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Studies Regarding the Influence of the Improving Elements Upon the Roughness of the Surface Processed of Polyamides

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ABSTRACT

The current work contains a study about the influence of the improving elements upon the roughness of a surface processed through longitudinal turning of some polyamides. The types of polyamides under discussion are: PA 66, PA 66 – GF 30 (PA 66 with 30% of glass fibred) and PA 66 MoS2 (PA with MoS2).

Keywords: *Polyamide, Nylatron, roughness.*

1. Introduction

As it is known, the surface condition is set off by the dimensional accuracy and by the roughness of the machined surface. From the two constituents of the surface condition, in this work it is presented only the roughness of the machined surface.

The processing operation had in view is the turning, and particularly it is about the cylindrical turning (rough turning and finish turning).

This work presents a series of dependence relationships between the roughness of the machined surface by the above-mentioned process and the elements of the cutting conditions, as well as the influence of the improving elements on this roughness.

2. Experimental

The materials on which experimental researches have been made are: polyamide PA 66, polyamide PA 66 – GF 30 and nylatron GSM (PA 66 MoS_2), and those properties are presented in table no.1.

Polyamide PA 66– GF 30 is a material based on a polyamide PA 66 to whom it was added, for the improvement of certain properties, 30% glass fibred, and the polyamide Nylatron GSM is composed by PA 66 to whom it was added 1% molybden disulphide (MoS_2).

The experimental assays established in basis of a research plan having as input variables the parameters of the cutting conditions (table no.2), were performed in the following conditions:

- turning tool (lathe tool) for each processing method (roughing/finishing), with the geometry presented in table no.3;
- the machine – tool: normal parallel lathe MSZ 5022;
- the measuring instrument: Surtronic 4;
- the processing were made without cooling;
- the ambient temperature: 20^0C;
- the semi-products utilized had a diameter of 50 mm.

Table 1

Mechanical properties of the materials used

	Unit	PA 66	PA 66–GF 30	PA 66 MoS_2
Density	g/cm^3	1,14	1,29	1,16
Breaking strength	MPa	90	100	78
Breaking elongation	%	>40	5	25
Resistance to shock	KJ/m^2	4,5	6	3,5
Ball test hardness	N/mm^2	160	165	160

The mathematical pattern from which we started is of the type:

$$R_a = A_0 \cdot v^{A_1} \cdot s^{A_2} \cdot t^{A_3} \quad [mm] \qquad (1)$$

where: $A_{0 \dots 3}$ – coefficients.

Table 2

Parameters of the cutting conditions

Parameters \ Processing		Roughing	Finishing
Cutting depth, t [mm]	Minimum	0,4	0,1
	Medium	0,7	0,18
	Maximum	1,2	0,3
Advance, s_l [mm/rot]	Minimum	0,4	0,1
	Medium	0,6	0,15
	Maximum	0,9	0,225
Cutting speed, v [m/min]	Minimum	29,83	117,75
	Medium	41,605	166,42
	Maximum	58,875	235,5

Table 3

The cutting tool used

Parameters \ Processing		Roughing	Finishing
Material	mm	Rp3	
Clearance angle	^{0}	8 [2,3]	
Rake angle	^{0}	30 [2,3]	
Nose radius	mm	1	
Entering angle	^{0}	45	75
End cutting edge angle	^{0}	45	5

It was chosen this mathematic model because it is very easy to linear.

3. Results and discussions

Starting from the established mathematical model and utilizing an orthogonal centered experimental plan of the type 2^3, after the processing of the obtained data, using specialty methods regarding the data processing, it resulted two equations for each material analyzed.

These equations are:

a. For roughing:

- PA 66 :

$$R_a = 37,15 \cdot v^{-0,132} \cdot s^{0,231} \cdot t^{0,039} \text{ [μm]}; \quad (2)$$

- PA 66 – GF30:

$$R_a = 101,41 \cdot v^{-0,227} \cdot s^{0,903} \cdot t^{0,059} \text{ [μm]}; \quad (3)$$

- PA 66 MoS_2:

$$R_a = 44,67 \cdot v^{-0,106} \cdot s^{0,524} \cdot t^{0,051} \text{ [μm]}; \quad (4)$$

b. For finishing:

- PA 66 :

$$R_a = 31,62 \cdot v^{-0,475} \cdot s^{0,219} \cdot t^{0,102} \text{ [μm]}; \quad (5)$$

- PA 66 – GF30:

$$R_a = 1,98 \cdot v^{-0,071} \cdot s^{0,13} \cdot t^{0,058} \text{ [μm]}; \quad (6)$$

- PA 66 MoS_2:

$$R_a = 3,01 \cdot v^{-0,177} \cdot s^{0,089} \cdot t^{0,076} \text{ [μm]}; \quad (7)$$

In basis of these dependence relationships were traced a series of graphics to mark both the influence of the cutting conditions on quality of the machined surface, and the influence of the improving elements from the materials analyzed on this quality.

