TOOL WEAR CHAMFERING FOR HIGH STRENGTH MATERIALS

MOHAMMAD SAZZAD
Research Scholar
Shri JJT University
sazzadmoh@gmail.com

DR. CHAKRADHAR GOUD
Research Guide
Shri JJT University
cgsakki@yahoo.com

DR. SAGGARLA MURALI
Research Co-Guide
Professor and Principal
AARM Mahaveer Engineering College
smuralichinna@gmail.com

Abstract

The ability to create structural materials of high yield strength and yet high ductility has been a dream for materials scientists for a long time. This paper will summarize the recent work related to the study of the mechanical behavior of the high strength materials. Significant enhancements in mechanical properties of the nanostructured surface layer in different materials will be analyzed. The effect of surface nanostructures on the mechanical behavior and on the failure mechanism of metallic material shows the possibility to develop a new strength gradient composite. The tool geometry is generally of great significance in metal cutting performance. The response surface method was used to optimize chamfer geometry to achieve reliable and minimum tool wear. Models were developed for edge chipping, rake wear, and flank wear

***Keywords**: High ductility, nanostructured, chamfer, chipping, rake wear, flank wear.*

Introduction

The design of the cutting tool wears down, surface roughness changes. When you use high-speed machining, you can get more done in less time. This leads to a smoother finished product by slowing down the wear process. Because of the melting temperature and high stability of hard-to-machine metals such high strength Ferro alloys, your cutting speed will be limited. Therefore, high-temperature mechanical characteristics and superior inertness are essential in tool materials.Ceramics with a high thermal conductivity include tic, Al_2O_3, and tin, to name a few. Ceramics and ordinary tool metals work better together to process hard, chemically reactive materials more quickly.

Tool wear:

When cutting tools wear out over time through regular use, it's called "tool wear." Machine tools' tipped tools, tool bits, and drill bits are all affected. Cutting tools that break down unexpectedly reduce production, cause components to be rejected, and result in financial losses. Roughness is reduced from tool's relief face by rubbing on machined surface. Abrasion from the crater causes the chip and rake face to become extremely rubbed together, leaving a scar that runs parallel to the primary cutting edge as the chip flows away.

This wear is most commonly found in cutting tools because of the amount of flank wear. Cutting conditions can increase crater wear therefore that is how tool life is estimated when these variables exist. The cutting force will be reduced if the cutting edge has crater wear, but the cutting edge's strength will be reduced as well.

Cutting tool flank faces small cut against work material, therefore how smooth the resulting surface is largely determined by how much flank wear there is. The cutting tool's nose radius will shrink as the amount of flank wear rises, resulting in a worse surface polish. Excessive flank wear is the most common wear mode for the tools studied, enhancing milling cutting forces and vibrations. Utilizing most of a company's cutting equipment might help to reduce production expenses for the organization. As a result, tool wear must be monitored and regulated to ensure it stays within the established limits. Work piece material milling process factors influence tool wear during the cutting operation. Tool flank wear, which is a cost-effective output from the manufacturing process, must be included in an acceptable end milling process model along with input machining parameters such as cutting speed, feed, and depth. Five level three components with an entire factorial method were used in Design of Trials (DOE) experiments to measure tool wear. Doing experiments is a scientific method that involves designing, carrying out, and analysing e>q) Data may be swiftly and cheaply derived by doing experiments to generate, research, and interpret the data. ANOVAis used as a first step in creating the final regression model for forecasting tool wear. If you look at a regression model's regression coefficients, you can see how much the control variables influenced the results. The final regression model's validity is checked using an ANN model, which compares actual values with predictions. Tools wear information helps the operator pick machining conditions that minimize tool wear.

Temperature-Resistant Durability

Longevity, resistance to wear, and hardness are all top-notch.

Because of consistent study and improvement throughout the last century, the cutting capabilities of tools have grown gradually. Temperature has a significant role on the wear rate of almost all tool materials. Unfortunately, determining fair limits is difficult. Conversely, empirical methods have been constructed using data collected via experiments. Assume that the chip takes in around 80% of the total thermal energy produced by the cutting process. Most of the energy will be dissipated by the blade. High-speed steel (HSS) can tolerate temperatures up to 1,200 degrees Celsius without softening, but mild steel can't sustain temperatures beyond 550 degrees Celsius during the cutting process. Both the cutting tool and the chip will heat up to well over a thousand degrees Celsius when processing high-strength steels with a cubic boron nitride tool.

