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ALUMINIUM CUTTING SPECIFIC ISSUES

Iulian POPESCU, Cristina Ileana PASCU
University of Craiova, Romania

Abstract. In this paper the difficulties of cutting pure aluminium, used mainly in large electrical contacts of high voltage equipment are presented. It can be noted that during the cutting without cutting liquid, at certain regimes, the chips are glued on the channel of the front face, remaining there and blocking the channel and cutting edge, so that accidents occur.

Also, different forms of chips resulted after cutting with different regimes, indicating in each set of chips used in the cutting regime are studied. The microscopic images of chips, as seen from the outside and from the area that came into contact with cutting edge of bit 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 them and microscopic images where the variation of deposit thickness and edge clearance are shown.

Keywords: aluminium, cutting, deposits on cutting edge of bit

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 [1, 2, 3]. Currently research in this area continues. In [4] special machines for aluminum alloy chips crushed for recycling are presented. Small chips are preferred.

In [5] is studied the correlation between the process of cutting and the resulting accuracy, leading to the optimization.

Process for removing copper, similar to the processing of aluminum, was studied by [6]. Orthogonal cutting is studied by measuring the temperature and voltages.

In [7] give information on laser cutting of complicated shapes of pieces of sheet aluminum.

The paper [8] gives information on cutting aluminum alloy profiles required for building facade construction.

In [9] images from milling of aluminum alloy parts are shown.

2. Shapes and microscopy of resulted chips

An aluminum alloy as close to pure electrical contacts used in electrical engineering from the large high-voltage electrical apparatus, denoted with the symbol Al 99.39% has been developed:

- chemical composition: Al 99.39%, 0.61% Si;
- hardness: HB 24.2 2.5 / 31.2 / 30.

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

On turning of 99.39% Al alloy were found interesting phenomena that have influenced the forms of chips and surface roughness. In the absence of a liquid deposit on the cutting edge are formed very large and continuously growing edge blocks, which can cause accidents.

In addition, the chips are soft, stick on the front face, which are also load and block.

In figure 1 resulted chips after cutting on different regimes are shown.

Abscissa showing the feed and cutting depth, as a fraction *f* / *p* (mm/rev/mm), and ordered from top to bottom, each row corresponds to one of the cutting speed: 180, 250, 350, 420, 525, 625, 710 m/min.

In figure 2 a chip "front" side is shown that is outside, that has not been in contact with the blade and "back" (figure 3) that part being in contact with the cutter and front face - the *v* / *f* / *a* that water of 525 / 0.25 / 1 (notation used below).

It can be notice a kind of membrane resulting from the initial bonding of the remaining chips on the front face, on the face and on specular area from the back.

In figure 4 a resulted chip after cutting with 525/0.25/2 (front) are presented and in figure 5 - back. It can be observed flakes fairly uniform on face and an area smooth, specular area on the back.

f/a_p 0.25/1 0.4/0.5 0.25/1.5 0.25/2 0.084/0.5 0.25/0.5

Figure 1. Resulted chips after cutting on different regimes

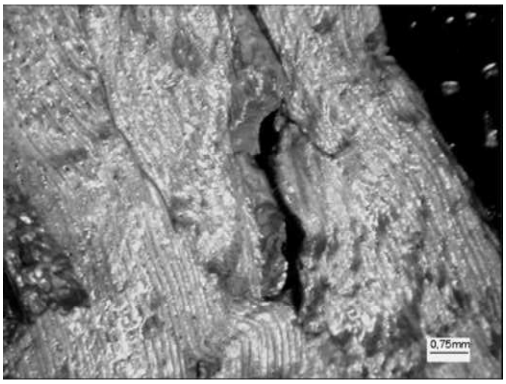

Figure 2. Front side of chip resulted after cutting with 52/0.25/1

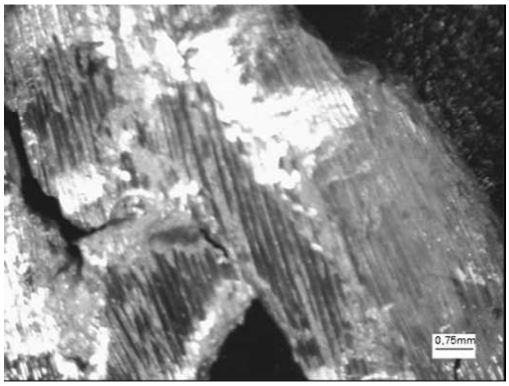

Figure 3. Back side of chip resulted after cutting with 52/0.25/1

It is thus evident that the chips are not uniform, stacked, with several scales, with slides between elements, with flaws, which mean that the cutting process is variable, the difficulties arising from the fact that the chips are glued to the drawknife and the cutting process generates unevenness. It must be emphasized that the images of figures 2-5 derive from high speed cutting (525 m/min), which means that of lower speeds, chips stick and the cutting process has a high degree of instability.

