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# ASPECTS OF THE ROUGHNESS OF PARTS OF LEAD AND ALUMINIUM OBTAINED BY COMBINED EXTRUSION TO COLD

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***ABSTRACT***: *In the first part of the paper are presented: the mold and the active elements used, as well as several types of lead and aluminum parts, obtained by combined extrusion. In the second part of the paper are presented through tables and diagrams the roughness of the surfaces of aluminum, lead and copper parts, obtained by extrusion combined with several types of active plates.*

***KEY WORDS:*** *roughness, combined extrusion, lead, aluminium, non-ferrous metals.*

## 1. INTRODUCTORY CHAPTER

The roughness of extruded surfaces is defined as the ensemble of irregularities that shapes the relief of real surfaces. The irregularities could be: striations, scratches, drawings of material particles, traces of active elements, funnels (empties), pores etc., which appear when processing by means of extrusion. The form and dimensions of irregularities depend on the type of extrusion used, on the geometry and quality of surfaces of active elements, on moulds and pressers' rigidity, on the characteristics of extruded material and other agents.

Getting a good roughness on extruded parts means elimination of subsequent finishing operations.

Owing to the fact that for many times the quality of the surface has influence upon the functional part of the parts, it is necessary to analyze the roughness of surfaces of the parts in non-ferrous metals at cold extrusion.

In order to make the analysis of the roughness of the surfaces in non-ferrous metals there were made parts of cylindrical and half-cylindrical lead and aluminum raw material.

At the combined extrusion the degree of deformation was different ε=83.34% ($D_0$=24,5mm and $D_f$=10mm) and ε=62,51% ($D_0$=24,5mm and $D_f$=15mm). The active plates which have been used have different half angle α: convex active plate (α=120˚; 105˚); plane active plate (α=90˚ and the rounding radius r=0; 2; 4 mm); conic active plate (α=60˚; 45˚).

For the combined extrusion there were used the active plates from the direct extrusion and the punches of two sizes from the inverse extrusion.

The mold, for the combined extrusion and some of the active elements used are shown in the figures: 1, 2 and 3

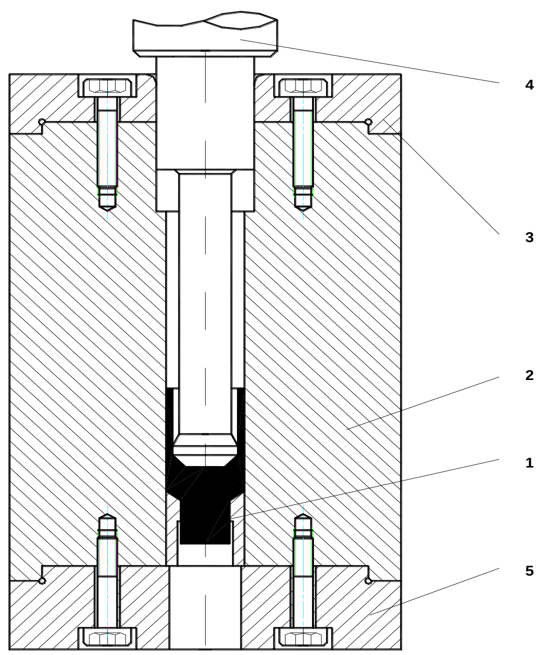



**Fig. 1. Mold for combined extrusion: 1 - active plate; 2 - body; 3 - upper plate; 4 - punch; 5 - lower plate.**

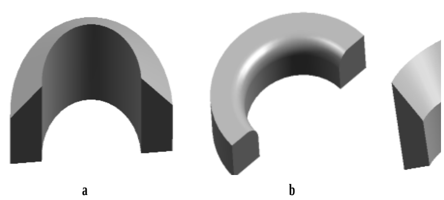


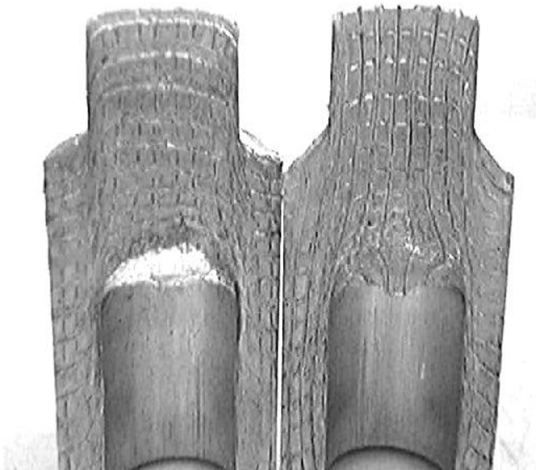

**Fig. 2. Active plates for combined extrusion of two pieces: a - convex; b - plane; c – conical.**

**Fig. 3 Punches for combined extrusion.**

The parts extruded could be seen in Fig. 4, 5, 6 and 7.

