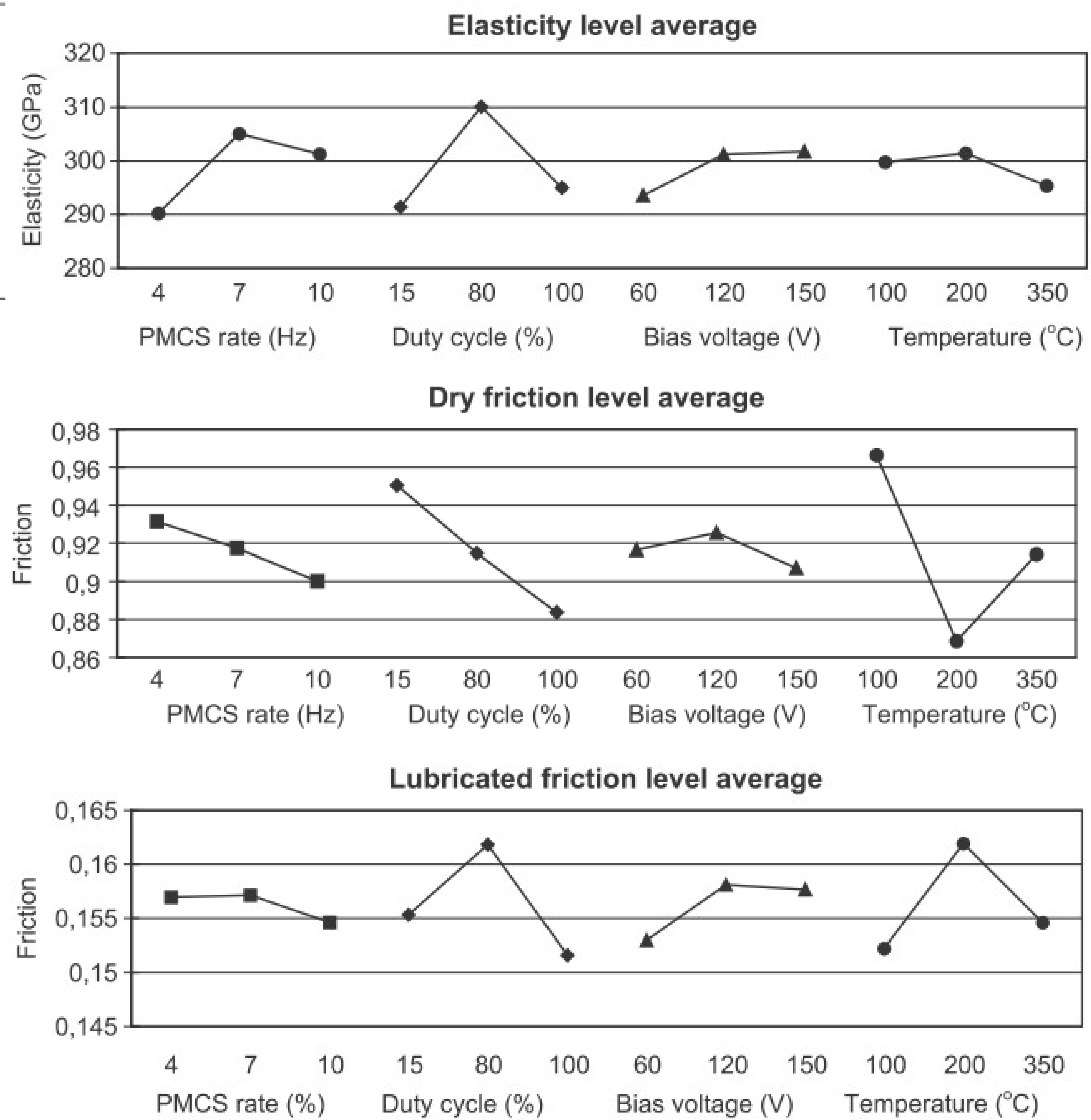
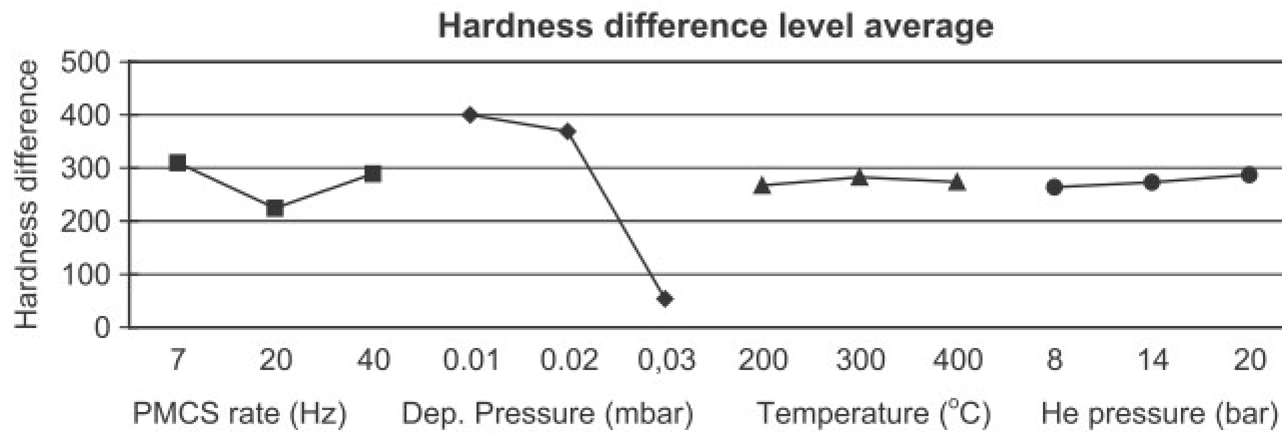