3. Deposits on the cutting edge of bit

Cutting tools with removable plates of rapid steel Rp2 (65 HRC, with χ_n = 300, channel of 5 mm wide and 0.9 mm deep have been used. Cutting was done without cutting fluid, the feed of 0.25 mm / rot and a_p = 0.5mm; χ_r = 850; χ_1 = 50.

In figures 6 and 7 is shown the deposition on cutting edge that appeared to v = 350m/min. It can be noted that the deposit was formed on the channel of cutting edge and on the front face, too. Like height, the deposition reaches 0.8 mm on cutting edge, increasing to 1.2 mm to 1.5 mm from the nose – on cutting edge - and then decreasing to zero at a distance of 3.5 mm from the nose (on cutting edge), respectively 1.25 mm on the channel of the front face.

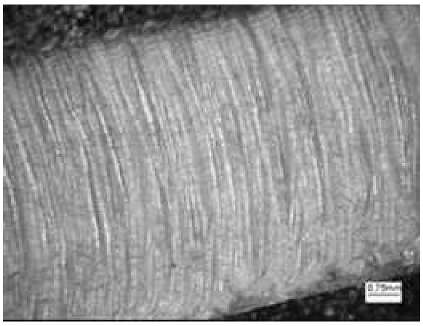

Figure 4. Front side of chip resulted after cutting with 52/0.25/2

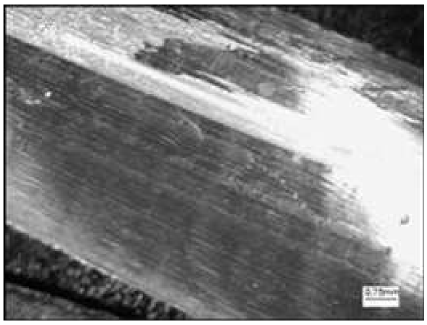

Figure 5. Back side of chip resulted after cutting with 52/0.25/2

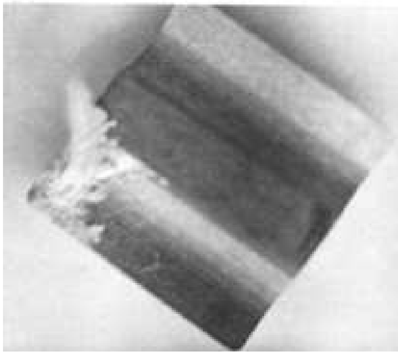

Figure 6. Deposition on cutting edge after cut with v = 350m/min

Figure 7. Deposition on cutting edge after cut with v = 350m/min

At v = 525 m/min shape deposit on the cutting edge (figures 8 and 9) that, as in v = 350m/min consists of overcrowding of chips that were made both along the cutting edge (the length 2.5 mm) and in channel on the front face. The height of this deposit reaches 2 mm at the channel on the front face and 0.75 mm on tip tool, decreasing along the cutting edge.

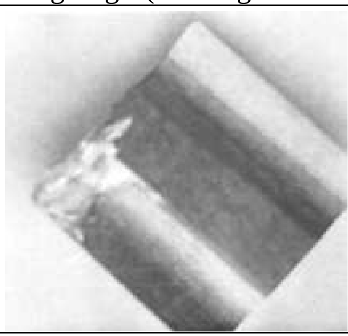

Figure 8. Deposition on cutting edge after cut with v = 525m/min

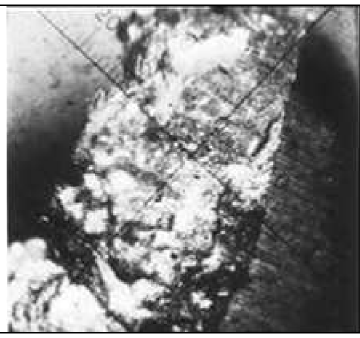

Figure 9. Deposition on cutting edge after cut with v = 525m/min

At v = 710m/min deposit forms again on the edge (figures 10, 11 and 12) but with smaller dimensions that for the other speeds. In figure 11 shows the deposit made on the top of front face and tip tool. In figure 12 deposits along the cutting edge is presented. It is found that the deposit formed at the tip reaches 0.8 mm, 1.1 mm at 1 mm peak-to-edge and 0.6 mm - on average - on the front face.

In figures 13 and 14 are shown the deposit corresponding for v = 180m/min, in case of the wrong disposition of plate which cut with "*a*" corner.

It can be observed that the deposit was formed in top of the tool and on front face, non-elongating along the cutting edge.

