RESEARCH PAPERS
FACULTY OF MATERIALS SCIENCE AND TECHNOLOGY IN TRNAVA
SLOVAK UNIVERSITY OF TECHNOLOGY IN BRATISLAVA

2010 Number 28

CONTRIBUTION TO THE INVESTIGATION OF SURFACE ROUGHNESS MODELS OF GRINDED PLASMA-JET SPRAYED CERAMIC COATINGS

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Abstract

Ceramic coatings acquired by plasma-jet spraying are considerably rough and inaccurate as for dimensions. To achieve a smooth and accurate surface, it is necessary to shape them and improve their technological properties. The surface roughness is one of these properties.

Key words

ceramic coating, roughness, surface, plasma-jet spraying

Introduction

Real surface can be formed by one or several layers of various chemical compounds or various textures and properties. These layers can originate in natural way as a result of production and utilisation of parts (hardening, oxidation) or in artificial way by deposition. Several techniques of deposition with different structure of layer can be used. These layers on surface can be called surface layers (subsurface layers) or coatings, too.

Properties of coatings

Coatings might have some properties similar to core properties even when coatings' composition does not differ too much from the core´s composition. Other properties might completely differ from the properties inside the part. These properties can be geometrical

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(length parameters), mechanical (e.g. hardness, strength), physical (e.g. thermal and electrical conductivity), chemical (e.g. anticorrosion), technological (e.g. machinability and welding property).

Sometimes, a coating can have inapt geometric and others properties (e.g. high roughness and porosity) and it is necessary to modify them. This can be done by removing a damaged or affected layer. Layers are added and removed by various technologies. When the size of an added or removed layer is in a micrometre scale, then micro technologies can be applied. Similarly, Nano and Pico technologies can be used.

Layers with specific properties are made by Plasma Spraying on material's surface, e.g. wear proof or electrically insulating coatings. Sometimes, mechanical treatment may cause cracks and then local or general unstuck of coating occurs. It is primarily a consequence of the fact that individual characteristics of coatings (e.g. material of coating, its structure and mainly the type of binding between the coating and material) were not taken into account.

Basic characteristics of coating shot plasma arc

Ceramic coating Al_2O_3 + 13 % TiO_2 which was made by plasma spraying of powder AMDRY 6224 compound was chosen, on which intermediate layer NiAl (powder AMDRY 956) was applied. The device used was Plasma – Technic Co SNECMA system at IMMM: Slovak Academy of Sciences and the background material was cylindrical aluminium alloy with dimensions D40x30. The thickness of coating was 0.6mm.

In plasma spraying technology, material is fed into plasma beam in a powder form. In plasma beam, powder particles are heated, melted and accelerated by exhalants of plasma gas and collide with roughed surface of material. After impact, distorting the shape of flat disc, they cool quickly to form a typical layered structure. The temperature in the longitudinal and transverse direction of the plasma beam is not the same, but it decreases with the distance from the beam axis. Individual particles of a different size are moving in the plasma beam using different paths, and heat up themselves to melting and evaporation temperatures. Typical structure of coatings with much non-homogeneity is gradually formed by the deformed particles. Non-homogeneity is caused mainly by non-deformed particles that are formed due to the fact that their heating temperature in plasma beam is low or it dropped before they had rammed the surface. The coating also contains pores, cracks and jet material particles on the surface of the substrate, and the new phases formed during heating or cooling the coating layers.

Those coatings are formed to overlap the different deformed particles distributed unevenly. The result is a film which has a rough surface with pores. This also applies to other types of metallic and ceramic plasma sprayed coatings. Roughness of the coating is mainly dependent on the grain size powders. The surface coating has a roughness which is usually higher than the usual requirements for the quality of surface of mechanical parts. Regarding the dimensional requirements, it is necessary not only to finish (smooth) the surface of coating, but also to machine it to the requested size. Potential ways of coating´s machining are listed below.