Table 2
Second Taguchi L9 array developed to study coating hardness

Run	Substrate temperature (°C)	PMCS discharge repetition rate (Hz)	Deposition pressure (mbar)	Helium pressure (mbar)
1	200	7	0.01	8
2	200	20	0.02	14
3	200	40	0.03	
4	300	7	0.02	
5	300	20	0.03	
6	300	40	0.01	
7	400	7	0.03	
8	400	20	0.01	
9	400	40	0.02	



The range of variation of the parameters under investigation must be very carefully chosen so that especially when very innovative processes are studied, it is necessary to first conduct a "wide scan" experiments campaign in order to identify the proper variation range for each parameter.

The results show that the investigated coating properties undergo limited variations within the range of deposition parameters investigated, with the exception of hardness, which changes considerably with deposition pressure.

3

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Materials Chemistry and Physics 46 (1996) 77–83

MATERIALS CHEMISTRY AND PHYSICS

The deposition and wear properties of cathodic arc plasma deposition TiAlN deposits

Kwang-Lung Lin [a], Ming-Yeong Hwang [a], Cheng-Dau Wu [b]

[a] *Department of Materials Science and Engineering, National Cheng Kung University, Tainan, Taiwan, ROC*

[b] *Metal Industry Research and Development Center, Kaohsiung, Taiwan, ROC*

Received 22 February 1995; accepted 20 December 1995

Abstract

TiAlN coatings on tool steel were produced with a cathodic arc plasma deposition system. The Taguchi experimental design was applied to achieve the optimum wear-resistant coating. Substrate bias, nitrogen partial pressure and target composition were found to be among the most influential variables that govern the wear resistance of the coatings. The coating properties investigated in the present work include the surface roughness, scanning electron microscope (SEM) surface micrographs, X-ray diffraction (XRD) phase identification, coating microstructure, coating compositions, wear surface micrographs and elemental analysis. The microstructure, microhardness, coating Ti content and residence of wearing debris were found to significantly affect the wear resistance of the coatings.

Table 1
The Taguchi L18 experimental design: variables

Variable	Design number		
	1	2	3
A: target atomic ratio (Ti/Al)	50/50	72/28	72/28
B: substrate bias (V)	50	100	75
C: N_2 pressure (mbar)	0.05	0.01	0.03
D: arc current (A)	70	85	100
E: TiAl deposition time (A h)	0	3	6
F: TiAlN deposition time (min)	50	65	35
G: surface condition	polishing	#800	#400
H: sputter clean (A h)	3	6	9

Table 2
The Taguchi L18 experimental design: design numbers

Experiment no.	Variable							
	A	B	C	D	E	F	G	H
1	1	1	1	1	1	1	1	1
2	1	1	2	2	2	2	2	2
3	1	1	3	3	3	3	3	3
4	1	2	1	1	2	2	3	3
5	1	2	2	2	3	3	1	1
6	1	2	3	3	1	1	2	2
7	1	3	1	2	1	3	2	3
8	1	3	2	3	2	1	3	1
9	1	3	3	1	3	2	1	2
10	2	1	1	3	3	2	2	1
11	2	1	2	1	1	3	3	2
12	2	1	3	2	2	1	1	3
13	2	2	1	2	3	1	3	2
14	2	2	2	3	1	2	1	3
15	2	2	3	1	2	3	2	1
16	2	3	1	3	2	3	1	2
17	2	3	2	1	3	1	2	3
18	2	3	3	2	1	2	3	1