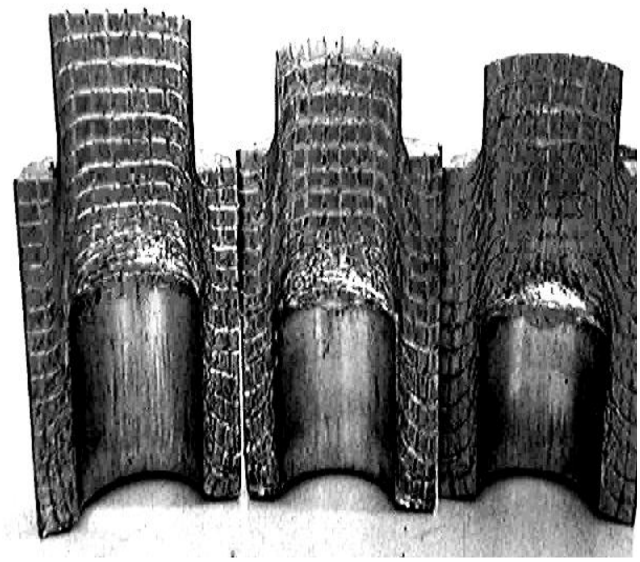
**Fig. 4. Parts in lead obtained by combined extrusion with conic active plates EC Pb 10x60x20x30(2/2).**

**Fig. 5. Parts in lead obtained by combined extrusion with convex active plates: a-EC Pb 10x120 x20x30(2/2); b-EC Pb 10x105 x20x30(2/2).**



**a** **b**

**Fig. 6. Parts in aluminium obtained by combined extrusion with conic active plates: a – EC Al 15x15x60x30 (2/2); b – ED Al 15x15x45x30 (2/2).**



**a b c**

**Fig. 7. Parts in aluminium obtained by combined extrusion with plane active plates: a – EC Al 15x90r0 x15x30 (2/2); b – ED Al 15x90r2 x15x30 (2/2); c – ED Al 15x90r4x15x30.(2/2).**

After their cleaning the extruded parts have been measured by means of roughness tester, Fig. 8, and all data have been stated in the table below. There were drawn the diagrams using the SigmaPlot 2001 program.

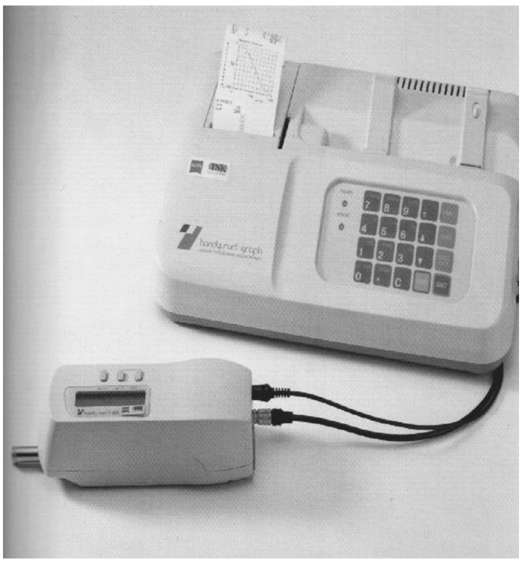


**Fig. 8. Roughness tester.**

When analyzing the roughness of the testing part in lead, got by means of combined extrusion, Table 1 and Fig. 9, one can notice that the better roughness has resulted for the internal surfaces. It could also notice that the weakest roughness is got when using the plane active plates without connecting radius in the deformation area.

**Table 1**

**Roughness $R_a$, EC Pb [µm]**

| Angle of the active plate [˚] | Surface of the part | |
|---|---|---|
| | internal | external |
| 120 | 0.2000 | 0.1600 |
| 105 | 0.1600 | 0.2000 |
| 90r0 | 0.2000 | 0.2300 |
| 90r2 | 0.2000 | 0.2000 |
| 60 | 0.1300 | 0.1600 |
| 45 | 0.1600 | 0.2000 |