Wear modes such as
(a) flanking,
(b) notching,
(c) cratering,
(d) edge rounding and chipping, and
(f) edge cracking may appear on a device over time
(g) Failed attempt of epic proportions

cutting causes wear, and that wear will eventually lead to the cutting tool failing. By replacing the tool or active edge when tool wear reaches a predetermined level, the desired cutting action is maintained

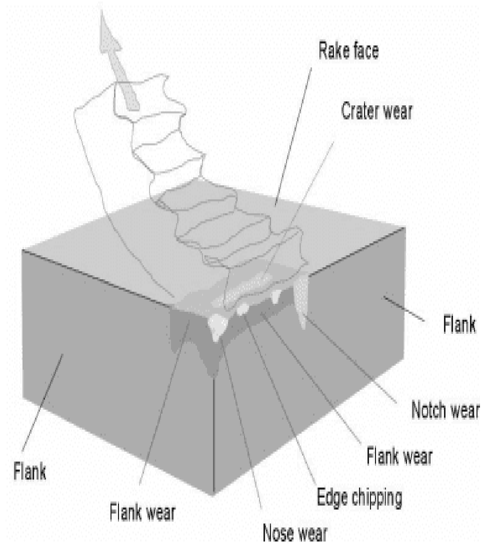


Figure: Dissimilarstyles of attire

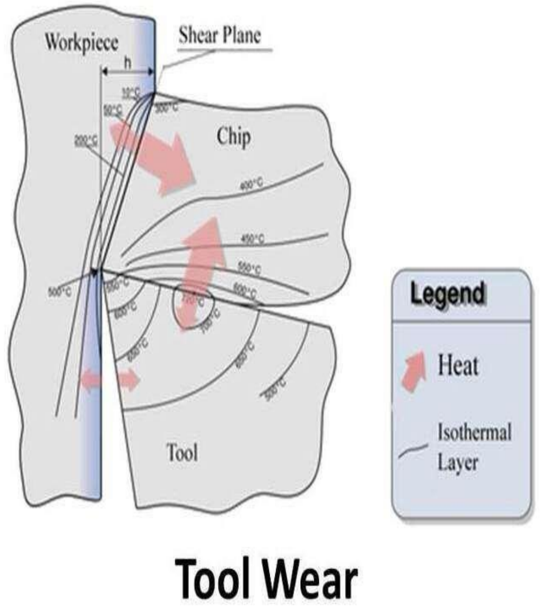


Figure : Tool attires marvels

They come into close touch with metal on metal when placed under tremendous stress and high temperature. An increase in the strain and temperature gradient caused by contact with the tool only serves to increase. To obtain the desired shape, size, and surface roughness, cutting tools remove material from the component during machining (finish). However, cutting causes wear, and that wear will eventually lead to the cutting tool failing. By replacing the tool or active edge when tool wear reaches a predetermined level, the desired cutting action is maintained

Literature Review

V.S Ramprasad (2020) Wear mechanism on the flank of a cutting tool is caused by friction between newly machined surface and the cutting tool, which plays predominant role in determining tool life. The wear on the cutting tools was occurred predominantly on the nose radius, as effect of lower feed rate and nose radius selected. Various wear studies on both coated and uncoated cutting tool such as abrasive wear, adhesive wear, adhering chip on the cutting edge, flaking chipping coating delamination of coated chamfering tool, crack and fracture.The crack occurred possibly due to machining at high cutting speed and high depth of cut.

MikeOlsson (2021) Tungsten is commonly used in cemented carbide tooling solutions and as an alloying element in superalloys and steels. In pure form, as a single-phase tungsten, it is used in nuclear and research facilities. Tungsten is known for its poor machinability resulting in excessive tool wear, which puts high requirements on the selected tooling solution. Also, single-phase tungsten is a highly brittle material, thus often leading to surface damage when machining. In this study, eleven different tool materials: ceramics, coated and uncoated cemented carbide, cermet, PcBN and PCD have been tested in longitudinal turning of high purity tungsten (W > 99.9%) in order to identify suitable tool candidates. Seven cutting tool solutions consistently suffered from excessive tool wear or breakage after a few seconds of engagement time. Only two tool materials, PCD and PVD (TiAlN – TiSiN) coated cemented carbide provided sufficient performance