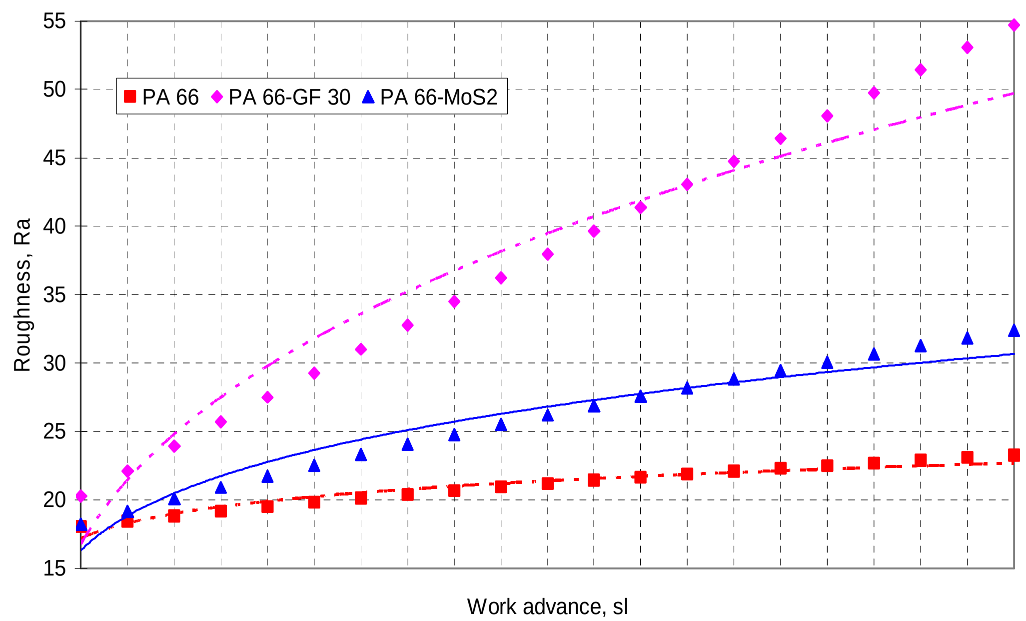

Figure 1. *Dependence between Ra and s, (v, t = const.), for roughing*

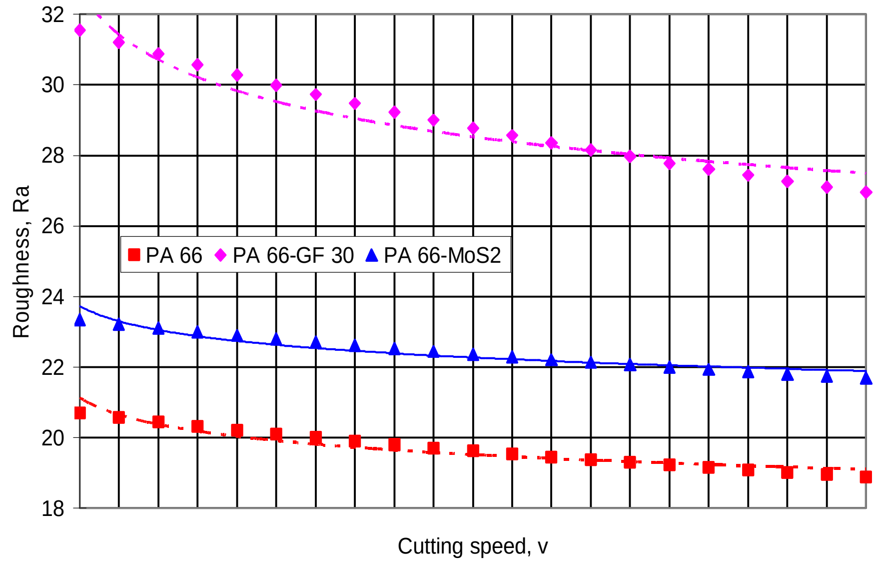

Figure 2. *Dependence between Ra and v,(s, t = const.), for roughing*

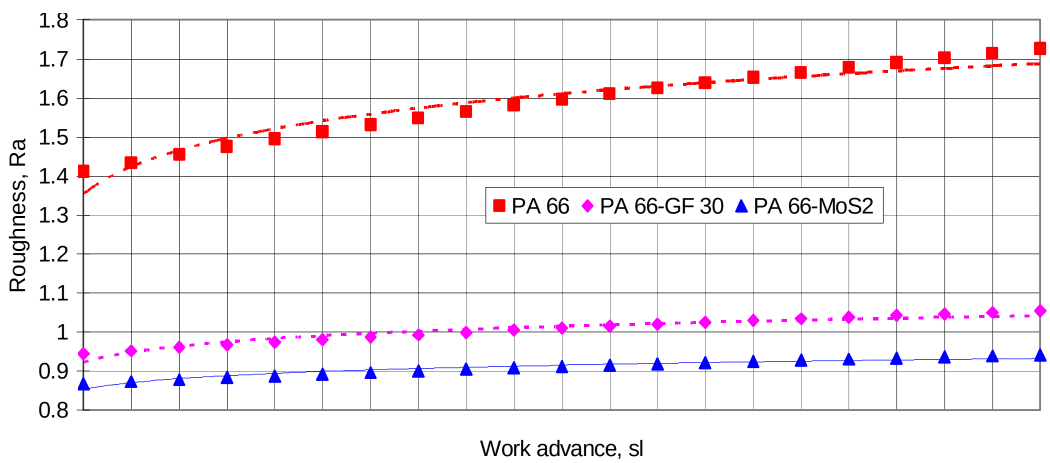

Figure 3. *Dependence between Ra and s, (v, t = const.), for finishing*

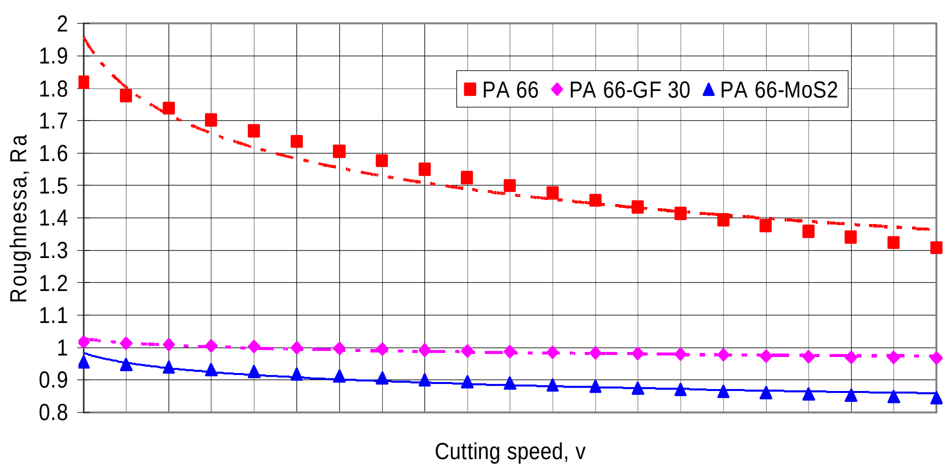

Figure 4. *Dependence between Ra and v,(s, t = const.), for finishing*

It can be observed, from these graphics, that the biggest influence on the surface roughness, between the parameters of the cutting conditions, has the work advance, s_l, followed by the cutting speed, v, and, with a very small influence, the cutting depth, t.

Analyzing the results obtained, both from the relations and from the graphics, it can be considered that an influence on the machined surface quality also has the improving element utilized for the modification of certain mechanical and/or chemical properties of the basis polyamide PA 66.

So it is observed that in the case of the longitudinal rough turning process a good processing is assured in the case of polyamide PA 66, so the improving elements added to this polyamide influence negatively the surface quality for this type of processing. The difference between the medium values obtained in the processing of the polyamide PA 66 and the other two polyamides, for example in the case of the constant cutting speed and depth machining and variable advance (fig. 1), it is approximately 42 % vis a vis the PA 66 – GF 30, respectively of 18 % vis a vis the PA 66 MoS_2.