Coatings processing

As mentioned above, to perform dimensional correction of a coated part, it is necessary not only to reach requested roughness, but also machine the coating in order to reach requested dimensions. However, adding another layer of coating (plasma spraying) usually does not improve dimensional accuracy; there is a need to find a way how to correct the size by removing a thin subsurface layer of the coating. In case of machining of cylindrical surfaces (in the case of our samples), turning, grinding, polishing and superfinishing can be taken into account. The last two methods require a combination with grinding, as there are stricter requirements for them regarding the previous operations or starting state of the surface. This particularly concerns superfinishing, regardless the needs of a special superfinishing machine and tool, and therefore plasma sprayed coatings are not considered so far.

Subsequent turning of coatings is not taken into account, because the turning of coatings is suitable for coatings with lower hardness and these were not the subject of our investigation. Our interest is focused on the grinding of coatings in particular.

The choice of the method and conditions of machining will depend on the strength of ties in the interface (i.e. when the coating does not peel off), we may seek the conditions for cultivation (mainly cutting rates), making it possible to achieve the desired surface roughness and dimensional accuracy of parts. Cutting process is evaluated by various parameters such as life of the cutting tool, cutting force (or its components), roughness of the machined surface, shape of chips and so on. Basic characteristics of the cutting process in machining coatings are cutting force (components and specific cutting resistance) and the temperature of the cutting. Cutting force and cutting temperature grow with increasing the cutting depth of the layer displacement, the absolute value of a negative angle of the forehead and the hardness of the coating. Cutting speed has a significant influence on the cutting temperature. In addition, cutting force and cutting temperature also affect other properties of the coating (e.g. thermal conductivity), and other machining conditions (cooling, lubrication, etc.). Cutting force has components, which tend to rip lamella coatings from each other or the entire coating from the base. This is true for almost all modes of machining.

Adhesion of coating to the substrate is about ten times lower when compared with the strength of the compact material, and therefore the application of the same machining conditions suitable for compact materials usually leads to success in machining coatings.

Successful machining of plasma spraying coatings primarily depends on:

- the coating material, its structure and physicochemical properties,
- the selection of the way and conditions of machining.

Size of cutting forces and temperature can influence particular choice of cutting ratios (cutting speeds, feed and depth of cutting layer). In their determination, we must take into account the restrictions on the exercise machine, the required durability of the instrument, the required surface roughness and adjustable levels of cutting conditions for the machine. As it is the same group of variable cutting conditions, the determination of the cutting ratios has to be considered as an optimisation issue.

Current plasma spraying coating thicknesses are about 0.6 mm in the light of the necessary layer collected. Considering the functional coating thickness 0.3 mm, total machining allowance is approximately 0.3 mm.

Grinding of plasma sprayed coatings

Ceramic coatings can be machined by super-hard cutting materials such as corundum Al_2O_3, SiC carbon corundum, $_{kub}C$ diamond and cubic boron nitride $_{kub}NB$. These cutting materials are used for grinding tools; therefore, grinding is the main method of machining of ceramic materials.

Grinding is characterized by removing small slits on the cut layer and a large (indefinite but limited) number of teeth in gear (grinding grains) with random geometry. Average value of the instrument´s orthogonal face angles is negative (around-30°). Furthermore, there is a high cutting speed resulting in high cutting temperature. Abrasive grains are gradually worn and abrasive wheel is filled with waste products of grinding which rises the cutting temperature and cutting force. Properties of grinding wheels and grinding conditions should be appropriately determined in order to avoid overheating of the surface layers of the coating, the emergence of crack, or peeling off. Grindstone is characterized by abrasives, abrasives texture, types of links (bonding materials), the hardness of the bonds, the structure (porosity), or impregnation of binder.