Methodology

Modeling of tool

Using SOLIDWORKS, a solid modeling computer-aided design programmed, the single-point cutting tool was solid modeled. In order to produce models and assemblies, Solid works uses a parametric feature-based method. Models and assemblies have shapes and geometries determined by the values of constraints. There are a variety of parameter types, including numeric parameters like tangent, parallel, concentric, and horizontal/vertical, for example. Relationships allow you to link numerical parameters together. A quick summary of tool and work piece dimensions can be found in the following table:

Table : Tool and work piece primary dimensions

	Cutting Tool	Work piece
Material	Cemented Carbide, Coated carbide	H30, SS304, Titanium alloy,
Cross-section	Dimensions: 13 x 101.98 mm, with a 30-degree side and terminal wounding advantage. The last angle of reprieve is 20 degrees.	Ø23*63.7 mm

5.15 Modelling of carbide tool:

To make a solid model of the Cemented Carbide single point cutting tool, we used SOLIDWORKS. The following images display both 3D and 2D views:

Figure: 3D view of Cemented Carbide model

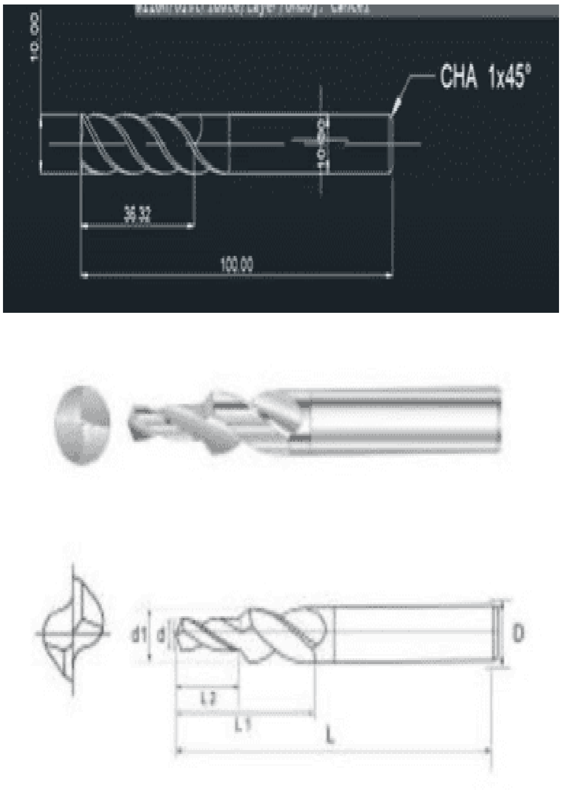


Figure : 2D view of Cemented Carbidetool model

Analysis of a cemented carbide tool using finite elements Geometry First,

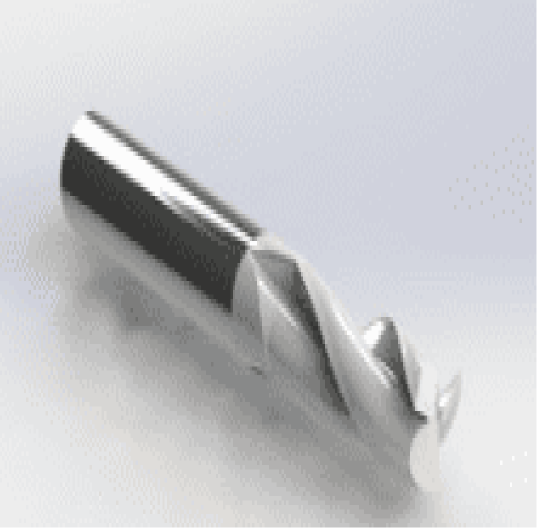


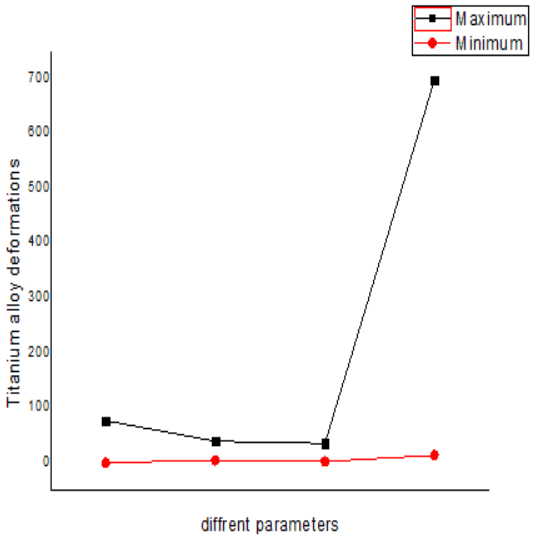
Figure ; Geometry of Paved Carbide tool

There are a variety of different titanium alloys on the market. These metal alloys are incredibly strong and durable under tensile stress (even at extreme temperatures). They're small, light, and resistant to corrosion and high temperatures, all at the same time. Titanium is regarded as one of the most powerful metals in the world. This metal is perfect for a wide range of uses due to its combination of strength, heat resistance, water and salt resistance, and light weight. Jewellery and dental implants, for example, are two common examples of such applications. Titanium is an incredibly strong and corrosion-resistant metal. Despite its hardness and corrosion resistance, titanium alloys become more malleable when mixed with another metal. Due to this, titanium alloys are more useful than pure titanium. There are four different titanium alloys and six different grades of pure titanium (grades 1, 2,3,4,7, and 11). Typical titanium alloys will contain traces of aluminium as well as other metals such as molybdenum, vanadium and niobium as well as tantalum and zirconium, as well as manganese and other elements such as iron and nickel.

Results and Discussions

Table : Structural analysis of Tool using with titanium alloys

Parameters	Maximum	Minimum
Total deformation	76.553	0
Directional deformation	39.102	4.5936
Equivalent elastic strain	35.10	2.2898
Equivalent stress	696.79	13.578



Graph: Structural analysis of Tool using with titanium alloys variationsStructural analysis of Tool using with H30