Table 3
The best wear-resistant variable values for the conditions investigated

Variable	Value
Target Ti/Al ratio	50/50
Bias (V)	50
N_2 pressure (mbar)	0.05
Arc current (A)	85
TiAl (A h)	6
TiAlN (min)	50
Surface condition	#400
Sputter clean (A h)	6

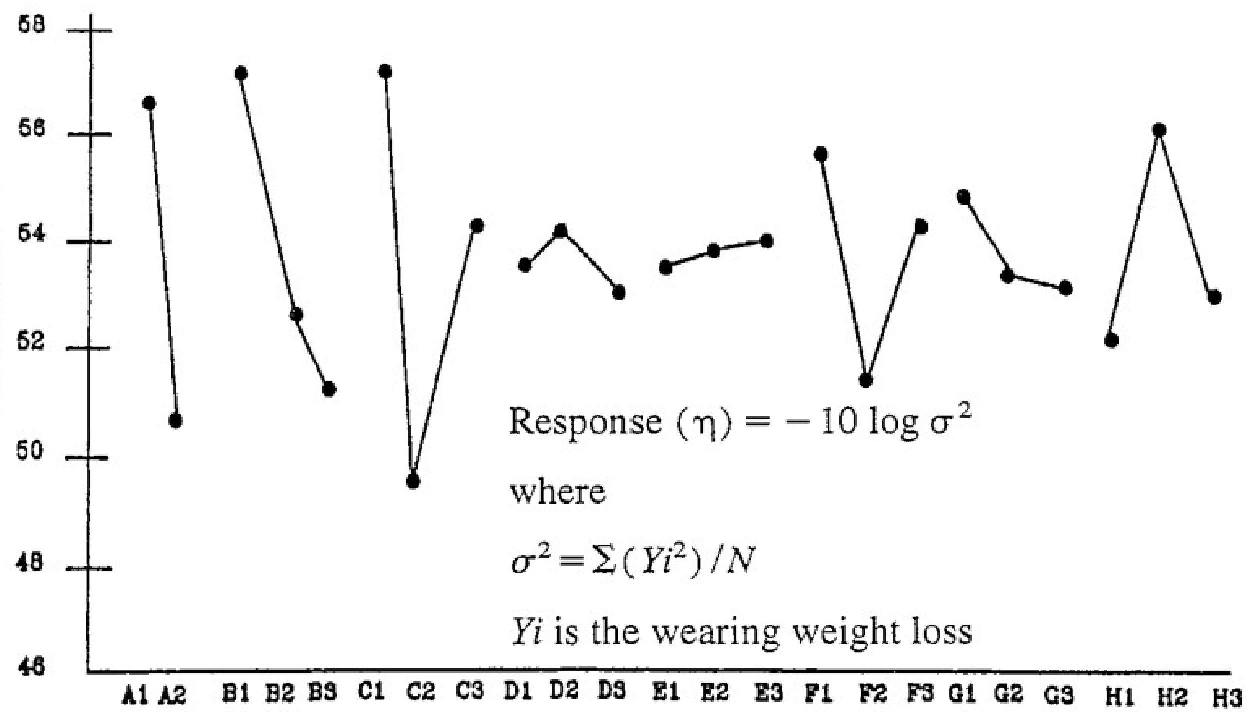

Fig. 1. The wearing response of the L18 testing configuration.

3

Przy pomocy metody Taguchi wyselekcjonowano próbki
do szczegółowych badań -
znów więc oszczędność czasu i środków

3.2. *Wear behavior and coating characteristics*

Six sets of experimental conditions, as shown in Table 4, were chosen to produce coatings for investigating various wearing properties. The corresponding response values are also presented in Table 4. The SEM morphologies of these coatings (Fig. 2, for instance) clearly show the existence of microparticles on the coating surfaces. The surface roughness of these coatings from experiments 1 to 6 are 0.459 ± 0.017, 0.366 ± 0.021, 0.409 ± 0.019, 0.353 ± 0.030, 0.397 ± 0.031 and 0.304 ± 0.020 μm, respectively. When comparing the corresponding η values in Table 4, it is of interest to see that

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Journal of Materials Processing Technology 123 (2002) 1–4