Basic recommendations for the choice are:

- Select an abrasive material with low wear rate, is easy to chop and restore cutting edge (diamond, cubic boron nitride, silicon carbide)
- Select granularity according to the type of operation (bigger grain size for roughing and smaller grain size for finishing)
- Hardness of the bonds must ensure release of blunted grains from the grinding disc. Therefore, select soft disks (hardness bond marked J and K)

Metal binding is suitable for diamond grinding wheels for roughing, and bitumen binding for finishing.

Cutting rates should be in the following limits: Depth of the cutting layer should be in the range from 0.002 to 0.02 mm (larger for roughing, smaller for finishing). The feed rate of workpiece should be in the range from 80 to 300 $mm.min^{-1}$. Peripheral speed of grinding disc (cutting speed) should be in the range 15-35 ms-1, while rather lower rates are recommended.

Due to the existence of pores in the coating, the grinded surface is more opaque when compared to the grinded surface of the steel. When grinding, it is recommended to use suitable cooling fluid of 3 to 5% solution of H emulsion.

Mathematical model of experiment

A study of parameter grinded surface coat´s will arithmetic mean deviation of assessed profile Ra. Regarding the circumferential speed of workpiece v_0, feed rate of workpiece v_f and depth of cut, etc., dependence of power type can be assumed

$$Ra = C_{Ra} \cdot v_0^{C_1} \cdot v_f^{C_2} \cdot a_p^{C_3}, \tag{1}$$

which is transformed to a linear formula

$$\log Ra = \log C_{Ra} + c_1 \log v_0 + c_2 \log v_f + c_3 \log a_p, \tag{2}$$

which can be presented as the following linear mathematical model of shape

$$y = b_0 + b_1x_1 + b_2x_2 + b_3x_3 \tag{3}$$

and if x0 = 1, we get

$$y = b_0x_0 + b_1x_1 + b_2x_2 + b_3x_3 \quad . \tag{4}$$

The challenge is to determine the coefficients b_0, b_1, b_2, b_3. This must be ascertained experimentally, for example method of planning experiments. The above mentioned variables v_0, v_f, etc. are called the natural factors and variables x_0, x_1, x_2, x_3 are called coded factors. The natural factors determine the upper, lower and middle level setting values for the experiments, ie v0max, v_{0min}, v_{0str}, v_{fmax}, v_{fmin}, v_{fstr}, a_{pmax}, a_{pmin}, a_{pstr}, and transformation

$$x_1 = \frac{2(\log v_0 - \log v_{0\max})}{\log v_{0\max} - \log v_{0\min}} + 1 \tag{5}$$

$$x_2 = \frac{2(\log v_f - \log v_{f\max})}{\log v_{f\max} - \log v_{f\min}} + 1 \tag{6}$$

$$x_3 = \frac{2(\log a_p - \log a_{p\max})}{\log a_{p\max} - \log a_{p\min}} + 1 \tag{7}$$

the received upper, lower and middle levels of the coded factors x1, x2, x3 in the values 1, -1, 0, although fictitious factor x0 is a constant value 1^{st}.

Plan of experiments for the linear model can be illustrated by Fig. 1.

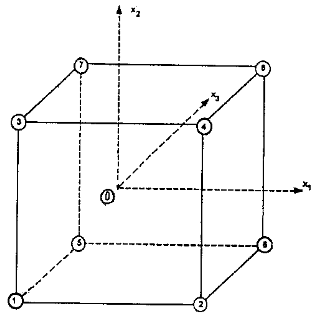

Fig. 1 *Model plan of experiments*

where the set values for the experiment is shown at the top of the cube. Peaks can be numbered as paragraphs 1 to 8, e.g. for point 1, set in the experiment values v0min, v_{fmin}, a_{pmin} for Item 4, set in the experiment values v0max, v_{fmax}, a_{pmin}. Point 0 is at the centre of the plan and shall be subject to the set value v_{0str}, v_{fstr}, a_{pstr}. We developed a matrix plan of experiments using the following Table 1.

