CUTTING EDGE PREPARATION

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Abstract- Proper selection and application of cutting tool edge preparation is considered one of the basic ingredients for a successfully manufactured and correctly performing hardmetal-cutting tool. It is widely known it's also called, of cutting tool edges can significantly increase the life of cutting tools by as much as 300% or more! Other benefits may include reduced cycle times of the cutting operation for the end user as a result of less chipping and a cooler running tool. Additionally, a better surface finish is obtained on the material being cut, thus the possibility of further cost & time reductions to the tool end user. The discussion is aimed at the process of Nylon Abrasive Filament brush honing and how it affects the tool as an end product. It also identifies some of the manufacturing related pitfalls and the problems that can drive manufacturing costs.

Keywords- Adhesion, Bristles, Honing and Micro-topography.

I. INTRODUCTION

In the last decade the research works on cutting edge preparation have increased due to its importance in micro-machining applications, and equally for the observed influence of the cutting edge preparation in different aspects of the machining process, mainly in wear development and tool life, cutting forces and moments, distribution of the temperature, chip formation, chip flow and transportation, stress and strain held during the cutting process, surface integrity of the work piece, precision and accuracy in the geometry of the work piece and the coating quality of the cutting tool in terms of adhesion and uniformity. The application of the edge preparation process seeks to solve this problem by means of the elimination of defects and irregularities and by the generation of a defined edge geometry and by modifying the micro-topography of the edge (notchedness) and the micro-structuring of the face and flank of the tool. The consideration of these cutting preparation aspects influences the cutting process causing improvements in tool life, tool reliability and work-piece quality.

II. IMPORTANCE OF CUTTING EDGE PREPARATION

A. Comparison

The systemic and controlled application of the cutting edge preparation process has several main purposes to add strength to the cutting edge, minimizes the edge chipping, eliminate previous defects of the cutting edge, increases tool life, prepares the tool surfaces for coating deposition, improves part quality (accuracy, surface finish). The comparison of Sharp edge and prepared edge could be described as shown in the figure:

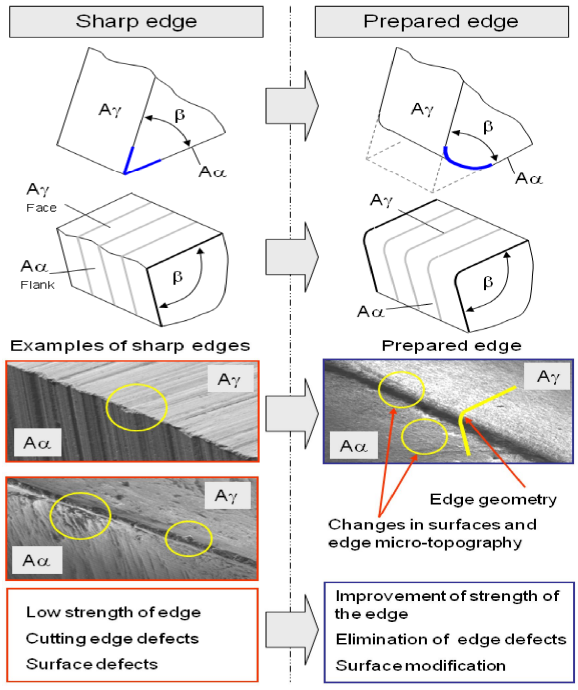


Fig1: Comparison between a SHARP edge and PREPARED edge

B. Importance

The application of new cutting strategies to improve productivity in the machining process and quality of work pieces requires the development of modern precision cutting tools.

For an integral and systemic development of a precision cutting tool, four related aspects are considered:

- Cutting tool material (substrate); economically viable and meeting the requirements of a specific application.
- Coating technology; economically viable in enhancing the properties of the substrate.
- Macro-geometry; technologically adequate for chip transportation, chip breaking, tool gripping and handling.
- Cutting edge preparation; precise, repeatable, controllable and compatible with a specific application and subsequent coating.

The control of each of these aspects affects the quality and reliability of the cutting tool that is subjected to extreme conditions in modern cutting technology; with local pressures between tool and work-piece material between 100-10000 N/mm2, temperatures between 300-1200±C and velocities between 100-6000 m/min.