Journal of Materials Processing Technology

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Comparison of the tool life of tungsten carbides coated by multi-layer TiCN and TiAlCN for end mills using the Taguchi method

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Received 19 May 2000

Abstract

The purpose of the experiments reported in this paper is to use the Taguchi methods to investigate the wear of TiCN/TiAlCN coated onto various tool materials under various cutting conditions in the milling of quenched AISI 1045 carbon steel. The experimental results demonstrate that the tool material is the major parameter among the four controllable factors (different coated deposition, feed rate, spindle speed and tool material) that influence the tool life for milling the quenched AISI 1045 carbon steel. Further, the TiCN coating has the best performance of the various hard-coated treatments. However, the effect of coated deposition is not significant if the different coated deposition matches the tool material. © 2002 Elsevier Science B.V. All rights reserved.

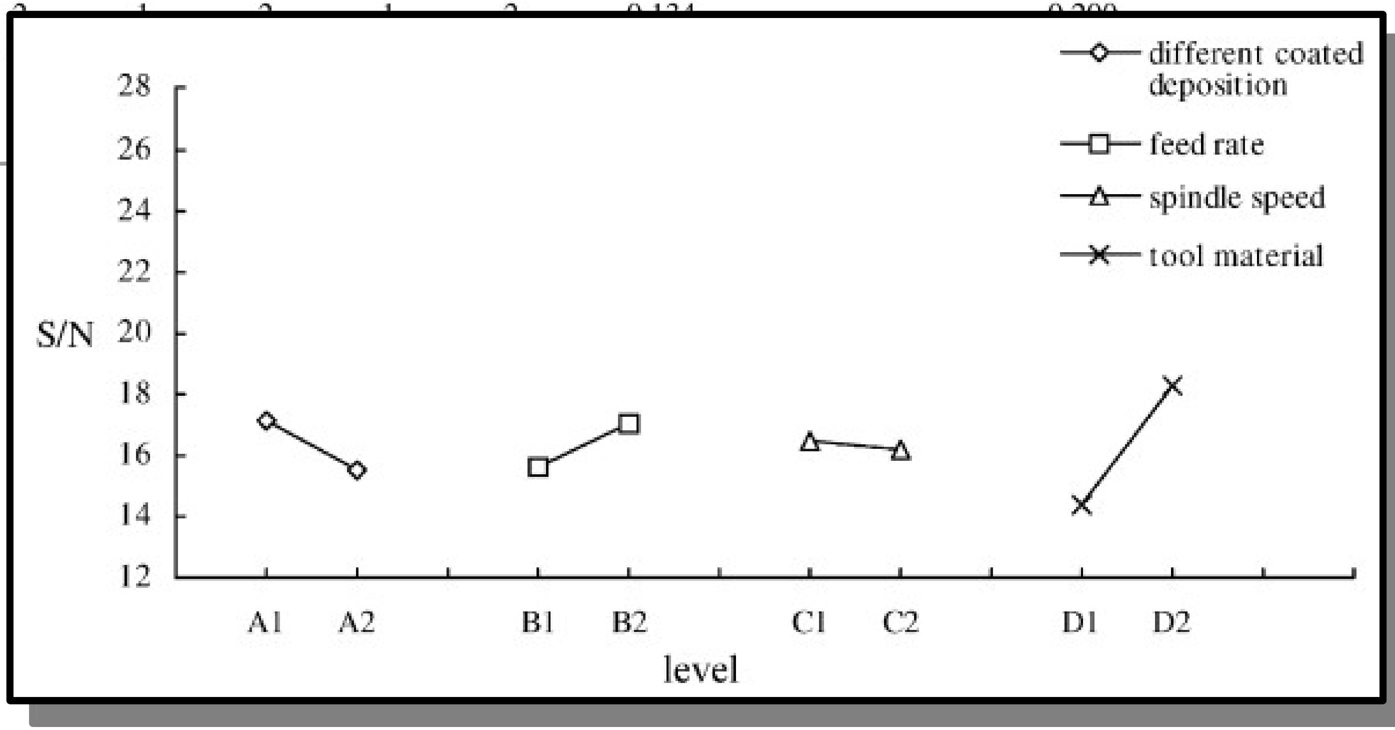
Table 3
The level table of milling test factors

Sample	Control factor	Level 1	Level 2
A	Different coated deposition	TiCN	TiAlCN
B	Feed rate (mm/rev)	0.08	0.12
C	Spindle speed (rpm)	1600	2000
D	Tool material	K10	K40