Table 1

Point of plan i	v_0	v_f	a_p	x_0	x_1	x_2	x_3	y_i **log Ra**	x_{1i},y_i	x_{2i},y_i	x_{3i},y_i
1	v_{0min}	v_{fmin}	a_{pmin}	+1	-1	-1	-1	y_1	$-y_1$	$-y_1$	$-y_1$
2	v_{0max}	v_{fmin}	a_{pmin}	+1	+1	-1	-1	y_2	$+y_2$	$-y_2$	$-y_2$
3	v_{0min}	v_{fmax}	a_{pmin}	+1	-1	+1	-1	y_3	$-y_3$	$+y_3$	$-y_3$
4	v_{0max}	v_{fmax}	a_{pmin}	+1	+1	+1	-1	y_4	$+y_4$	$+y_4$	$-y_4$
5	v_{0min}	v_{fmin}	a_{pmax}	+1	-1	-1	+1	y_5	$-y_5$	$-y_5$	$+y_5$
6	v_{0max}	v_{fmin}	a_{pmax}	+1	+1	-1	+1	y_6	$+y_6$	$-y_6$	$+y_6$
7	v_{0min}	v_{fmax}	a_{pmax}	+1	-1	+1	+1	y_7	$-y_7$	$+y_7$	$+y_7$
8	v_{0max}	v_{fmax}	a_{pmax}	+1	+1	+1	+1	y_8	$+y_8$	$+y_8$	$+y_8$
$\sum = 8$				8	0	0	0	$\sum y_i$	$\sum x_{1i}y_i$	$\sum x_{2i}y_i$	$\sum x_{3i}y_i$

i = 1 to 8, N = 8 (the number of points)

then the coefficients will be:

$$b_0 = \frac{1}{N}\sum x_{0i} y_i = \frac{1}{N}\sum y_i \, , \tag{8}$$

$$b_1 = \frac{1}{N}\sum x_{1i} y_i \, , \tag{9}$$

$$b_2 = \frac{1}{N}\sum x_{2i} y_i \, , \tag{10}$$

$$b_3 = \frac{1}{N}\sum x_{3i} y_i \, . \tag{11}$$

Obtaining the coefficients b_0, b_1, b_2, b_3, and their substitution into (3), which also represents the transformation relations (5), (6), (7) we receive a specific formula (2) and its specific antilogarithm formula (1) for our experiments.

Place of formula (1), which is dimensional non-homogeneous, we can use dimensional homogeneous shape of the equation:

$$Ra = C'_{Ra} \cdot \left(\frac{v_0}{v_{0str}}\right)^{C_1} \cdot \left(\frac{v_f}{v_{fstr}}\right)^{C_2} \cdot \left(\frac{a_p}{a_{pstr}}\right)^{C} \, , \tag{12}$$

here we need to consider the following transformation relations

$$x_1 = \frac{2\left(\log\frac{v_0}{v_{0str}} - \log\frac{v_{0max}}{v_{0str}}\right)}{\log\frac{v_{0max}}{v_{0str}} - \log\frac{v_{0min}}{v_{0str}}} + 1 \, , \tag{13}$$

$$x_2 = \frac{2\left(\log\frac{v_f}{v_{fstr}} - \log\frac{v_{f\,max}}{v_{fstr}}\right)}{\log\frac{v_{f\,max}}{v_{fstr}} - \log\frac{v_{f\,min}}{v_{fstr}}} + 1, \tag{14}$$

$$x_3 = \frac{2\left(\log\frac{a_p}{a_{pstr}} - \log\frac{a_{p\,max}}{a_{pstr}}\right)}{\log\frac{a_{p\,max}}{a_{pstr}} - \log\frac{a_{p\,min}}{a_{pstr}}} + 1 \tag{15}$$

then in Table 1 for values v_0, v_f, then is needed to used denominators v_{0str}, v_{fstr}, a_{pstr}. Calculation of the coefficients b_0, b_1, b_2, b_3, however, will be under (8), (9), (10), (11). Equations (1) and (12) have different constants C_{Ra} and C'_{Ra}.

