

EVOLUTION OF ROUGHNESS PARAMETERS ALONG POLISHING TESTS OF PREVIOUSLY GROUND SURFACES

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ABSTRACT

In polishing tests, precise determination of polishing time needed is difficult, since representation of surface roughness against polishing time leads to an asymptotic curve. In the present work, results of the polishing tests of previously ground surfaces are presented. Different roughness parameters were considered. Grinding wheels of 100 and 150 Norton grain size respectively were used. Cutting speed was 25 m s^{-1} and depth of cut was 0.02 mm. Two different feeds were considered: 9 m min^{-1} and 15 m min^{-1} . A polishing test was performed by means of corundum polishing pads of grain size 2500. Results show that, the higher the initial grain size of the grinding wheel, the higher initial roughness is as expected. Amplitude roughness parameters such as R_a and R_q decrease with polishing time. Regarding material percentage parameters, R_k and R_{pk} decrease more sharply than amplitude roughness parameters in the first 20 s of the polishing test, and afterwards decrease slightly. R_{vk} decreases more slowly than amplitude roughness parameters along the polishing test.

Keywords: grinding, polishing, roughness parameters

1. INTRODUCTION

In polishing tests, roughness parameters such as R_a usually decrease with polishing time [1, 2]. However, behaviour of other roughness parameters in polishing operations has not been widely treated. In previous works, results were presented about polishing tests of previously ground surfaces, as well as specifications of the polishing test [3, 4]. The aim of the present paper is to study evolution of roughness parameters of previously ground surfaces along a polishing test. First, steel blocks were ground, using different grain size of abrasive and different feed speed. Then surfaces were polished and roughness was measured at different polishing times. Roughness parameters R_a , R_q , R_k , R_{pk} and R_{vk} were studied.

2. MATERIALS AND METHODS

2.1. Materials

W Nr. 1.2344 hardened steel blocks of hardness HRC 52, of 66 x 50 x 40 mm were machined. Machined area was 66 x 6 mm.

2.2. Methods

Grinding operations

Corundum grinding wheels of grain size 100 and 150 respectively were used. Cutting speed $v_c = 25 \text{ m}\cdot\text{s}^{-1}$; depth of cut $p = 0.02 \text{ mm}$; refrigerant cooling. Feed speed $f_r = 9$ and $15 \text{ m}\cdot\text{min}^{-1}$. Grinding experiments are presented in Table 1.

Table 1. Cutting conditions in the grinding experiments.

| Samples | Grain size | Feed speed (m min ⁻¹) |
|----------|------------|-----------------------------------|
| 2344-100 | 100 | 15 |
| 2344-101 | 100 | 9 |
| 2344-102 | 150 | 15 |
| 2344-103 | 150 | 9 |

Polishing operations

An automatic polishing machine Mecapol P230 was employed. Corundum polishing pads were used with grain size 2500. Parameters employed in the polishing tests are presented in Table 2.

Table 2. Characteristics of polishing tests

| Force (daN) | Speed (min ⁻¹) | Test time (s) | Total time (s) |
|-------------|----------------------------|---------------|----------------|
| 1.5 | 50 | 10 | 100 |

Roughness measurements

A Taylor Hobson Taylsurf Series 2 roughness stylus profilometer with Taylor Hobson ultra software (v. 4.6.8) was used. Different roughness parameters were measured: R_a , R_q , R_k , Rpk and Rvk . Each measuring process consisted of first measuring roughness of the ground surface and then measuring roughness after different polishing times, in order to study the evolution of roughness parameters with polishing time. Ten measurements were performed in the longitudinal direction and five measurements in the transversal direction. In the present work, results in the transversal direction (perpendicular to the grinding direction) are presented.

3. RESULTS

Results for average roughness R_a are presented in Figures 1.

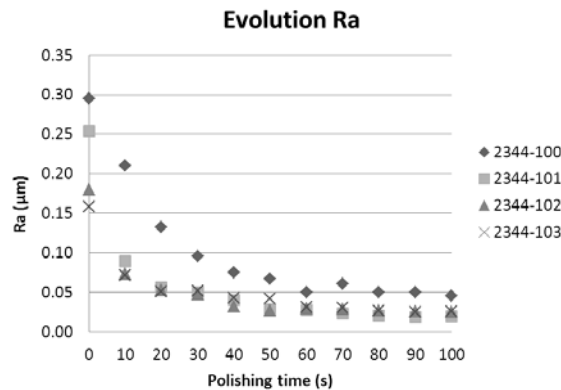


Figure 1. Roughness R_a in polishing experiments

According to average roughness R_a , time required to finish the polishing process is 40 s for samples 2344-101, 2344-102 and 2344-103, while time required to finish the polishing process for sample 2344-100 is 60 s. After this required polishing time, R_a roughness parameter does not remarkably decrease with more polishing time. Final roughness for sample 2344-100 is higher than that for samples 2344-101, 2344-102 and 2344-103. Results agree with those obtained by Wu and Wang, in which if initial roughness values is too high for a certain grain size of polishing abrasive, polishing abrasive grain is not able to reduce roughness to the expected value, since the polishing grains wear out before achieving expected roughness [1].

Amplitude roughness parameter R_a decreases with polishing time as expected. Initial R_a values are higher for samples obtained with high grain size than for those obtained at low grain size. When comparing two samples obtained with the same grain size, those machined at high feed speed present higher roughness than those obtained at low feed speed.