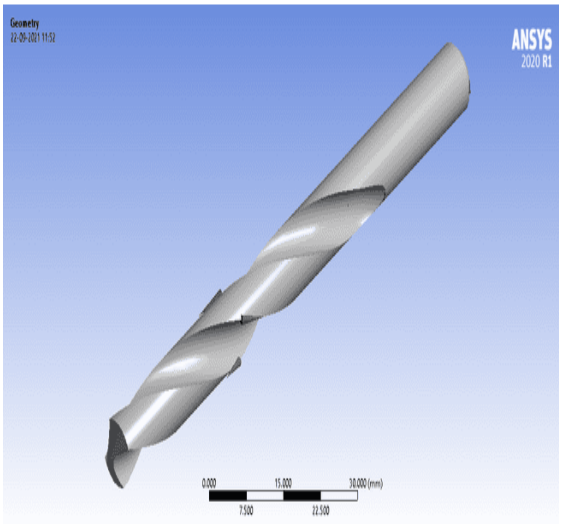


Figure: Geometrical model

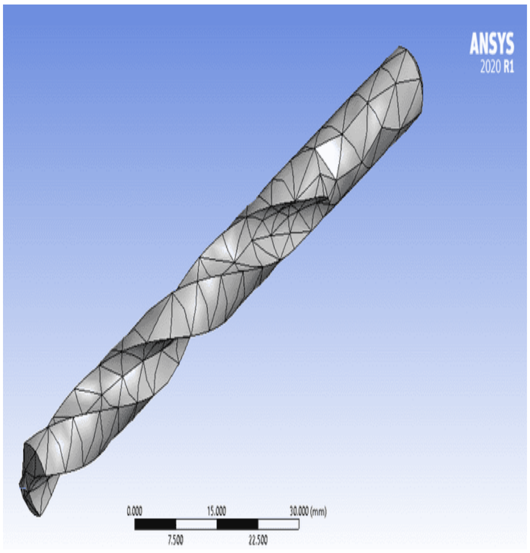


Figure: Meshed model

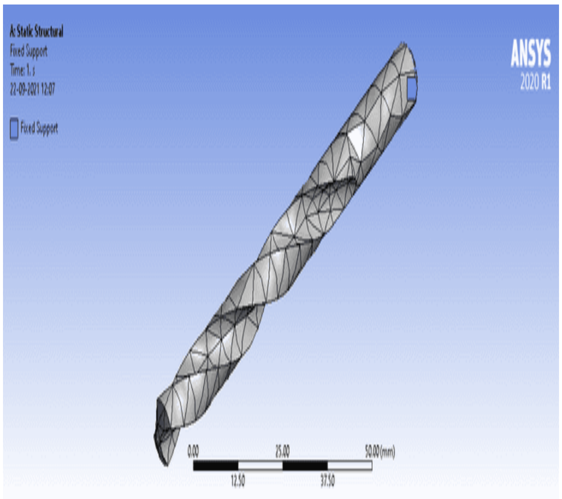


Figure: Fixed support model

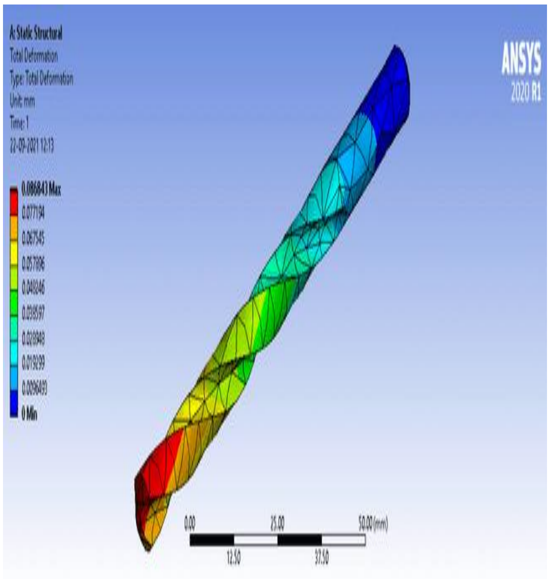


Figure: Total deformation

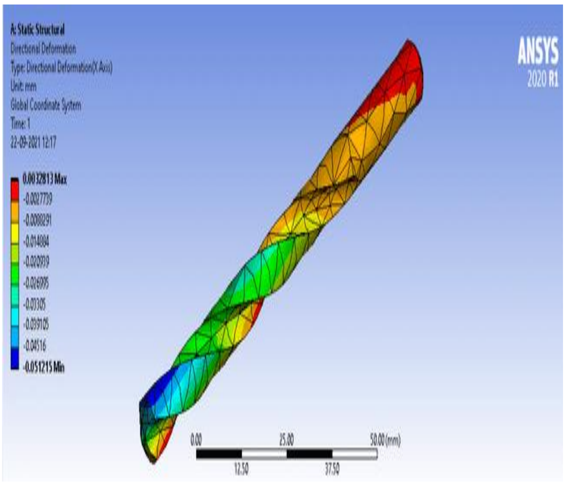


Figure: Directional Total deformation

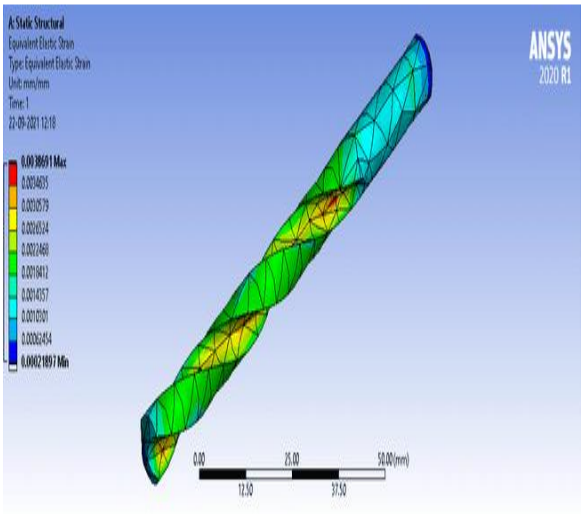


Figure: Equivalent Elastic Strain

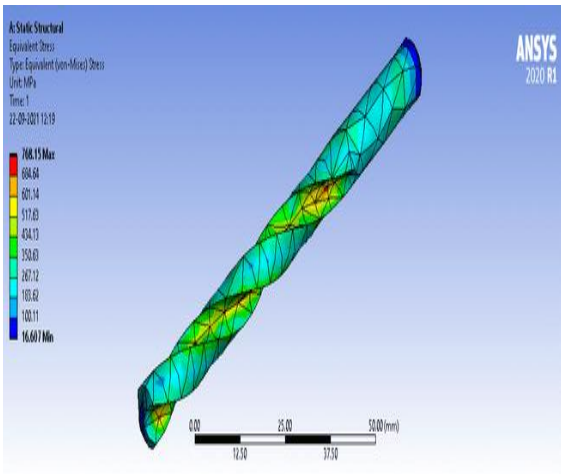
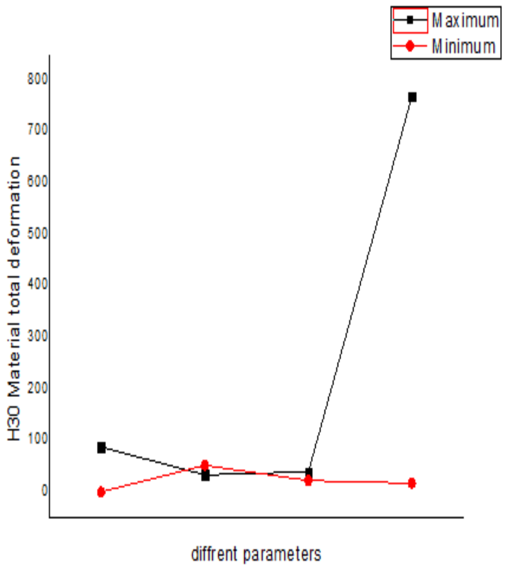


Figure: Equivalent stress

Table 6.44: Structural analysis of Tool using with H 30 alloys

Parameters	Maximum	Minimum
Total deformation	86.843	0
Directional deformation	32.813	51.215
Equivalent elastic strain	38.691	21.897
Equivalent stress	768.15	16.607



Graph: Structural analysis of Tool using with H 30 alloys variations

Conclusion

Temperature of contact between Cemented Carbide chip and tool The Single Point Cutting Tool is selected according to the machining speed. The temperature of the tool or chip being tested at the connecting site is measured using Fluke's IR Thermal Imaging technology. The finite element model of a single-point