III. INFLUENCE OF CUTTING EDGE PREPARATION IN MACHINING

The cutting edge preparation process generates the contour of the cutting edge, changes the micro topography of the cutting edge, and also modifies the micro-structuring of the surfaces in the vicinity of the edge. These aspects of the cutting edge preparation influence the cutting process. As a result consequences on the tool performance and work piece quality are observed.

The cutting edge preparation geometry influences the thermo-mechanical aspects of the cutting process:

- Shape of deformation zones
- Distribution of temperatures in cutting
- Cutting forces
- Distribution of stresses in cutting

These effects in turn affect:

- Chip formation and chip flow
- Surface integrity of the workpiece (e.g. residual stress)
- Surface roughness of the workpiece
- Tool wear resistance

Influence is portrayed in the following figure:

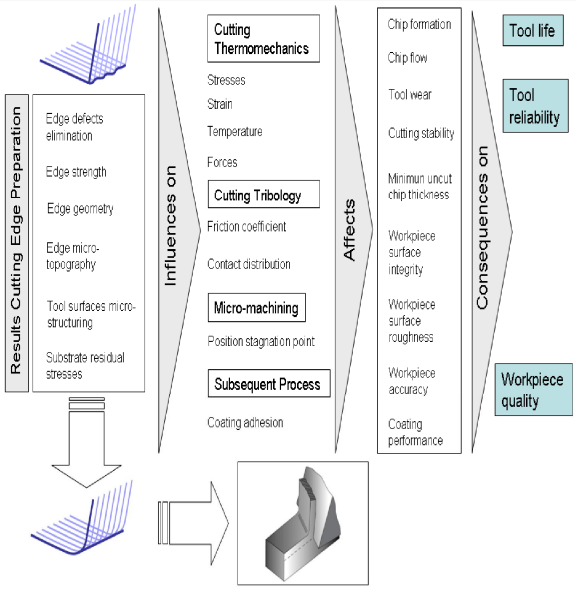


Fig. 2: Influence of the cutting edge preparation on the machining process

IV. PROCESS FOR CUTTING EDGE PREPARATION

There are different technological possibilities for carrying out the cutting edge preparation of precision cutting tools. The considered processes utilize a variety of energy sources for removing the required material for the cutting edge preparation. Some of the most frequently used processes are shown schematically in Figures 3 and 4, grouped according to the energy source used (mechanical, thermal and chemical processes).



Fig. 3: Mechanical preparation processes

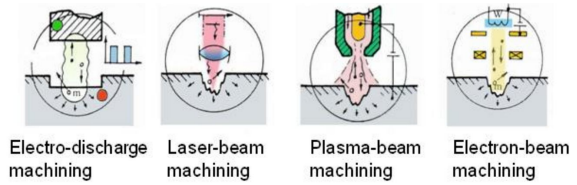


Fig. 4: Thermal preparation processes

V. EXPERIMENTAL SETUP

A. Priniciple of with abrasive filaments for cutting edge preparation

Brushing with nylon abrasive filaments (BNAF) uses a brush with abrasive filaments formed by a nylon matrix and particles of hard abrasive (aluminium oxide, silicon car- bide, cubic boron nitride and diamond) as filling material to remove material by abrasion. The experimental set-up for cutting edge preparation by BNAF is illustrated in Fig. 5 and Fig. 6.



Fig. 5: Diagram of the equipment for BNAF

The cutting tool to be prepared is mounted in a fixture on a table that has movement in two orthogonal horizontal directions, one to adjust the penetration depth of the filaments and other to approximate the cutting tool to the brush before applying the alternating feed movement of the table. The brush is mounted with the axis in horizontal position coupled to a electric motor with controlled rotational speed and with the possibility of changing the rotational direction during the process cycle.

