SPECIFIC ISSUES AT CUTTING OF ALUMINIUM WITH SILICON ALLOY

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Abstract: In this paper the difficulties of aluminium with silicon alloys cutting, used mainly in large electrical contacts of high voltage equipment are presented. Also, different forms of chips resulted after cutting with different regimes are shown. The deposition under the cutting edge of bit after cutting at different cutting regimes and different geometrical parameters of used drawknife are presented. Images of cutting edges are given with elements of chips on the influence of cutting fluid on resulted chip shapes are studied.

1. INTRODUCTION

Aluminium alloys were used for a long time in light industry, in aviation, electronics and other fields. There are very soft aluminum alloys and other very hard, so cutting these materials is dependent on their hardness.

Over the years various researches on cutting these materials have been made, establishing relationships for the temperature, roughness, cutting forces for different aluminum alloys [10-12, 14, 15]. Currently research in this area continues. In [16] is studied the correlation between the process of cutting and the resulting accuracy, leading to the optimization.

Copper cutting process, similar to the processing of aluminum, was studied by [13]. Orthogonal cutting is studied by measuring the temperature and voltages [13].

In [2] give information on laser cutting of complicated shapes of pieces of sheet aluminum.

In [9] appear details about formation and control of resulted chips for industrial applications, for this study contributing 60 researchers, in 40 scientific papers. They insisted on chip breaking procedures

In [8] images from milling of aluminum alloy parts are shown. Other aspects about processing of aluminum alloys in [4,5, 17] are presented.

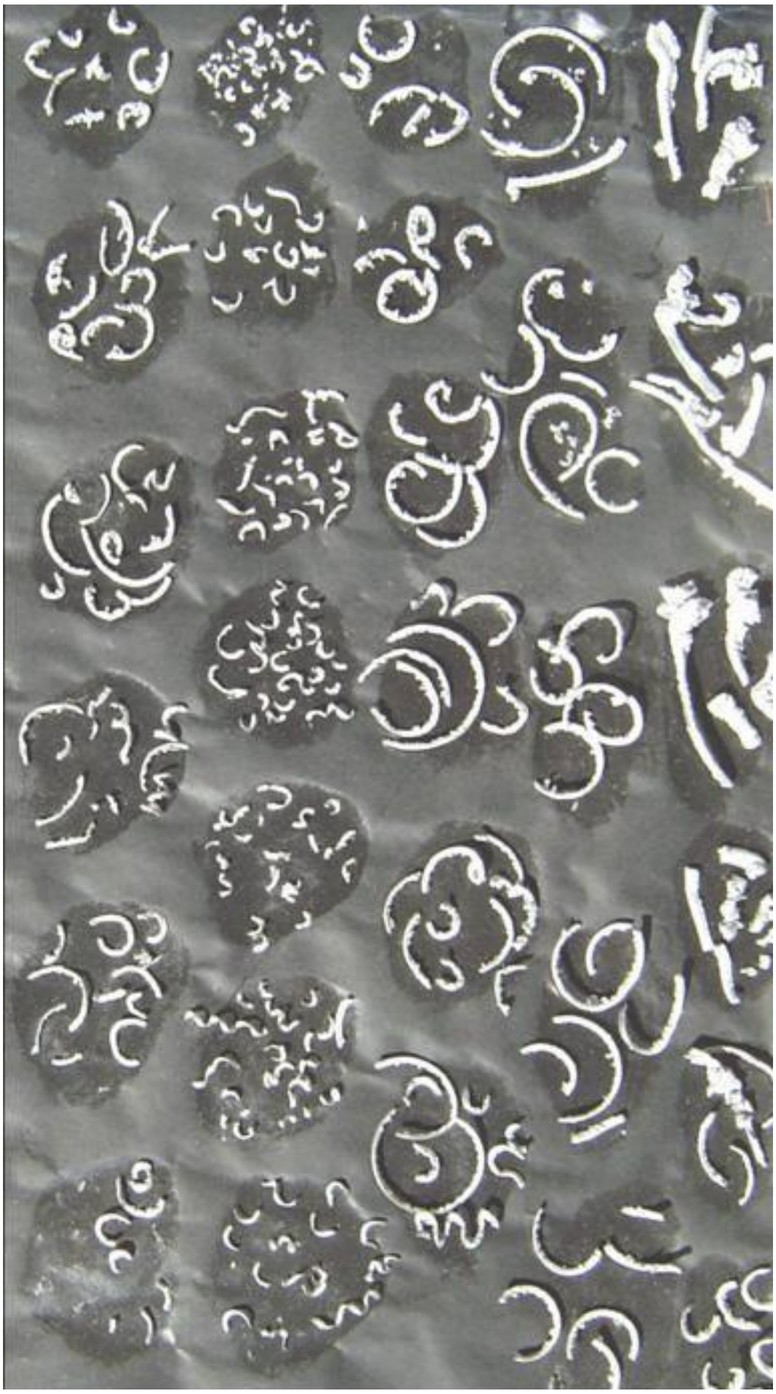
2. SHAPES AND MICROSCOPY OF RESULTED CHIPS