cutting tool in ANSYS Workbench 15 was built using SOLIDWORKS.The impact of cutting speed and depth on temperature is compared head-to-head based on experimental and FEA results. When comparing the two data sets, there is a difference of over 7%. The findings show that the two most important determinants of rising cutting temperatures are cutting speed (v) and depth of cut (d).The ANOVA table shows that the two most important machining factors that contribute to temperature rise are cutting speed and depth of cut.

References

1. *Sutter G., Faure L., Molinari A., Ranc N., Pina V., "An experimental technique for the measurement of temperature fields for the orthogonal cutting in high-speed machining", International Journal of Machine Tools & Manufacture 43 (2003) 671–678.*
2. *Singh, D.; Venkateshwara, P.R. (2007): Optimization of tool geometry and cutting parameters for hard turning materials. Mater. Manuf. Process. 22, ISSN: 2359-1568, vol. 3, pp. 1370-1373.*
3. *Soran, J. N. Hwangz, S. Lee and L.Shapiro, "Tremor detection using motion filtering and SVM,"21st International Conference on Pattern Recognition ((ICPR 2012), pp 178-181, November 2012. Tsukuba, Japan*
4. *Sullivan D. O' and Cotterill M., "Temperature measurement in single point turning". Cork Institute Technology. Vol. 118, 2001, pp. 301-308.*
5. *Senthil, N.; Tamizharasam, T.; Gobikanna, S. (2014): Application of re-sponse surface methodology (RSM) and firefly algorithm for optimizing multiple responses. Arab. J. Sci. Eng. 39, ISSN: 1489-2030, vol. 8920, pp.5961-5630*
6. *S. SreeHari Raju1 and E. G. Rajan Skin Texture Analysis Using Morphological Dilation and Erosion International Journal of Pure and Applied Mathematics Volume 118 No. 19 2018, 205-223*
7. *Chen, T., Song, L., Li, S. et al. Experimental Study on Wear Characteristics of PCBN Tool with Variable Chamfered Edge. Chin. J. Mech. Eng. 32, 37 (2019). https://doi.org/10.1186/s10033-019-0351-9.*
8. *V S Ramprasad (2020) "Wear In Carbide End Mills For High Strength Materials Macronising", Solid state Technology,Volum-63, No-1.*
9. *MikeOlsson"Evaluation of tool wear mechanisms and tool performance in machining single-phase tungsten",International Journal of Refractory Metals and Hard Materials,Issnno-0263-4368.Volume-94, https://doi.org/10.1016/j.ijrmhm.2020.105379*