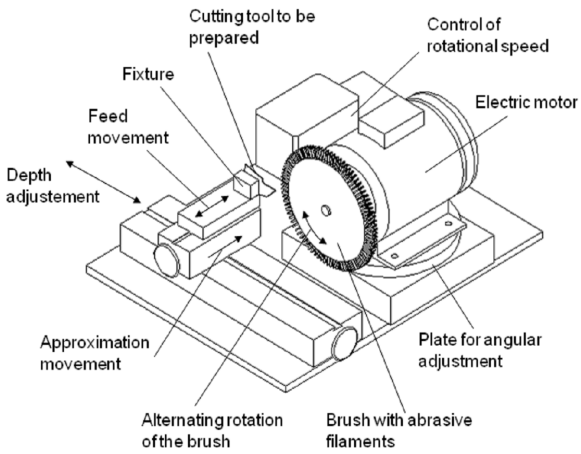


Fig. 6: Principle of Abrasive Brushing edge preparation

B. Cutting edge preparation geometries:

To specify the form of the cutting edge, tool designers and manufacturers provide various possibilities of tool edge geometries, which are commonly referred to as tool edge preparation. Fig. 7 illustrates the major types of edge preparation design that are used in most commercial precision cutting tools.

In general there are three types: Round, Waterfall, Trumpet/Reverse waterfall The rounded edge can have variants depending on the form of the profile that connects A° and A®. If the curvature of the rounded profile, that joins Aα and A□, is relatively uniform without strong variations along the profile, a nominal single radius is considered. On the other hand, if the rounded profile has a strong curvature variation, two geometries are considered: waterfall or trumpet form.

In the waterfall form, the curvature is bigger at the end of the profile that connects with the tool flank Aα and the curvature is smaller at the end of the profile that connects with the face A□.

In contrast, in the trumpet geometry, the curvature is bigger at the end of the profile that connects with the tool face A□ and the curvature is smaller at the end that connects the tool flank Aα.

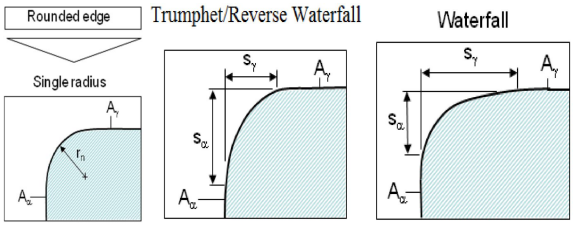


Fig. 7: Different Edge Preparation Profiles

C. Comparison between Radial and Waterfall Profiles:

The geometric shape of the edge hone affects tool performance just as much as hone size does. The radius-shape hone is, overwhelmingly, the preferred choice. More than 80 percent of honed cutting tools receive a radius hone, which is centrally located on the cutting corner of the tool.

This hone forms a true circular shape that blends equally with the top surface of the tool and the tool's flank, or side. With a waterfall-shaped hone, the edge prep is skewed toward the top side of the tool. The ratio of the top side of the

edge to its side is normally 2:1. The main benefit of a waterfall hone is that the honing process leaves more tool material directly under the cutting edge, which further strengthens the corner.

Waterfall hones are mostly used for very rough machining applications, such as those involving interrupted cuts or removing scale from a workpiece. In most heavy cutting applications, a tool with a waterfall hone will outperform one with a radius hone. However, for most standard cutting.

Applications—those that warrants a radius edge—the use of a waterfall edge would increase tool pressure and shorten tool life.

A waterfall hone is achieved around the 4 to 4:30 o'clock position. The Hone size can be adjusted by adjusting the brush speed. Decrease the brush rotation speed to decrease the hone size and increase the brush rotation speed to decrease the hone size. In and out movement of the brush will affect the size of the hone. Movement of the brush towards the insert will increase the size of the hone and moving the brush away from the insert will decrease the size of the hone. There are two kinds of brushes The study of both rectangular and round brushes were conducted in order to acheieve the Waterfall profile, where the variations in the edge roundness value of the inserts were more, so that a forecast would be established for Inserts as the profile and the Edge Roundness values are within permissible limits

VI. RESULTS AND DISCUSSIONS

Comparing the Round and Rectangular bristles gives us a better view of Waterfall profile used with different bristle brushes. The comparison of these bristle brushes are shown in Fig. 7 and Fig. 8.

