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COMPARISON OF CONVENTIONAL AND STRUCTURED ABRASIVES

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Abstract

This article describes two basic types of abrasive belts, which are most used in practice today. The first type is conventional abrasive, used for a long period and is currently applied because of its relatively low price. The second type described in the article is structured abrasives, which have found application mainly for their good properties (i.e. long life, constant cutting ability, and others).

Key words

grinding, conventional abrasive, structured abrasive, roughness

Introduction

Grinding is a machining method using a high number of cutting wedges. A grinding tool is characterized by irregular deployment of cutting wedges (abrasive grains), which have random orientation and hence, a randomly ordered geometry of cutting wedges.

In this article, I will focus on the description of a new method of grinding and its comparison to conventional abrasives. These abrasives are known in practice for many years. I describe a completely new method to grinding surfaces, referred to as structured abrasives.

Description of Conventional and Structured Abrasives

In practice abrasives include grinding wheels, grinding segments, abrasive belts and abrasive papers. Given the wide range of tools I will deal only with abrasive belts.

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Since the beginning, flexible grinding systems were produced in a conventional construction. These grinding tools are made of grain, resin, and the backing. Abrasives are applied chaotically on the surface and are characterized by gradual wear-cutting edges as shown in Figure 1.

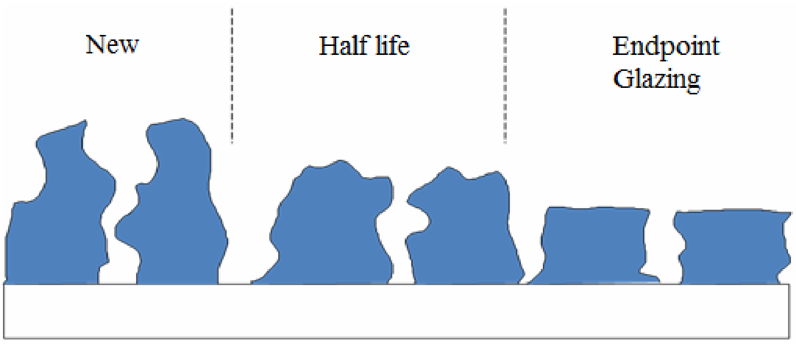


Fig. 1. *Wear of conventional abrasive belt [3]*

Currently there are many non-conventional grinding systems on the market. One of them is a product from 3M ™ called Trizact - micro replication abrasives. The belt´s surface consists of precise structures uniformly applied to the backing - providing a very even distribution of minerals. These abrasives are produced by creating small three-dimensional structures. The structures are applied on the surface. The synthetic resin puts together the abrasive structure [3].

Once the surface of a traditional abrasive belt is worn away, the belt needs changing. Using structured abrasives provides another new layer allowing the same quality grinding. Grinding power is increased because there is still a new layer opening the structure like a pyramid. This is ensured by the action of huge numbers of cutting wedges on the surface of the cut material (Fig. 2).

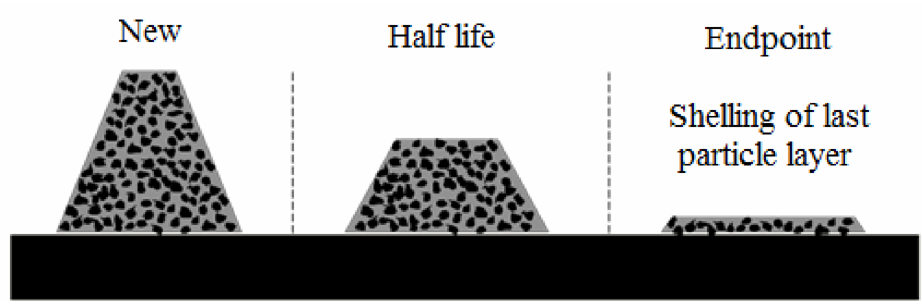
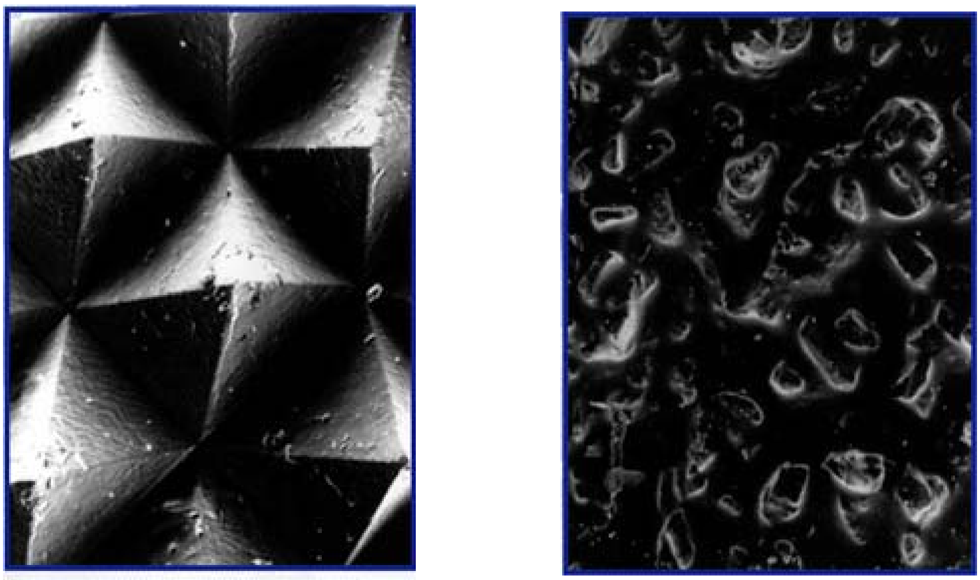