Turning process of an aluminum alloy denoted with the symbol ATSi7Mg has been developed:

- chemical composition: 7.67% Si; below 0.4% Mg; below 0.1% Mn; 0.259% Fe; 0.05%Ti; rest aluminum;
- fracture strength: $\sigma_r = 14$ daN/mm^2;
- elongation: 2.2%
- hardness: HB 44 5 / 31.2 / 30;
- chill casting;
- without heat treatment.

The research consisted of spinning discs front of this material, such as cutting speed vary continuously.

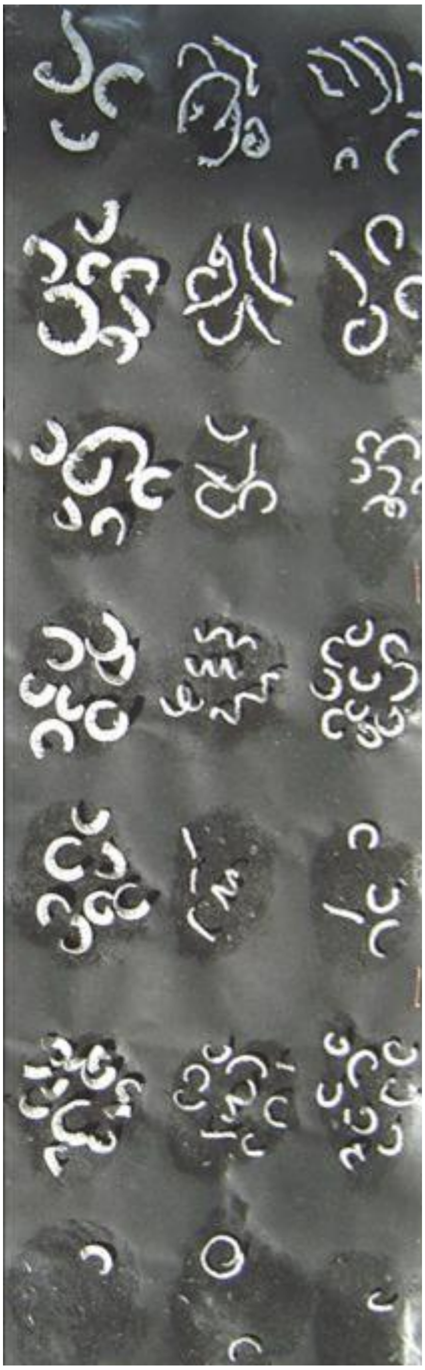
ATSi7Mg alloy is easy turning, because of silicon presence and being tough. In figures 1 and 2 shows types of resulted particles in different turning regimes are presented. On abscissa the feed and depth of cut, as a fraction f / a_p (mm/rot/mm) are shown, and on y-coordinate from top to bottom, at each row corresponds one cutting speed: 180, 250, 350, 420, 525, 625, 710 m/min (in the figures below on chips, are considered the same vertical speeds cutting).



f/a_p 0,25/0,5 0,1/0,5 0,3/0,5 0,25/1 0,25/1,5

Fig. 1. Resulted chips after turning on different regimes

In fig.2 chips are more uniform, but become more dangerous at large depths of cut. It can be observed that the turning regime has a clearly influence which affect the shape of chips.



f/a_p 0,25/1,5 0,35/0,5 0,25/0,5

Fig. 2. Resulted chips after turning on different regimes

In fig.3 a chip resulted after turning regime with 420/0.3/0.5 is shown. It can be observed wrinkles and serried microchips.