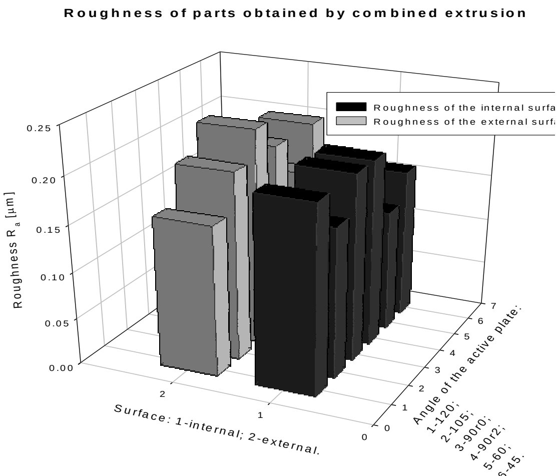



**Fig. 9. $R_a$ roughness of the surfaces of the parts in lead obtained by combined extrusion**

The best roughness at the testing part in aluminium got by means of combined extrusion has resulted for the internal surfaces and the weakest one when using the plane active plates without connecting radius in the deformation area, Table 2 and Fig. 10.

**Table 2.**

**Roughness $R_a$, EC Al [µm]**

| Angle of the active plate [˚] | Surface of the part | |
|---|---|---|
| | internal | external |
| 120 | 0.4000 | 1.7000 |
| 105 | 0.2000 | 1.1000 |
| 90r0 | 0.3600 | 1.8000 |
| 90r2 | 0.2000 | 1.6000 |
| 60 | 0.1800 | 1.5000 |
| 45 | 0.3000 | 1.4000 |

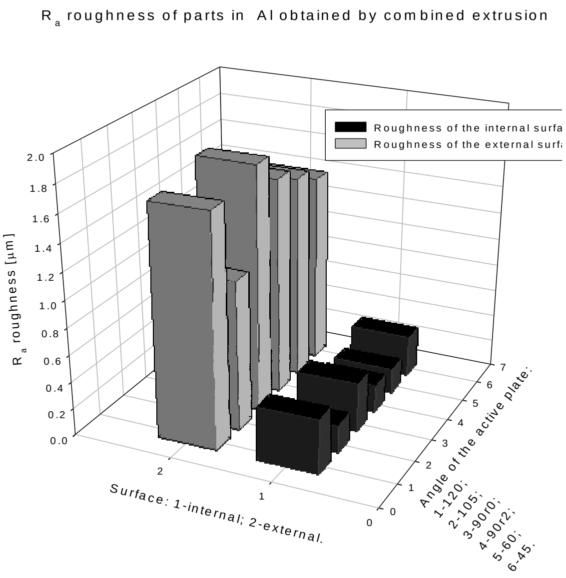



**Fig. 10. $R_a$ roughness of the surfaces of the parts in aluminium obtained by combined extrusion.**

Lubrication has an important part beside reduction of friction between the active elements of the mould and of the deformation force, the reduction of stress inside the material during the deformation process, increase of durability of active elements by reduction of their wear and against improvement of the quality of the processed surfaces and of the accuracy of the part resulting.

As concerns the accuracy of the geometric form of the products in metal and non-ferrous alloys, got by extrusion, it is very much influenced by the accuracy of the active elements, these semi-finished products being generally mild materials. For the testing parts got during the experimental researches, in the present work it is not eloquent an analysis of the accuracy of the geometric form because the active plates, which were used have been made of two pieces in order to be able to draw out the parts more easily, without deformations, strokes, pinches or other faults coming from this operation.

## 3. CONCLUSIONS

Regarding the roughness of the surfaces of the parts of lead and aluminum by cold extrusion, the following conclusions can be drawn:

- the flow of the material during the combined and reverse extrusion process can be altered when using the convex or planar radius plates in the deformation zone;
- in the extruded parts the roughness increases with the increase of the degree of deformation and it is also less good when using the flat active plates;
- for the parts obtained by the reverse extrusion and combined roughness much better is obtained on the inner surfaces as compared to the outer surfaces;
- the precision of the geometrical shape of the products of non-ferrous metals and alloys, obtained by extrusion, is greatly influenced by the accuracy of the active elements, these semi-fabricated ones being generally soft materials.

## 4. REFERENCES

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## 5. NOTATION

The following symbols are used in this paper:
Al= Aluminum;
Pb= Lead;
EC= Combined extrusion;
$R_a$ =Roughness;
90r0; 90r2;90 r4 = Angle and rounding radius of the active board;
(2/2)= 2 piece cylindrical semi-finished product
$D_0$= Initial diameter of the blank;
$D_f$= Final diameter of the blank;
$\varepsilon$= Degree of deformation;
$\alpha$= Angle of the active board.