Eventually we can use standard equation for calculating the physical quantities of Ra, depending on the variables X_1, X_2, X_3, instead of equation (1):

$$Ra = K \cdot X_1^{e_1} \cdot X_2^{e_2} \cdot X_3^{e_3} \ldots\ , \tag{16}$$

where K is a numerical constant dependent on the choice of X_1, X_2, X_3. . . relevant variables, and e_1, e_2, e_3. . . the numerical exponent (integer or fragments).

Then a system of physical units has to be specified so that each relevant variable has a physical dimension. Units can be selected with respect to SI. Then exponents e_1, e_2, e_3. . . should be taken so as the monitored variable gets the dimension with respect to SI. These requirements are rather due to the fact that it is recommended to use the SI, and not because it is the only way possible.

Further on, the procedure well known from the matrix calculus can be used. We can proceed as follows:

- Construct the dimensional matrix so that we will enter the dimensions (length L, mass M, time T, the temperature θ) into the heading of matrix lines, while we will write involved values into the headings of matrix columns.
- The acquired dimensional matrix can be divided into two sub-matrices from the top so that the first sub-matrix (the upper one) will be square and called a basic dimensional matrix P. The other sub-matrix is called an additional dimensional matrix Q. Basic dimensional matrix must be regular (with non-zero determinant), if not, the regularity can be achieved so that one line is replaced by another line of sub-matrix Q. -
- Determine the basic rank-dimensional matrix P.
- According to Buckingham Theorem, dimensional equation with values of X_i:

$$\varphi(X_1, X_2, X_3 \ldots X_n) = 0\,, \tag{17}$$

can be transferred to the formula with non-dimensional parameters π_i:

$$\psi(\pi_1, \pi_2, \pi_3 \ldots \pi_m) = 0\ , \tag{18}$$

then it is always m <n:

$$m = n - r\,, \tag{19}$$

where r is the rank of the matrix p.

- According to the rules of matrix number, we will find the inverse matrix P 'to matrix P, then we will find the coefficient of matrices QP', then we determine the matrix-QP' to matrix QP,' and after that we will attach a unit matrix Ito the system, obtaining thus the matrix E, which is the exponent matrix of the variables e_{ij} for individual π - parameters.

$$\pi_i = X_1^{e_{i1}} \cdot X_2^{e_{i2}} \cdot X_3^{e_{i3}} ... X_n^{e_{in}} \tag{20}$$

Formulas (5) for individual π – parameters are called primary definition formulas.

- Then write so-called “criterial equation”:

$$\pi_0 = \pi_1^{u_1} \cdot \pi_2^{u_2} \cdot \pi_3^{u_3} ... \pi_m^{u_m}\,, \tag{21}$$

where π_0 and u_i are constants to be determined.

- Finally, from criterial equation, we eliminate the searched value, thus getting so called fundamental equation, for example in the form

$$Ra = k \cdot a_p \left(\frac{v_f}{v_0} \right)^e, \tag{22}$$

where vf is the feed rate of the workpiece.

Experimental conditions and results of grinding of ceramic coatings

BUA 16 grinder which had two C 49 80 K 9V and D63/50 K100 B III grinding discs was used for grinding. A modified lathe SV 18 R with abrasive (polishing) Al2O3 grain belts of 120 and 400 (fine) and SiC particle size 240 (rather fine) was used for polishing. Corundum grains (Al_2O_3) size 40, 63, 100 (coarse and fine) were used for blasting.

To detect the surface roughness, Surtronic the 3 + (Rank Taylor Hobson Ltd.) was used.

