

Research about the quality of the surface after turning out of duralumin alloy

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Abstract. This paper describes a study concerning the inner turning of a piece of duralumin, using 6 values of the feed. The shapes and micro-geometry of the resulting chips have been observed experimentally and these are explained by the large deformations in the cutting area. The processed surfaces, both by enlarging them to a microscope and by measuring the roughness have been experimentally studied. Also, the sections of chips are analysed, giving the theoretical and real dimension values, also interpreted on the basis of the deformations in the cutting area. Also, values of roughness parameters are presented.

1. Introduction

Duralumin has been used extensively in aircrafts construction [1] and aerospace applications [2,3], is a durable and lightweight material [4].

For a long time, only duralumin mats have been used, but other types of Al alloy bars have also been made over time, or have been machined [5]. Thus arose research on processing by turning and milling of this material [6-10]. Thus, in the [11] the process of turning the duralumin alloy 2017 is modeled. The stresses and temperature of the cutting area are studied for the purpose of processing machines with numerical controls. The roughness of the processed surfaces have been analyzed and photographs were taken at the microscope.

In [12] probabilistic methods for estimation the feed and cutting speed influence on the surface roughness of the finish machined at the turning for the following materials: brass, steel, alpac and duralumin are used. Numerous charts of roughness and estimated roughness are presented.

In [13] the milling of 5 types of aluminum alloys at cutting speeds from 60 to 250 m / min, using a 20 mm cylindrical-frontal cutter has been analyzed. They were studied: the processing precision, the cutting forces and roughness of the machined surface. Also, the roughness diagrams are given.

Machining of duralumin AL-2017-T4 alloy for aerospace applications is studied in [14].

The cutting force reduction and surface quality improvement have been investigated. In doctoral thesis [15] the milling processing on centers milling with head spherical having 8 mm radius of the sphere, using an experimental program based on 27 experiences is studied. The cutter speed range was between 1000 and 8000 rpm. The chips root and tool geometry, roughness and precision are modeled.

In [16] the turning and grinding of 4 cast aluminum alloys at different cutting regimes with different cutting fluids has been studied. The optimal geometry of the drawknife for each alloy are settled, the cutting forces, roughness and temperature in the cutting area have been measured. The forms of the resulting chips were studied, explained by the analysis of the phenomena in the cutting area have been established. Tools wear and determine the cutting speed relationships for each alloy have been determined.

In the [17] the almost pure aluminum turning with 99.39% aluminum with the hardness HB 24.2 2.5/31.2/30 are investigated. The shapes of chips resulting from different cutting regimes have been studied, the shape of the channel on the face of the groove has been optimized and they have been analyzed the depositions on edge, which are very pronounced.

In [18] turning of aluminum alloy ATSi7Mg, with HB 44 5 / 31.2/ 30 with $\sigma_r = 14$ daN/mm² was studied, analyzing in detail the forms of chips in various combinations feed - the depth of cut with different cutting speeds. The dimensions of the cuttings at different cutting speeds have been detailed.

Also, in [19-22] some research about duralumin turning and the effect of the process parameter on the surface quality are presented.

2. Initial Data

A duralumin Al Cu4 Mg1 Mn alloy tube was turned out inside with different feeds, without cutting fluid. After machining, the piece was cut in two for measuring the roughness and view the shaded surfaces (figure 1). It was run at a speed of 500 rot/min and a cutting depth of 0.5 mm.

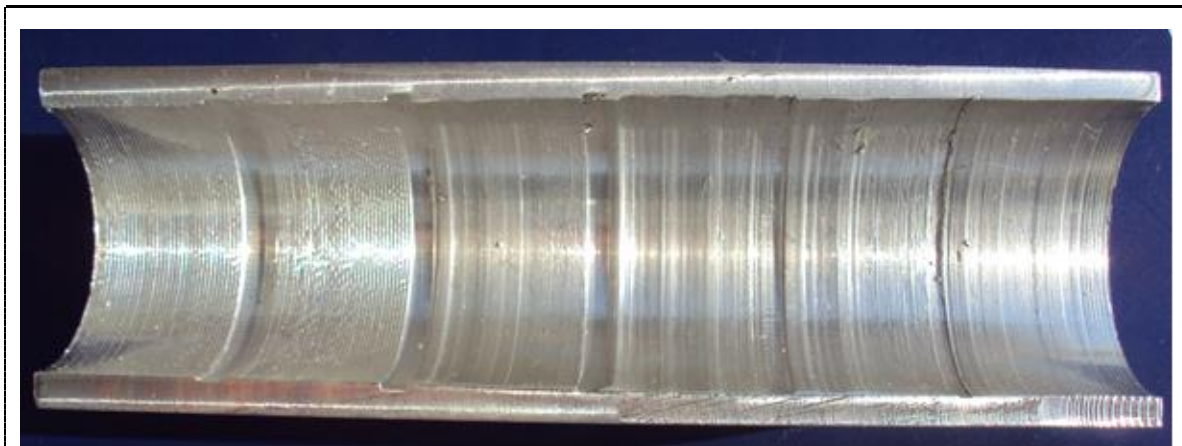


Figure 1. Turned piece.