Fig. 2. *Working life of structured abrasive belt [3]*

The process continues until the material is no longer reaching the backing. That means the structured abrasive has a longer life than the conventional graded abrasive with a usefulness of over 95 %.

Figure 3 shows the macrostructure of these two abrasives:



Structured coating *Random coating*

Fig. 3. *Macrostructure look of structured and conventional abrasives [3]*

Structured abrasives find application especially in these market segments:

- Manufacture of blades for turbines
- Production of aluminum, cast iron, and brass castings
- Manufacture of hand tools
- Production of medical implants

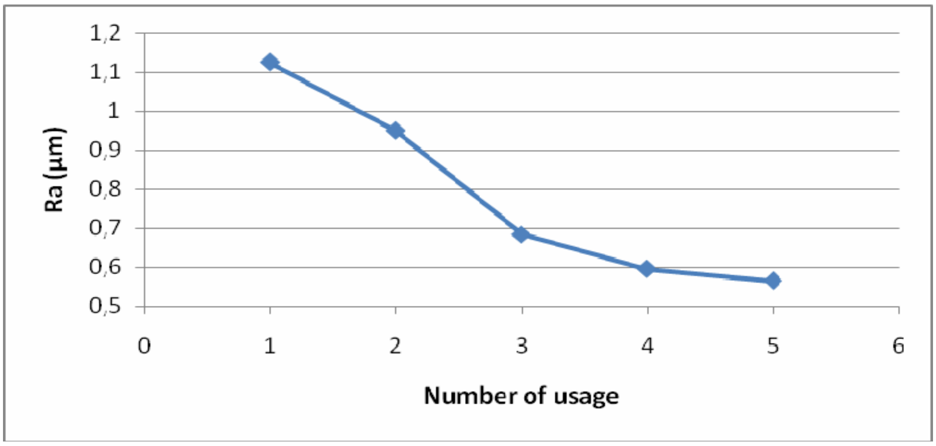
The structured abrasives are used especially for metals such as stainless steel, carbon steel, brass, titanium, cast iron, and chrome plating.

Experiment 1 and Results

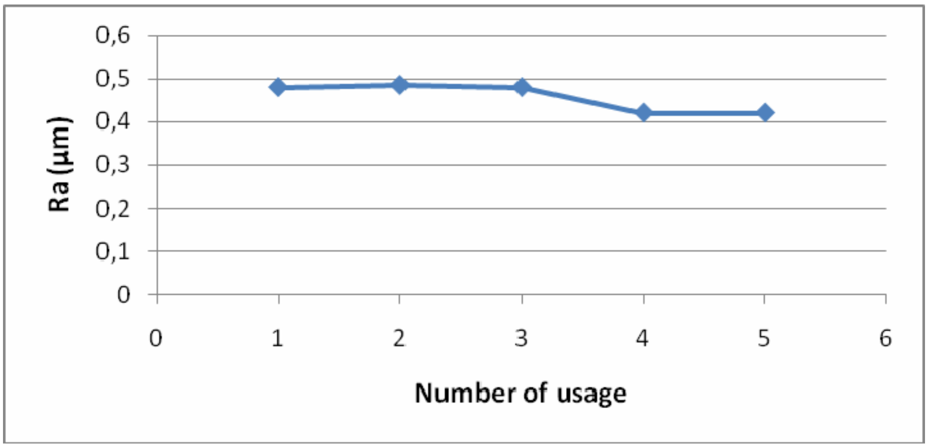
To compare the course of time for wear of conventional and structured abrasives, an experiment was conducted. This experiment shows us the importance of the stability of abrasives. This is particularly important for the exchange of new abrasives. The roll steel section plate 17 441 (EN 10088-2) was ground. Initial arithmetical mean deviation (Ra) of the work piece was 1,24 μm. Sample No. 1 was ground by the classic abrasive P150 (Main diameter in mm is 100 [4]). The surface was ground 5 times for 20 seconds each. The roughness after each surface grinding was measured at 4 different places. Surface roughness was measured by contact instrument TALYSURF Surtronic 3 + from manufacturer Taylor - Hobson. Graph 1 shows the average Ra results.