Also, it can be seen great irregularities on the face chip opposed to tool contact area, which is explained by high pressing of chip elements to the inner curvature, so that many scales are exfoliate towards the outside.

Chip area that came in contact with the cutting edge of bit is not perfectly uniform polished. This is explained by the fact that chip stuck in some areas by deposition on the cutting edge, then was unsoldered out from the cutting edge, leading with it some portions of the deposit.

Chip observed in fig. 4 (420/0.35/0.5) are helical, there is uneven and presents many thick scales with cracks between them, showing great deformation that occurs during the cutting process.

Even here, the area being in contact with the cutting edge is not uniform, which explains all the deposits formed on the edge.

Flakes edges have teeth shaped blades, with a uniform step, which shows a uniform release of flakes from basic material turned in chip.

Fig.3. Resulted chip after cutting with 420/0.3/0.5

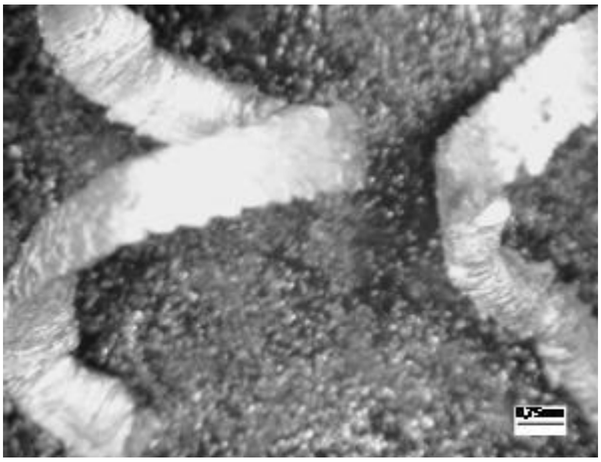


Fig.4. Resulted chip after cutting with 420/0.35/0.5

In fig. 5 the influence of different cutting fluids and feed on the chips shapes, at v=350 m/min; a_p = 0,5 mm is shown.