Grinding conditions were for grinding with grinding disc of silicium carbide as follows:
- Cutting speed (circumferential speed of grinding wheels) v_c = 30 m / s
- Circumferential speed of workpiece = 20 m / min
- Longitudinal feed f = 4.5 mm
- Depth of cutting layer a_p = 0.005 mm

Grinding conditions for grinding diamond grinding wheels were as follows:
- Cutting speed (circumferential speed of grinding wheels) v_c = 30 m / s
- Circumferential speed of workpiece = 20 m / min
- Longitudinal displacement f = 4.5 mm
- Depth of cutting layer a_p = 0.01 mm

Conditions of polishing with the above-mentioned abrasive belts were as follows:
- Polishing speed v = 11.3 m / s
- Longitudinal feed with hand

For a method of planned experiments on grinding dia-disc D 107 C 100 B VII (thicker size, mean concentrations and harder of phenol-formaldehyde bonding) conditions were:

- v_c = 30 m / s
- v_{0min} = 17.59 m / min
- v_{0max} = 35.18 m / min
- v_{fmin} = 750 mm / min
- v_{fmax} = 1500 mm / min
- a_{pmi}n = 0.02 mm
- a_{pmax} = 0.04 mm
- v_{0str} = 25.13 m / min
- v_{fstr} = 1000 mm / min (F_{STR} = 5 mm, $n_{w\,str}$ = 200 min-1)
- $v_f = f.n_w$
- a_{pstr} = 0.025 mm

where n_w is the frequency of rotation of the workpiece.

Results obtained were as follows:

- Arithmetic mean deviation of assessed profile Ra on the basis of AlCu4Mg after spraying plasma showed values of roughness Ra 5.01 ± 0.29 μm
- Interlayer NiAl (0.055 mm) after spraying plasma showed values of roughness Ra = 6.15 ± 0.9 μm
- Ceramic coating Al_2O_3 + 13% TiO_2 (0.5 mm) after spraying plasma showed values of roughness Ra = 3.16 ± 0.29 μm
- Ceramic coating Al_2O_3 + 13% TiO_2 after buffing wheel siliciumcarbid showed values of roughness Ra = 0.83 ± 0.22 μm
- Ceramic coating Al_2O_3 + 13% TiO_2 after diamond grinding wheel showed values of roughness Ra = 0.82 ± 0.23 μm
- Ceramic coating Al_2O_3 + 13% TiO_2 after abrasive belt (which was polished) with Al_2O_3 grains size 120 and 400 showed values of roughness Ra = 1.67 ± 0.46 μm
- Ceramic coating Al_2O_3 + 13% TiO_2 after abrasive belt (which was polished) with Al_2O_3 and SiC grains 120 grain 240 showed values of roughness Ra = 1.23 ± 0.51 μm.
- A method of planning experiments at grinding with by diamond grinding wheel, we found dependence (for Ra_i = 0.9, 0.95, 0.96, 1.00, 1.00, 1.06, 1.17, 1.52 mm)

$$Ra = 0,37 \cdot v_0^{0,15} \cdot v_f^{0,23} \cdot a_p^{0,29} \qquad [\mu m]\,, \tag{23}$$

$$\text{resp. } Ra = 1,02 \cdot \left(\frac{v_0}{25,13}\right)^{0,15} \cdot \left(\frac{v_f}{1000}\right)^{0,23} \cdot \left(\frac{a_p}{0,025}\right)^{0,29} \quad [\mu m] \tag{24}$$

and also

$$Ra = 0,37 \cdot v_0^{0,15} \cdot f^{\,0,23} \cdot n_w^{0,23} \cdot a_p^{0,29} \qquad [\mu m] \tag{25}$$

$$Ra = 1,02 \cdot \left(\frac{v_0}{25,13}\right)^{0,15} \cdot \left(\frac{f}{5}\right)^{0,23} \cdot \left(\frac{n_w}{200}\right)^{0,23} \cdot \left(\frac{a_p}{0,025}\right)^{0,29} \quad [\mu m] \tag{26}$$

if h_{eq} is equivalent thickness of chips and formula as follow (for external grinding to round)

$$h_{eq} = \frac{v_0 \cdot f \cdot a_p}{60 \cdot v_c \cdot b_s} = \frac{v_0 \cdot v_f \cdot a_p}{60 \cdot v_c \cdot n_w \cdot b_s} \quad [mm] \tag{28}$$

b_s is the width of grinding disc [mm] .