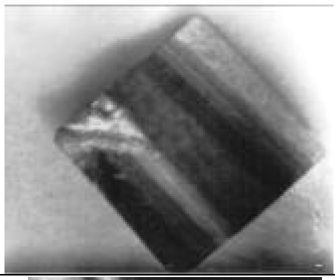

Figure 10. Deposition on cutting edge after cut with *v* = 710m/min

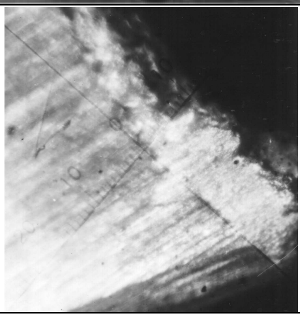

Figure 11. Deposit on the front of cutting edge after cut with *v* = 710m/min

Figure 12. Deposit on among of cutting edge after cut with *v* = 710m/min

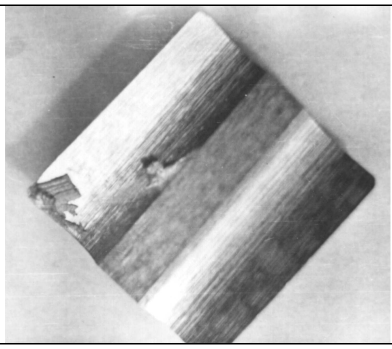

Figure 13. Deposition on cutting edge after cut with *v* = 180m/min

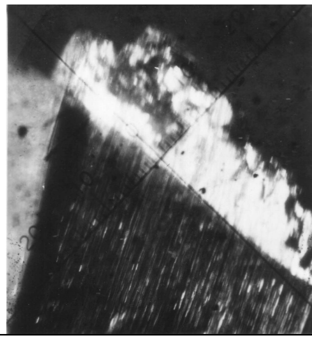

Figure 14. Deposition on cutting edge after cut with *v* = 180m/min

Deposit reaches of 0.5 mm height on peak of the tool and increases to 0.8 mm at distance of 0.75 mm of front face, decreasing uniformly to the depth channel.

The dimensions of this deposit is not large because the cutting speed is small and because the channel length directions of the chips has increased, going through this channel chip with a greater inclination towards the cutting edge, so as to avoid crowding the chips in a small space.

From figure 1 can be noted an irregular shape of some of the chips and parts that were glued on the channel of front face.

Based on these studies clearly resulted that aluminium is acceptable cut only using cutting fluids.

4. Conclusions

Almost pure aluminium is very fictile, so at cutting process appear adhesions of chips on the channel of front face.

At high cutting speeds can splinter off acceptable.

Large plastic deformation that appears in cutting area, discovered because the chips shapes aggravates the roughness of processed surface.

Deposits occur on the cutting edge and even soldering that crowd, even injuries are possible.

At cutting this material should be mandatory used cutting fluid.

References

1. Kardos, A. (2008) *Determination of soil coefficient of chip at Aluminium turning*. Metalurgia International, Vol. 13, No. 4, p. 349 -358, ISSN 1582-2214
2. Livsit, B.V. (1963) *Some features of the process of cutting of aluminium alloys*. Izvestia VUZ Masinostroeska, Moskva, Russia, No. 1, p. 140-144
3. Popescu, I. (1969) *Contribuții la stabilirea procesului optim de prelucrare a aliajelor de aluminium pe strunguri automate* (*Contributions at establishment of optimal processing technology of aluminium alloys on automatic lathes*). Ph.D. thesis. Politehnica University of Bucharest, Romania (in Romanian)
4. Popescu, I., Pascu, C.I. (2010) *Rugozitatea la strunjire* (*Roughness at turning*). Sitech Publishing House, ISBN 978-606-11-0744-5, Craiova, Romania (in Romanian)

5. *** *YAG-500 Aluminium laser cutting machine*. Available from: www.alibaba.com/showroom/alluminium-cutting.html, Accessed: 24/11/2010
6. Schulz, H., Bimschas, K. (1993) *Optimization of precision machining by simulation of the cutting process*, CIRP Annals, STC C, Vol.42, No.1, p. 55-67, ISSN 0007-8506.
7. Moriwaki, T., Sugimura, N., Sheng, L. (1993) *Combined stress, material flow and heat analysis of orthogonal micromachining of copper*. CIRP Annals, STC C, Vol. 42, No. 1, p. 75-87, ISSN 0007-8506
8. http://www.youtube.com/watch?v=zt7SnKTU0OY
9. http://www.multipaneluk.co.uk/?gclid= CMbTy6DohagCFQuEzAodvRyVsA
10. *** *Aluminium Chip Conveyors*. Available from: www.magtoolsindia.org/aluminium-chip-conveyors.htm, Accessed: 05/05/2011