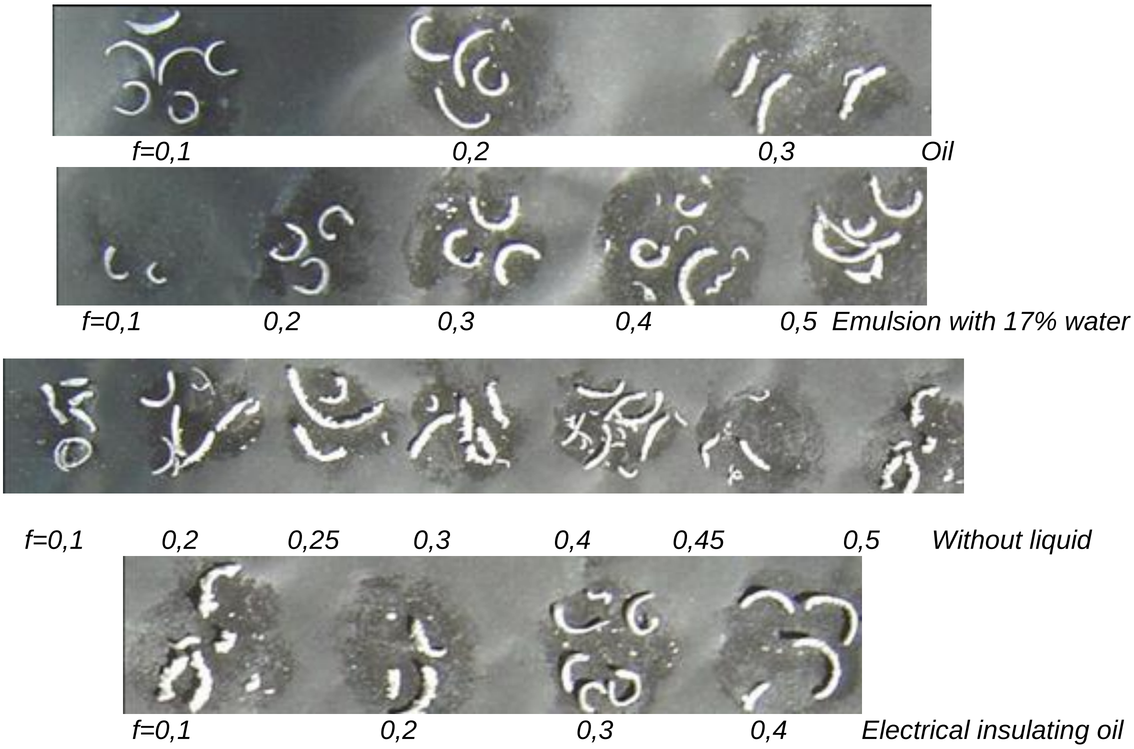


Fig.5. The influence of different cutting fluids and feed on the chips shapes

It is found that the oil gives better results, but also when using emulsions, chips are acceptable forms.

3. DEPOSITS ON THE CUTTING EDGE OF BIT

For ATSi7Mg alloy cutting tools with removable plates of rapid steel Rp2 (65 HRC), channel of 5 mm wide and 0,9 mm deep have been used. Turning was done without cutting fluid, the feed of 0,25 mm/rot and ap = 0,5mm; $a_p = 0,5$, $\chi_r = 85^0$; $\chi_1 = 5^0$.

In figures 6.a and 7 are shown the deposits on cutting edge that appeared to v = 180 m/min. It can be noted that the deposit was formed on the edged tool but not at the sintered-carbide tip but at 1.25mm from the top, reaching a height of 0.15 mm, extending on the front face at a distance of 1 mm.

It is also observed the formation of very small deposits under 0.075 mm, the channel on front face in the direction of movement of the chip, the width of this deposit was 1.5 mm.

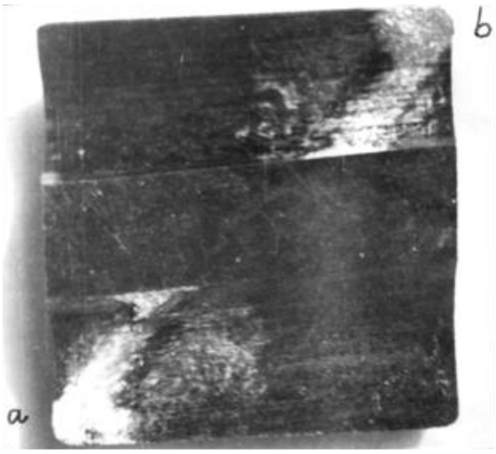


Fig.6. Deposits on cutting edge after turning with v = 180m/min

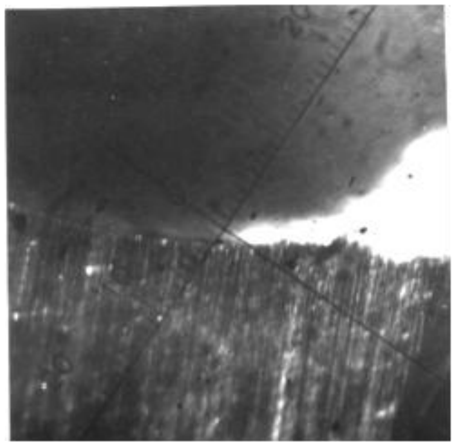


Fig.7. Deposits on cutting edge after turning with v = 180m/min

In figures 6.b and 8 the deposits on cutting edge that appeared after turning with v = 250 m/min are presented.

From the fig.8 it can be noticed also very small deposits on cutting edge under 0.075 mm, which extends from the channel of front face, in the direction of chips movement, on a width of 2.5 mm at nose of cutting edge and 1.5 mm below the nose on cutting edge).

Fig.8. Deposits on cutting edge after turning with v = 250m/min

In figures 9 and 10 is shown the deposits on cutting edge that appeared to v = 350m/min.

It can be noted that the deposits were formed on the cutting edge and on the front face, too. The deposits achieve a height of 0.15 to 0.25 mm on cutting edge, 0.15 mm on back edge and 0.4 to 0.5 mm at the front face.