Discussion

We have not found the formulas for grinding of coatings similar to ours (formula 23 to 28) in the professional literature, Similar relations are known for grinding the compact materials. Maslov [9] found the relationship:

$$Ra = \left(490 \cdot v_c^{-0,97} \cdot d_w^{-0,15} \cdot b_s^{-0,15}\right) \cdot a_p^{0,56} \cdot f^{\,0,75} \cdot v_0^{0,68} \qquad [\mu m] \ . \tag{29}$$

The term in parentheses is based on the variability of the cutting speed v_c, workpiece diameters d_w and width (thickness) grinding disc b_s, and f is axial displacement. When considering the frequency of rotation of the workpiece nw, the relationship (41) can be rewritten using the formula

$$Ra = \left(490 \cdot v_c^{-0,97} \cdot d_w^{-0,15} \cdot b_s^{-0,15} \cdot n_w^{-,075}\right) \cdot a_p^{0,56} \cdot v_f^{\,0,75} \cdot v_0^{0,68} \qquad [\mu m] \ , \tag{30}$$

while the expression in brackets is replaced by the constants in our formula (23) to (28). Formula (29) resulted from the experiments. In larger scale experiments, more values can be considered, however in equation (29) they are taken into account by the constant 490. These values can be: the coefficient of rigidity of grinding machine tool and tool holder, the coefficient of the properties of grinding wheel (multiplication of abrasive coefficient, binding type coefficient, binding hardness coefficient, binding impregnation coefficient, granularity coefficient and coefficient of porosity of grinding wheel), the coefficient of cutting fluid properties, the coefficient of grinding time (number of strokes) and the coefficient of spark-out time (number of spark-out strokes).

Values of exponents of cutting conditions' parameters are more interesting than the above mentioned constant. Formula (29) also says that roughness of grinded surface is affected mostly by feed velocity (in axial direction), and then by tip velocity of work piece, and finally by the depth of the cut (stroke, feed, etc.). However, experiments brought the following rate: depth of cut, feed velocity and at least tip velocity. This can be justified as follows:

When grinding very hard materials (including coatings), grinding wheel is markedly worn, the rate material removal declines and more material is pushed away. Feed and particularly infeed (stroke, depth of cut) can be used to overcome the deformation forces by cutting forces. Infeed can therefore substantially influence the material removal rates and also roughness of the grinded surface.

Conclusion

The achieved results can be taken into account for coatings' machinability, also called micro-machinability. At present, it can be considered as absolute micro-machinability according to the achieved surface roughness (absolute micro-geometric micro-machinability), because we did not define standard conditions including standard instrument, and so we could not yet determine the relative machinability achieved by buffing the surface roughness (relative micro-geometric micro-machinability grinding). If machinability by grinding we called grindibility, we could talk about the absolute or relative micro-geometric micro-grindibility.

Ceramic and hard metal coatings obtained by plasma spraying exhibit high roughness, porosity, and indeed cannot always meet the requirements of the manufacturer on the quality of the surface. It must therefore be carefully grinded to avoid overheating of the surface layer coating (may cause cracks) and possibly to avoid possible peel off coating from the substrate and to prevent the deterioration of the bearing curve profile, which should result in a decrease in carrying capacity of the surface coating, increased friction and wear in the possible exploitation of a coated part.

Acknowledgements

The authors thank the grant agency **VEGA for supporting the grant No. 1/4111/07 "Implantation of differential and other mathematical methods in the analytical theory of machining,"** within which the contribution was prepared.

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