Raczej skromna przestrzeń zmienności parametrów

Table 4
The L_8 (2^7) orthogonal array and two sets of data for the width of the side flank wear y and their corresponding η values

Trial	1	2	3	4	5	6	7	Average width of the side flank wear, y_1 (mm)	Average width of the side flank wear, y_2 (mm)	S/N ratio, η (db)
	A	B		C			D			
1	1	1	1	1	1	1	1	0.175	0.117	16.556
2	1	1	1	2	2	2	2	0.125	0.117	18.340
3	1	2	2	1	1	2	2	0.084	0.125	19.470
4	1	2	2	2	2	1	1	0.192	0.192	14.357
5	2	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	15.389
6	2	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	12.302
7	2	2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	14.434
8	2	2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	19.883



4

4. Conclusions

According to the results of these experiments, the following can be concluded.

1. The experimental results demonstrate that the material of the tool is the main parameter among the four controllable factors (different coated deposition, feed rate, spindle speed and tool material) that influence the tool life in milling quenched AISI 1045 carbon steel. Moreover, the TiCN hard coating deposition has the best performance of the different hard-coated treatments. However, the effect of hard coating deposition is not significant if the different coated deposition matches the tool material.
2. The hard coating deposition can improve the problem of wear on the tool surface. The TiCN-coated deposition with K40 tool material has the best wear resistance for the machining of quenched AISI 1045 carbon steel. In relation to the TiAlCN-coated deposition and K10 tool material cutter under the similar milling conditions, the TiCN-coated deposition and K40 tool material cutter achieves around 188% improvement.

hmmm...

Luridiana and Mutti wrote:

The range of variation of the parameters under investigation must be very carefully chosen so that especially when very innovative processes are studied, it is necessary to first conduct a ‘‘wide scan’’ experiments campaign in order to identify the proper variation range for each parameter.

It looks like the „wide scan” is to wide

5

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Taguchi multiple-performance characteristics optimization in drilling of medium density fibreboard (MDF) to minimize delamination using utility concept

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Taguchi orthogonal array
Utility concept

ABSTRACT

This paper presents the methodology of Taguchi optimization method for simultaneous minimization of delamination factor at entry and exit of the holes in drilling of SUPERPAN DÉCOR (melamine coating layer) MDF panel. The delamination in drilling of MDF affects the aesthetical aspect of the final product and hence it is essential to select the best combination values of the drilling process parameters to minimize it. The utility concept has been employed for the multi-performance characteristics optimization using Taguchi design. The experiments were carried out as per L_9 orthogonal array with each experiment performed under different conditions of feed rate and cutting speed. The analysis of means (ANOM) was performed to determine the optimal levels of the parameters and the analysis of variance (ANOVA) was employed to identify the level of importance of the machining parameters on delamination factor. The investigations revealed that the delamination can be effectively reduced in drilling of MDF materials by employing the higher cutting speed and lower feed rate values.