Sample No. 2 was ground by the structured abrasive 3M Trizact ™ 237AA with the A45 grain size (Table 1). Number of grindings and measuring surface roughness was the same as for sample No.1. Graph 2 shows the results of this measurement.

The machine used for the experiment was PTX100 sander, which uses a belt size of 100 x 289 mm.



Graph 1. *Ability stabilization of conventional abrasive*



Graph 2. *Ability stabilization of structured abrasive*

The graphs reveal that the cutting ability with conventional abrasives is highest at the beginning and stabilizes the abrasive as time runs. It can be assumed that the values of roughness Ra will be the same, which were measured after the fourth and fifth uses. We could say that the time abrasive has already stabilized. In structured abrasives we can see that from the beginning to the end it works about the same while cutting ability of the belt does not diminish and it is ultimately more constant.

TABLE OF 3M TRIZACT™ VS. FEPA GRADE COMPARISON   Table 1

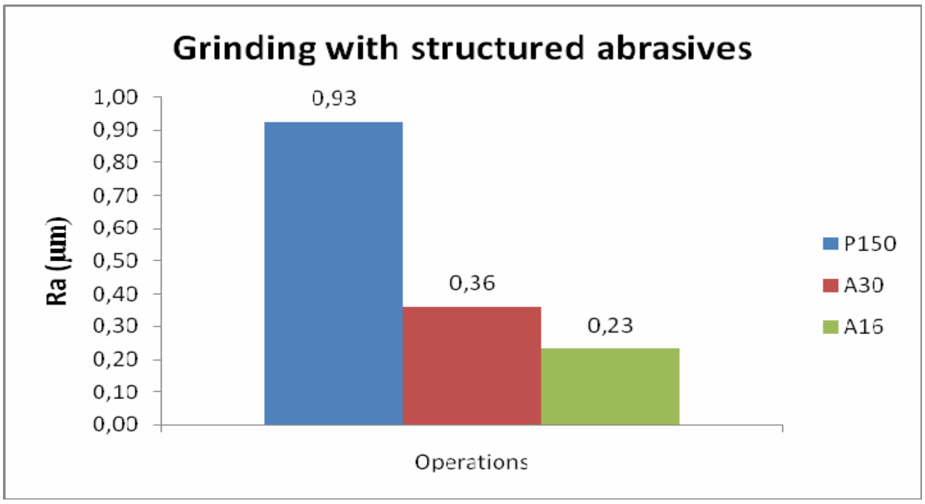
TRIZACT™ STRUCTURED ABRASIVES	FEPA P EQUIVALENT GRITS
A3	P3500
A5	P3000
A6	P2000
A16	P1200
A20	P1000
A30	P600
A40	P500
A45	P400
A60	P320
A65	P280
A80	P240
A90	P220
A100	P220
A110	P180
A130	P150
A160	P120
A300	P80
A400	P60

Experiment 2 and Results

Structured abrasives 3M ™ Trizact are presented for customers as "a way to dramatically cut finishing costs". Experiment 2 was done to verify this claim.