Figure 2 shows results for roughness parameters Rq , Rk , Rpk and Rvk .

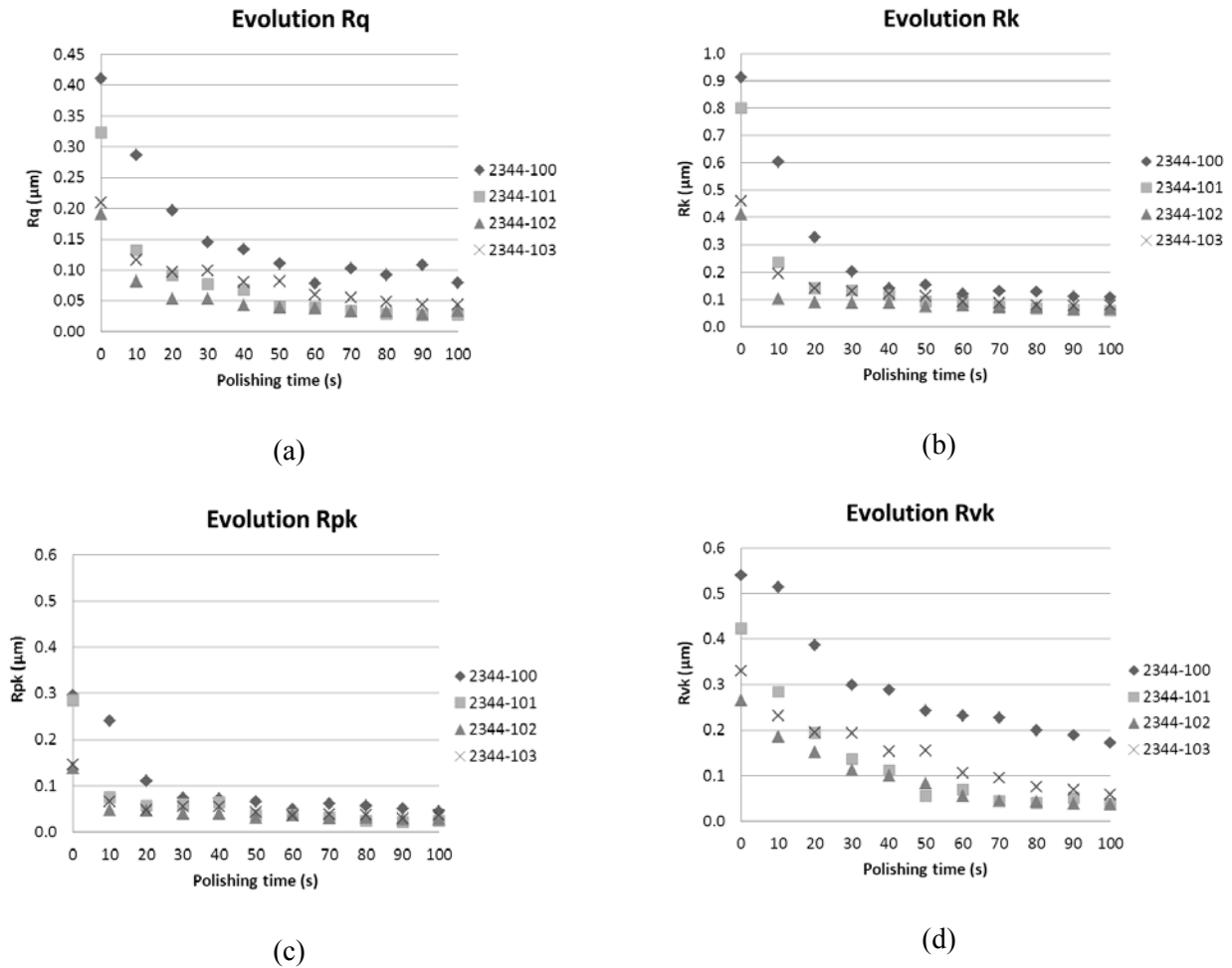


Figure 2. Roughness parameters in polishing experiments: a) Rq , b) Rk , c) Rpk , d) Rvk

Roughness parameter Rq , which is an average roughness parameter similar to Ra , shows the same behaviour than Ra . Material percentage parameters also decrease with polishing time. Rk and Rpk decrease markedly in the first 30 s of the polishing test, and then they decrease slightly. Rvk decreases in a smoother way along the polishing test. In this case, Rvk values of sample 2344-100 along the polishing test are higher than Rvk values for the rest of the samples. Polishing abrasive is not able to remove valleys of the initial ground surface.

In Figure 3 the magnified pictures (4x) of sample 2344-101 are presented:



Figure 3. Magnified photographs (4x) of sample 2344-101: a) ground sample, b) polished sample

Ground samples show marks in the longitudinal direction of the grinding machine. Polished samples present marks whose directions are randomly distributed on the workpiece's surface.

4. CONCLUSIONS

Amplitude roughness parameters Ra and Rq decrease with polishing time as expected. Regarding material percentage parameters, Rk and Rpk decrease markedly in the first stages of the polishing test, while Rvk decreases more smoothly than amplitude roughness parameters along the polishing test. If initial roughness is too high compared to polishing abrasive grain size, along the polishing test it is not possible to completely remove valleys from the previous grinding operation.

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6. REFERENCES

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