In the case of the finish turning it can be observed that the added elements are good for the machined surface quality, because the best quality (roughness) was obtained in the processing of the polyamides PA 66 MoS_2 and PA 66 – GF 30 that is the additive ones. The difference between the medium values obtained in the processing of the polyamides PA 66 MoS_2 and PA 66 – GF 30 vis a vis the polyamide PA 66, for example in the case of the constant cutting speed and depth machining and variable advance (fig. 3), it is of approximately 36 % in the case of PA 66 GF30, respectively of 42% in the case of PA 66 MoS_2.

4. Concluding remarks

In the wake of the results obtained, the following conclusions can be drawn:

- in the case when one wants to obtain a superior quality of the machined surface, it is indicated to be utilized one of the additive polyamides, PA 66 GF 30 or PA 66 MoS_2, this in the case when there are not imposed certain conditions from a mechanical point of view (situation in which the material cannot be changed);
- in the case when the quality of the obtained surface after the processing is not important, it is preferable to utilize the polyamide PA 66 – GF 30.

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Studii privind influenta elementelor de îmbunătățire asupra rugozității suprafeței prelucrate a poliamidelor

Rezumat

Lucrarea prezintă un studiu asupra influentei elementelor de îmbunătățire asupra rugozității suprafeței prelucrate prin strunjire longitudinală a unor poliamide. Tipurile de poliamidă studiate sunt: PA 66, PA 66 – GF 30 (PA 66 cu 30% fibra de sticla) şi PA 66 MoS2 (PA cu MoS2).

Études concernant l’influence des éléments d’amélioration sur la rugosité de la surface profilée des polyamides

Résumé

Le travail représente un étude sur l’influence des éléments d’amélioration sur la rugosité de la surface profilée par chariotage longitudinal des certaines polyamides. Les types de polyamide étudiés sont: PA 66, PA 66 – GF 30 et PA 66 MoS2 (PA avec MoS2).