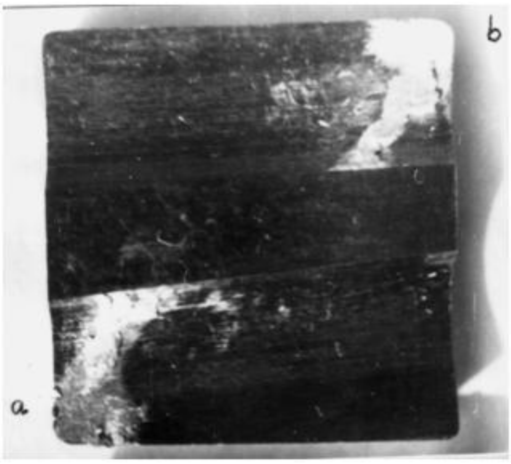


Fig.9. Deposits on cutting edge after turning with v = 350m/min

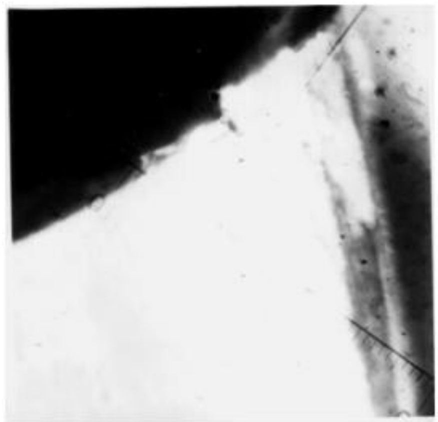


Fig.10. Deposits on cutting edge after turning with v = 350m/min

At v = 420m/min, fig.9.b deposits formed achieve height of 0.2 mm on the cutting edge, 0.1 mm on back edge and 0.6mm on front face.

At v=625m/min, fig.11, deposits are formed, on reaching 0.4 mm at cutting edge constantly maintaining for a distance of 2.5 mm from the nose and 2 mm from the front face.

From the fig.11 can be noted that formed deposit continues in the direction of chip flow across the channel, with a width of 0.3 mm. Also, it can be observed deposits on the back edge reach a height of 0.1 mm.

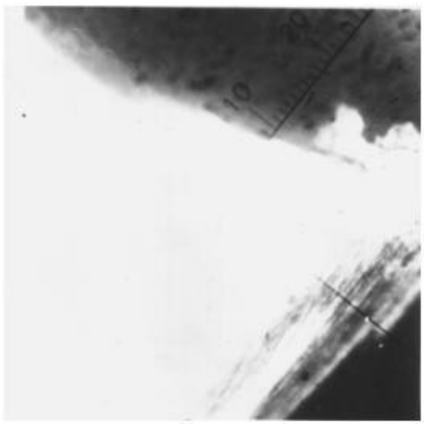


Fig.11. Deposits on cutting edge after turning with v = 625m/min

In fig.12 the deposits on cutting edge that appeared for a v = 710m/min are presented.

From the fig.12 it can be noticed that deposit formed reaches at only 0.1 mm on the cuting edge and front face.

In the offtake (the exhaust channel), even on the direction of cuttings removal a deposit of 1 mm width and thickness of 0.5 mm has been formed.

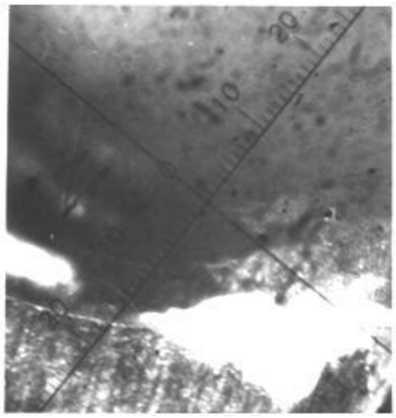


Fig.12. Deposits on cutting edge after turning with v = 710m/min

4. CONCLUSIONS

- The studied aluminum alloy having silicon is heavier than pure aluminum and because of this relatively easy has been turned.
- The influence of various liquids on the cutting process, aiming the shapes of resulted chips has been studied.
- Also, was observed the forming of the deposits on the cutting edge and even small solderings, which were crowded into the channel on the front face if there has not penetrated the cutting fluid.

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