For machining, an inside boring tool from high-speed steel, , with the following geometry: a channel on the front face with the dimensions of 11.46 mm x 3.36 mm and depth of 3.5 mm, $\kappa_r=110^\circ$, $\kappa_r'=8^\circ$, $\alpha_n=18^\circ$, $\gamma_n=30^\circ$.

3. Experimental Results

In figure 2 the forms of chips obtained a cutting feed of $f=0.096$ mm/rot. A bold used as a scale factor, with a length of 28 mm and a diameter of 0.76 mm, appears on the images.

Silver-white splinters of different shapes resulted. Some are in the form of propellers, not more than 90 mm long, 6 mm in diameter and 10.89 mm in pitch, others are in the form of a gem, starting from helical shapes but tangled after having a longer length 10 mm, reaching on random shapes with volumes entered in spheres with a maximum diameter of 45 mm. There are also comma-shaped chips, about half a spiral of an Archimedes spiral.

In figure 3 the chips micro-geometry on the surface that did not come into contact with the channel on the cutting tool front face is shown.

It can be observed many uneven scales, which demonstrates large deformation of the chip in the cutting area.



Figure 2. Resulted chips after turning with a feed $f=0.096$ mm/rot.

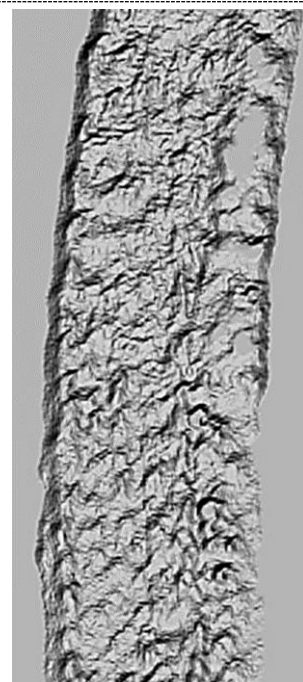


Figure 3. Chip micro-geometry for a feed of $f=0.096$ mm/rot

The surface roughness is given by the profile micro-unevenness presented in figure 4, measured with an electronic roughness tester Mitutoyo type, a SJ-201 P model. The device provided the image of the profile micro-unevenness and the following values of the roughness parameters (SR ISO 4287): R_a , defined as the arithmetic average deviation of the evaluated profile and represents the arithmetic mean of the absolute values of the deviations of the profile, within the limits of the basic length l_p ; R_z - the maximum profile height, defined as the sum of the largest of the projections of the profile, Z_{pmax} , and the largest of the depths of the profile gaps, Z_{vmax} , within the basic length limits; R_q - the square average deviation of the profile, as a quadratic mean of the values of the ordinates $Z(x)$ within the basic length limit.