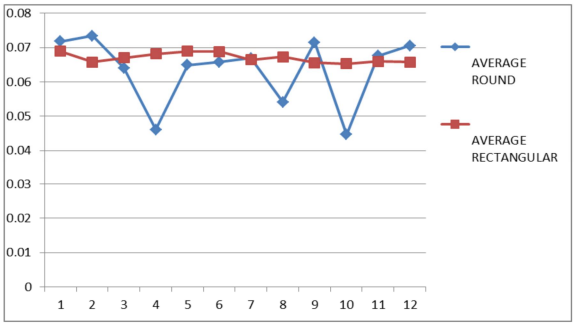


Fig. 8: Comparison between Round and Rectangular brushes readings

SAMPLES	REQUIRED DIMENSIONS		OBTAINED AVERAGE DIMENSIONS	
	MEAN	TOLERANCE	ROUND	RECTANGULAR
1	0.076	±0.025	0.071825	0.06892
2	0.076	±0.025	0.0734	0.0657575
3	0.076	±0.025	0.064025	0.066975
4	0.076	±0.025	0.046125	0.0681925
5	0.076	±0.025	0.0649	0.06894
6	0.076	±0.025	0.065775	0.06882
7	0.076	±0.025	0.066925	0.066475
8	0.076	±0.025	0.0541	0.0673
9	0.076	±0.025	0.071475	0.06553
10	0.076	±0.025	0.044675	0.065255
11	0.076	±0.025	0.0676	0.065985
12	0.076	±0.025	0.070525	0.06578575

Fig. 9: Comparison Between Round And Rectangular Brushes For Average Edge Rounding Values

CONCLUSION

Machine was studied in detail, calculated few samples and compared with the actual working of the brushes on machine with optimum operating parameters. The study of both rectangular and round brushes were conducted in order to acheieve the Waterfall profile, where the variations in the edge roundness value of the inserts were more, so that a forecast would be established for Inserts as the profile and the Edge Roundness values are within permissible limits.

A sample of 15 inserts were inspected under Round-Bristles Brushes wherein the average edge roundness value variations was found to be 27.15 microns. Further, after a thorough evaluation of the samples under observation and discussions with the Production Team and counterparts, it was brought into consideration that Rectangular-Bristles Brushes should be used in place of Round-Bristles Brushes. A sample of 120 inserts were tested under Rectangular bristles brushes and it was seen that the average variations in the Edge-Roundness values of the inserts was brought down by 3.67microns.

Further, the profiles of the inserts were very much similar to the international standards. This replacement of Round Brushes with the Rectangular Brushes has enhanced the production of Inserts as the Waterfall profile and the Edge Roundness values are within permissible limits.
The time study of the EDGE HONING operation gave experience to the real time exposure in interacting with the operator and understanding the operation and behaviour the workmen within the organisation.

REFERENCES

[1] Bhattacharyya, B. ; Munda, J. ; Malapati, M.: Advancement in electrochemical micro-machininIn: International journal of machine tools and manufacture44 (2004), S. 1577{1589}.

[2] Boothroyd, G. ; Knight, W.: Fundamentals omachining and machine tools. 3rd ed. Boca Raton: Taylor and Francis Group, 2006.

[3] Cai, M. ; Li, X. ; M., Rahman ; Tay, A.: Crack initiation in relation to the tool edge radius and cutting conditions in nanoscale cutting of silicon.International Journal of Machi Tools and Manufacture 47 (2007), S. 562{569}.

[4] C. J. C. Rodriguez, Cutting edge preparation of precision tools by applying microabrasive jet machining and brushing, Dissertation (2009), Kassel University.

[5] J. Rech, Cutting Edge Preparation and Surface Issue HSS Forum's International Conference" Smart solutions for metal cutting ", Aachen,2005.

[6] H. Ramasawmy, L. Blunt, E_ect of EDM process parameters on 3D surfacetopography, Journal o Material Processing Technology, 148 (2004), 155{164}.

[7] A. Weckenmann, V. P. Radhakrishnan, S. Schmitz, Fringe Projection Method for Measuring Geometry and Wear of Cutting Tool Inserts, Proceedings of ASPE, 14th Annual Meeting, Monterey, USA 1999, 473-476.

[8] Wikipedia links.

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