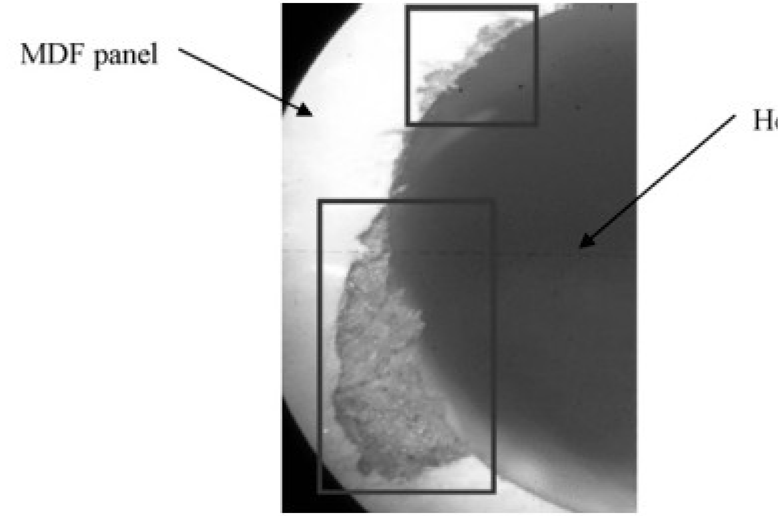
5

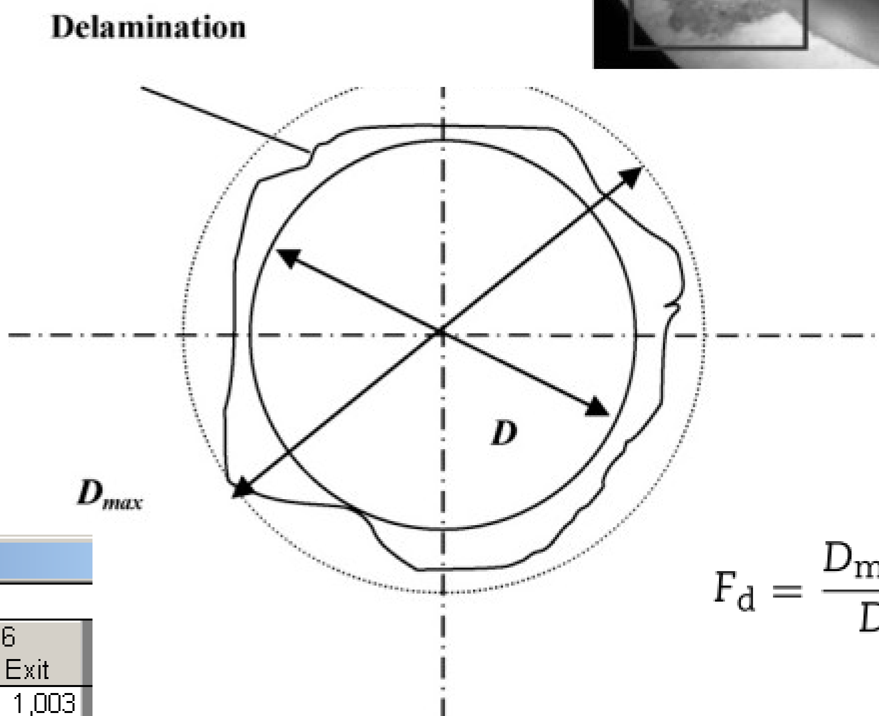
Table 1 – Factors and levels

Code	Factor	Levels		
		1	2	3
A	Feed rate (*f*) (m/min)	0.10	2.55	5.00
B	Cutting speed (*v*) (m/min)	16	63	110

Table 2 – L_9 orthogonal array

Trial no.	Levels of input factors	
	A	B
1	1	1
2	1	2
3	1	3
4	2	1
5	2	2
6	2	3
7	3	1
8	3	2
9	3	3





$$F_d = \frac{D_{max}}{D}$$

Dane: Arkusz41 (6 zmn. * 9 prz.)

	1 Feed rate	2 Cutting speed	3 Zmn3	4 Zmn4	5 Fd Entry	6 Fd Exit
1	1	1			1,003	1,003
2	1	2			1,002	1,015
3	1	3			1,001	1,01
4	2	1			1,351	1,295
5	2	2			1,045	1,059
6	2	3			1,037	1,05
7	3	1			1,709	1,311
8	3	2			1,147	1,217
9	3	3			1,076	1,029