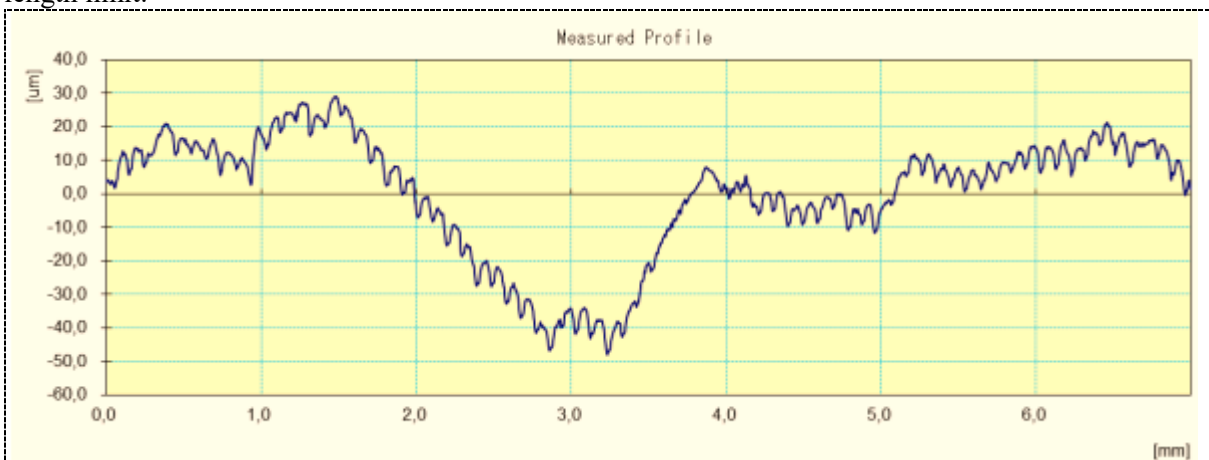
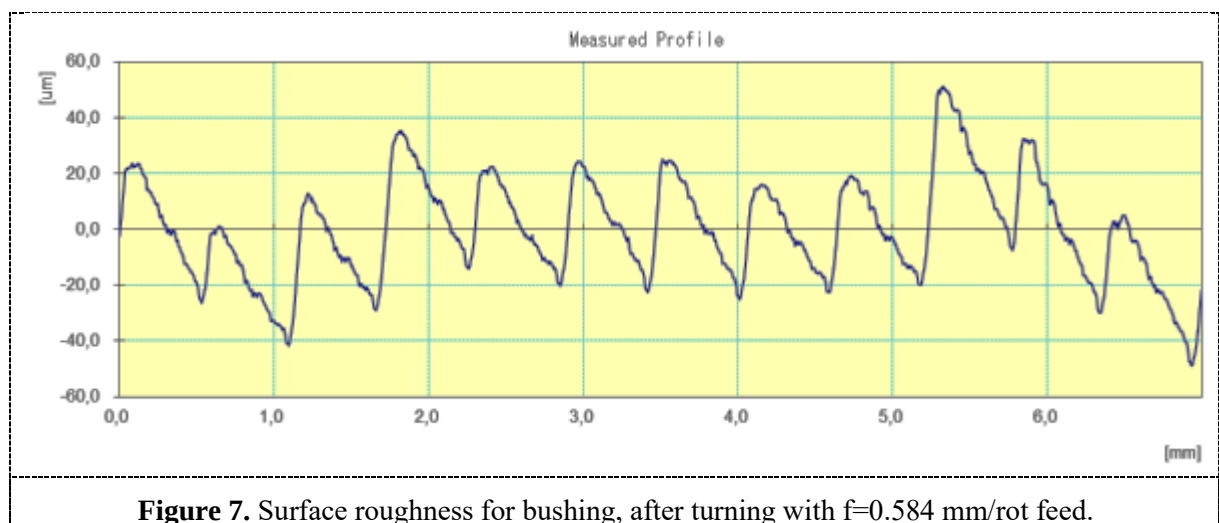
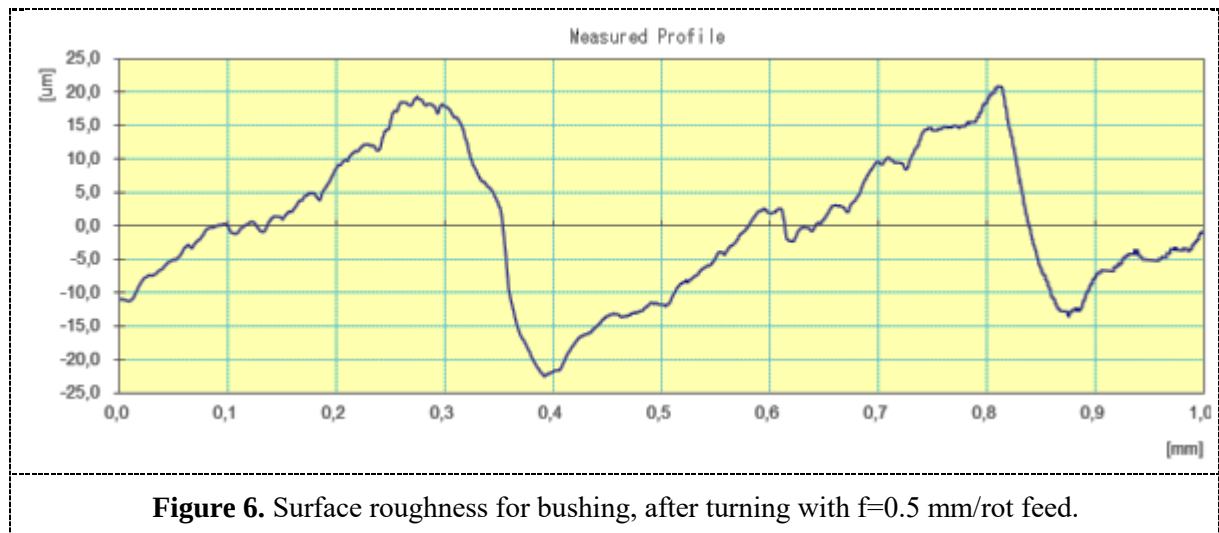


Figure 4. Surface roughness for bushing, after turning with $f=0.096$ mm/rot feed.

In figures 5 to 7 the roughness images for other feeds are presented.



In the table 1 the values of roughness parameters are given.

Table 1. The values of roughness parameters.

f (mm/rot)	Ra (μm)	Rz (μm)	Rq (μm)
0.096	6.94	47.98	9.46
0.208	5.28	32.84	6.44
0.302	3.74	26.95	4.61
0.416	4.48	36.74	5.92
0.5	4.46	26.97	6.15
0.584	12.92	81.17	15.83

3. Conclusions

The turning out process for a duralumin alloy part with 6 different feeds, collecting the resulting chips, studying their shapes and micro-geometry have been studied.

The processed surfaces were evaluated by enlarging them to a microscope and measuring three roughness parameters.

All this evidence shows that the material is easy to process, but it does not produce deposits on the cutting edge to disturb the cutting process. However, the not too high hardness of the material causes large deformations in the cutting area, so that the process does not flow uniformly, the chip pieces overlap on each other forming the scales.

The overall conclusion is that this material is easy to process, but in the cutting area they appear large deformations of the chipping faces.

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