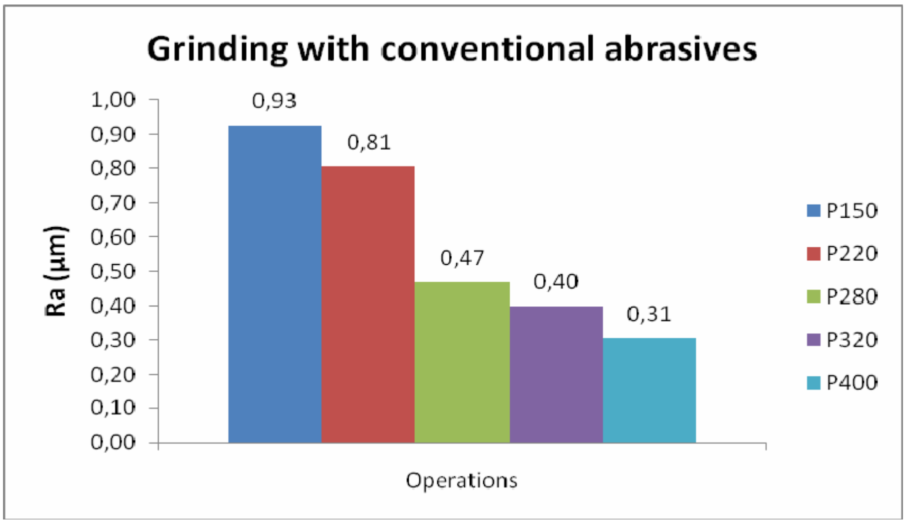
The roll steel section plate 17 441 (EN 10088-2) was ground and initial arithmetical mean deviation (Ra) of the work piece was 1,02 µm.

Sample No.1 was ground with classic abrasive belt size sorting: P150, P220 (Main diameter in mm is 68), P280 (Mean grain size d_{s50}-value in µm 52,2 ± 2), P320 (46,2 ± 1,5) and P400 (35,0 ± 1,5) [5]. The surface was ground in 20 seconds. The roughness after each surface grinding was measured at 7 different places. Surface roughness was measured as in Experiment 1 by contact instrument TALYSURF Surtronic 3+ manufactured by Taylor - Hobson. Graph 3 shows the average Ra.



Graph 3*. Grinding with structured abrasives*

Conventional abrasive P150 was used for sample No. 2 in the first step. 3M Trizact ™ 237AA in grains A30, A16 were used for the following steps. Number of measuring surface roughness was the same as for sample No.1. The results of this measurement are shown in Graph 4.



Graph 4. *Grinding with conventional abrasives*

Graphs 3 and 4 show that with conventional abrasives it is necessary to use 5 kinds of abrasives to achieve roughness, Ra = 0,31 µm. While using a structured abrasive Ra = 0,23 µm, with only 3 kinds of abrasive belts being necessary.

Results:

Conventional abrasives Ra = 0,31 µm→ 5 kinds of abrasives → 5 stages

Structured abrasives	Ra = 0,23 µm → 3 kinds of abrasives → 3 stages → less time used for surface finishing → cuts finishing costs

If we wanted to get through the classical abrasive roughness Ra = 0,23 µm, we would have still used abrasive P600.

Own Contribution

Own contribution to this article is to describe the structured abrasives and compare their performance with the conventional abrasives. The paper summarizes advantages of using structured abrasives. The primary advantages were confirmed by experiments.

Conclusion

Structured abrasives are increasingly used in practice. It is mainly due to its undeniable advantages. This abrasive saves and reduces working time and guarantees cutting costs. The consistency of the unique pyramid surface of Trizact structured abrasives, both in size and wear rate, delivers such a predictable, consistent level of abrasive performance, as confirmed by Experiment 1.

Results of Experiment 2 confirmed that structured abrasives reduce the finishing process – in fewer stages – in shorter sequence – with less operations.

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References:

[1] JANÁČ, A., LIPA, Z., CHARBULA, J., PETERKA, J., GÖRÖG, A.: *Technológia obrábania a metrológia. Návody na cvičenia.* Slovenská technická univerzita v Bratislave, 2002, 193 s. ISBN 80-227-1711-8

[2] STN EN ISO 4287 : 1997 Geometrické špecifikácie výrobkov (GPS). Charakter povrchu: Profilová metóda – Termíny, definície a parametre charakteru povrchu.

[3] 3M brochures for customers.

[4] FEPA-standard 43-1:2006: Grains of fused aluminum oxide, silicon carbide, and other abrasive materials for coated abrasives. Macrogrits P 12 to P 220.

[5] FEPA-standard 43-2:2006: Grains of fused aluminum oxide, silicon carbide, and other abrasive materials for coated abrasives. Microgrits P 240 to P 2500.

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