$$\eta_1 = -10\log_{10}[F^2_{d(entry)}]$$

$$\eta_2 = -10\log_{10}[F^2_{d(exit)}]$$

5

Table 1 – Factors and levels

Code	Factor	Levels		
		1	2	3
A	Feed rate (*f*) (m/min)	0.10	2.55	5.00
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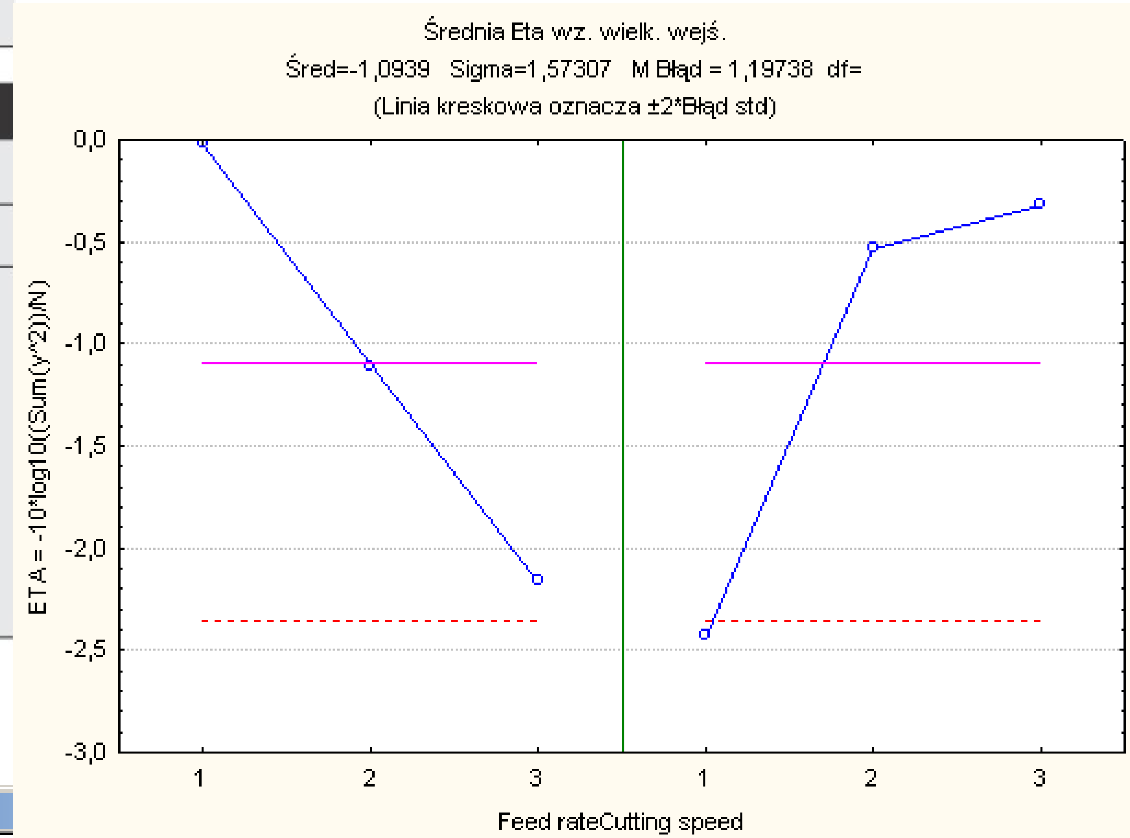
6	2	3
7	3	1
8	3	2
9	3	3



Dane: Arkusz41 (6 zmn. * 9 prz.)

	1 Feed rate	2 Cutting speed	3 Zmn3	4 Zmn4	5 Fd Entry	6 Fd Exit
1	1	1			1,003	1,003
2	1	2			1,002	1,015
3	1	3			1,001	1,01
4	2	1			1,351	1,295
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6	2	3			1,037	1,05
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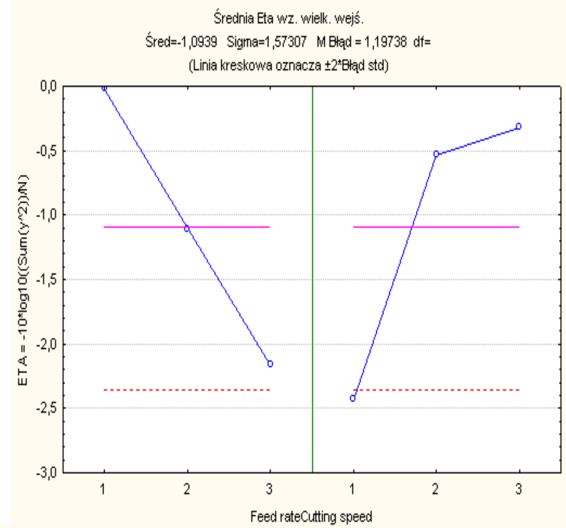
9	3	3			1,076	1,029

Table 1 – Factors and levels

Code	Factor	Levels 1	Levels 2	Levels 3
A	Feed rate (*f*) (m/min)	0.10	2.55	5.00
B	Cutting speed (*v*) (m/min)	16	63	110

