The Study of the Flat Grinding Process of Workpieces of Composite Materials

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Abstract. The paper shows the results of the carried out examination of the grit of the processed surface and the intensiveness of the flat grinding of workpieces of composite materials. The processing has been carried out using of a special grinding tool with anti-frictional fillers produced in accordance with the microwave technology. The grit and components of grinding forces of workpieces of aluminomatrix composite materials with various carbon contents have been determined.

1 Introduction

Now that science and technology have caught on, requirements applied to structural materials become tougher. Specifically, new composite materials with lower density, able to retain their physical and mechanical properties at elevated temperatures, are sought-after in many industrial fields [1-4]. Heat-treated composite materials, resulting from aluminum carbon mechanical alloying, find ever-growing use in the aerospace field, machine engineering, energetics, medicine [5-9]. With the appearance of new materials the world faced with the issue to develop the best available technologies of their mechanical processing.

When flat grinding of metalocomposites, particularly carbon-alloyed aluminomatrix composite materials, additional requirements are specified for the equipment and tools related to providing of the minimum radial run-out of the working surface of the wheel and the minimum clogging level of the grinding tool. It is possible to achieve the desired result by using of the special grinding tool with anti-frictional fillers produced in accordance with the microwave technology providing the good health of the grinding tool [10-14]. This paper shows some results of the experimental study of the health of grinding wheels on a bakelite bunch with graphite fillers and bakelized in the microwave field when flat grinding of workpieces of carbon-alloyed aluminomatrix composite materials.

2 Materials

To obtain experimental specimens of the composite material, the following basic materials have been used: the primary dispersed aluminum powder PAD-1 (STO22436138-006-

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2006), the technical carbon powder K 354 (GOST 7885). The aluminum powder has been primarily passed through a 30- μ screen. The amorphous carbon granulated powder has been originally grinded in the mechanical reactor (MR) during 10 minutes to destroy pellets and agglomerations. The alloying process has been carried out in MR. The carbon content in the mixture has been 3, 4 and 5 % by mass [15-17].

The obtained composite granule mixture has been cold-compacted under the pressure of 600 MPa to the density 2,4 g/cm³. Specimens have been heat-treated in the argon medium at exposure of 5 hours under the temperature 530 °C. An X-ray phased and structural analysis has been carried out with the aid of the diffractometer DRON-3M in Cu-radiation. The coherent scattering area (CSA) dimensions have been evaluated by diffraction line broadening. The CSA dimension has been identified with the average crystallite dimension D. In this case, the CSA dimension is somewhat lower than the same value obtained with the help of electronic microscopy, since the CSA reflects the inner (ordered) crystallite area which excludes highly distorted boundaries [18-20]. Formulation and concentration growth of aluminum carbide hardening dispersoids have been assessed by formation and densification of diffraction lines. The microhardness has been measured with the help of the durometer type Tukon 1102 Micro Vickers (Vickers technique) under the indenter load 100 g and the exposure time 10 s (Table 1).

Table 1. Parameters of CM specimens for tests.

Designation	Carbon content, %	Microhardness, MPa	Crystallite dimension, nm
AMK-3	3	65	51
AMK-4	4	89	44
AMK-5	5	103	40

3 Research technique

Comparative technological tests have been carried out using of the experimental installation mounted on the basis of the flat grinding machine (mod. 3E711BΦ2). The automated working station has been created for measuring of force components and the average contact temperature. This automated working station gives an opportunity to tune settings of test scenarios, to store and to search for a relevant scenario in the database, to carry out the cut-through calibration of measuring channels, a real-time measuring with simultaneous archiving and visualizing of test data, to look through and to analyze the results. Grinding wheels (GW) on a bakelite bunch 1–300’40’76’ 14A50C15B with a graphite filler 4 % (of weight) have been used as grinding tools. Their semi-finished products have been heat-treated (bakelized) in the microwave field using of the original experimental and industrial microwave installation.

The hardness of GW has been controlled by the acoustic method using of the device «Zvuk–203M». The mechanical performance of wheels has been tested at the stand «SIP-800». Tests have been carried out on prismatic specimens with the length of 45 mm and the section of 15 × 15. Specimens have been produced of the one batch of materials with the hardness diffusion not exceeding of ± 4 %. Before beginning of each series of tests the batch of specimens have been grinded to one and the same size with the 7th tolerance grade and the grit Ra ≤ 1,6 μ m.

4 Study results

After finishing of the calibration of the dynamometer, grit tests of the processed surface and intensiveness tests of the flat grinding of workpieces of aluminomatrix composite materials with various carbon content, produced using of the mechanical alloying method, have been carried out. Test results are shown in the Table 2 and the Table 3.

Table 2. Values of force components when grinding of different marks of composite materials.

№ of test	Designation of the composite material					
	AMK-3		AMK-4		AMK-5	
	Grinding force components, H					
	P_y	P_z	P_y	P_z	P_y	P_z
1	11,8	8,2	13,4	9,6	14,9	10,8
2	12,4	8,5	13,9	9,3	14,7	11,1
3	11,5	8,4	13,1	9,9	15,5	10,7

Table 3. Values of the arithmetical mean deviation of the profile Ra of specimens of composite materials after the flat grinding operation.

№ of test	Designation of the composite material		
	AMK-3	AMK-4	AMK-5
1	1,34	1,1	0,9
2	1,39	1,21	0,84
3	1,31	1,08	0,83

5 Conclusions

The carried out tests justified the application efficiency of the special grinding tool with anti-frictional fillers produced in accordance with the microwave technology when processing of carbon-alloyed aluminomatrix composite materials. Application of the special grinding tool has given an opportunity to extend by 1,8 times the health of the tool and to reduce the grit of the processed surface. It has been made clear that increasing of the carbon content in the processed specimens leads to the increase in grinding forces. The longest health of the tool has been noted when processing of specimens with the maximum carbon content. The grit of the processed surface is slightly reduced with the increase in the carbon content in the processed specimens. This can be explained with the increased microhardness of specimens and the decreased health of the wheel.

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