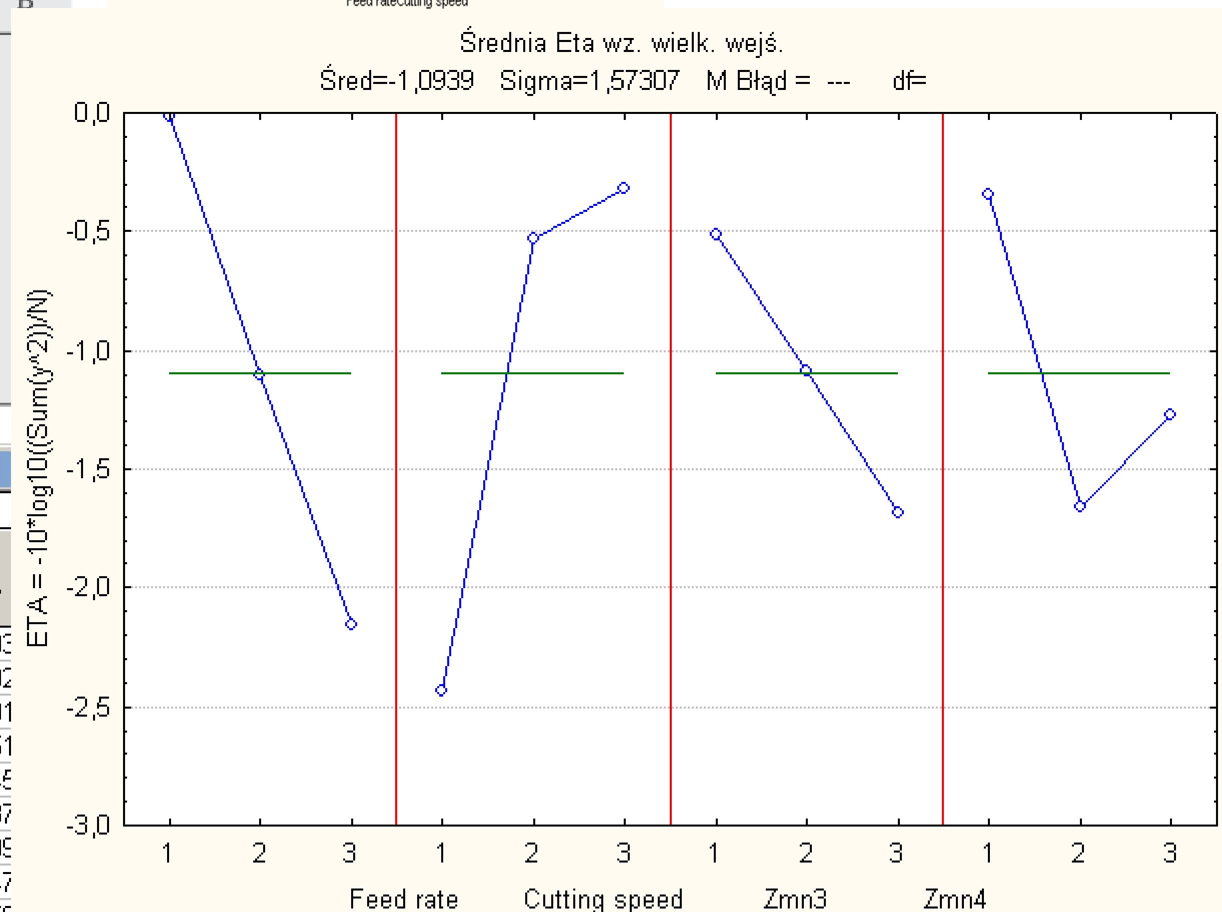
Table 2 – L_9 orthogonal array

Trial no.	Levels of input factors A	B
1	1	
2	1	
3	1	
4	2	
5	2	
6	2	
7	3	
8	3	
9	3	



Dane: Arkusz42 (6 zmn. * 9 prz.)

	1 Feed rate	2 Cutting speed	3 Zmn3	4 Zmn4	5 Fd Entry
1	1	1	1	1	1,003
2	1	2	2	2	1,002
3	1	3	3	3	1,001
4	2	1	2	3	1,351
5	2	2	3	1	1,045
6	2	3	1	2	1,037
7	3	1	3	2	1,709
8	3	2	1	3	1,147
9	3	3	2	1	1,076



Poniższy artykuł nie dotyczy bezpośrednio metody Taguchi
ale poruszonych jest w nim wiele ciekawych aspektów metod
statystycznych w odniesieniu do naszej dziedziny

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SURFACE & COATINGS TECHNOLOGY

Performance analysis of coated tools in real-life industrial experiments using statistical techniques

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Research Centre in Surface Engineering, Department of Engineering Design and Manufacture, University of Hull, Hull, HU6 7TW, UK

Wnioski

Taguchi ogólnie

- Taguchi był modny zwłaszcza w latach 95-98 :-)
- Dlaczego tylko trójpoziomowe zmienne są używane? Trochę niepokojące jest to zamiłowanie
- Zwykle niewielka ilość parametrów jest uwzględniana
- Dołączanie „sztucznego” parametru wydaje się być pewną metodą testu istotności

Taguchi w STATISTICA

- Zmiana danych w arkuszu nie powoduje zmiany wyników analizy
- Nieokreślone warunki zaznaczania lub nie odchylenia standardowego na wykresach