D. DOBROTĂ, C. IANCU

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RESEARCHES REGARDING STRUCTURAL MODIFICATIONS THAT APPEARS IN THE MATERIAL OF TOOLS USED FOR RUBBER WASTE ATTRITION

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Tools commonly used for shredding rubber waste, currently produced, are made of neatly cast iron in the composite is to avoid the presence of sulfur and phosphorus. In this paper are presented the main structural material changes that occur in different areas, located at different distances from the active surface of tools. Structural changes occurred mainly refers to the transformation of white iron surface layer to gray cast iron and graphite separations appearance, which causes the crack primers and cracking corrosion phenomena in tools material.

Key words: tools, corrosion, wear, rubber waste, attrition

INTRODUCTION

Recycling and recovery of waste rubber is a process imperative and extremely complex, making, as currently, that a small amount of rubber is to be reused in another type of new product [1]. One very important operations necessary for the recycling of waste rubber is represented by shredding them [2]. Tools used to grinding waste rubber are ribbed cylinder type, provided with helical grooves. Cylinders are constructed so that it can be cooled in accordance with the requirements of the technological process.

Cylinders are generally obtained by casting and full tab metal cylinder is placed in plaster, so the quick cool ensures formation of a surface layer of a high hardness. Surface layer thickness made so is about 15÷18 / mm. Spindles and parts crossing should not be hardened.

Tools used in the process of grinding waste rubber are required to cyclic fatigue, but they work also to in a chemically aggressive environment. Aggressiveness working environment of these tools can be explained by the presence in the chemical composition of waste rubber of various chemicals (especially sulfur). These chemicals, under certain conditions of pressure and temperature can form certain compounds that can be corrosive on metallic materials [3-5].

If you take into account that during the shred waste it is random efforts distribution, must be taken into account all possibilities of application [6-7].

Due to special complex requests of tools used for grinding scrap rubber, materials must satisfy certain requirements: work area for tools being subject to the friction with shred material and in contact with foreign objects must have their material characterized by a hardness values ranging from 330 to 340 / HB; for cooling tools to be made in optimum conditions it must that constituting material has a coefficient of heat transfer of high value, because the tools used for grinding scrap rubber are strongly requested to fatigue their material must meet these requirements too.

D. Dobrotă, C. Iancu, Engineering Faculty, "Constantin Brâncuşi" University of Târgu-Jiu, Romania

STUDY OF STRUCTURAL MODIFICATION

Usually cylinders are obtained now from neatly cast iron, which in the chemical composition is to avoid the presence of sulfur and phosphorus. Using these tools has been found that it has several types of wear, but most important is about the cracking wear and then break, that mainly determine the disposal of these tools.

Material existing in tools used in milling waste rubber is mainly cast iron. Cast iron is characterized by the presence of graphite and classified basic component in: ferritic, pearlitic or ferito-pearlitic, according to the percentage constituents present. After the shape, size and distribution of graphite, cast iron can be divided into: lamellar graphite cast iron, vernicular, distributed in nests, nodular, etc.

For an analysis of structural transformation of the tools material was necessary primarily a knowledge of the main types of structures that can occur in their material.

This used tools material structural analysis is done by four tests conducted in the area of rupture of a used cylinder. Sampling was done in the area of rupture of the cylinder because it was considered that in this place are the most important structural changes. Samples were taken from both cuts from broken tool.

Because on one of the pieces broken cracks were observed, in this area were taken 3 tests and from the other one, just a single sample. In terms of form of used

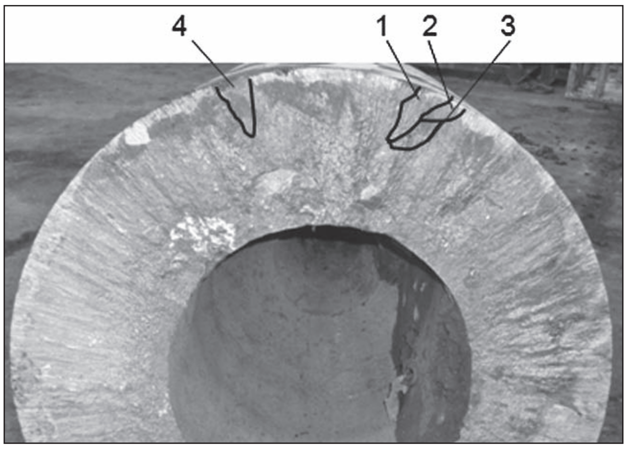

Figure 1 Worn tool and sampling areas

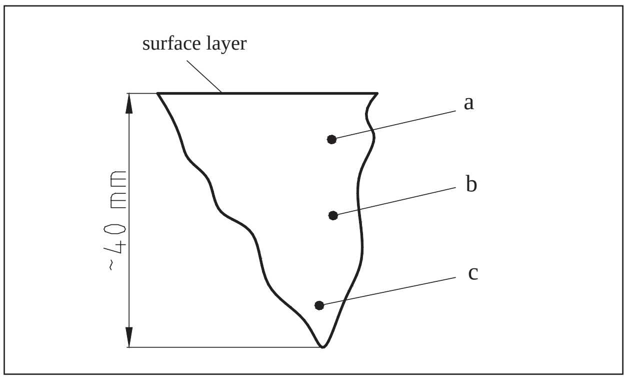

Figure 2 Form sample 1, a, b, c - points of performing the structural analysis

tool from which samples were taken and the sampling areas are shown in Figure 1. When sampling was taken has been considered that they belong to both the surface layer where there is white iron, and core tool, where gray iron can be found.

Form of no. 1 sample which was subjected to structural analysis is presented in Figure 2, and to achieve complete structural analysis of the test portion were observed images, on metallographic microscope, of the material structure at different points within a certain distance of the top layer.

Analysis corresponding to the three points will show three different microstructures presented in Figure 3 for point a, Figure 4 for the point b and Figure 5 for point c.

It was taken and another sample, 2, where small cracks were observed, and the form of sample 2 for which an analysis of structural changes was made, is presented in Figure 6.

Figure 3 White iron characteristic of surface layer, point a

Figure 4 White iron characteristic of surface layer with a tendency to shift to gray iron, point b

Figure 5 The transition zone from white to gray cast iron and gray cast iron, point c

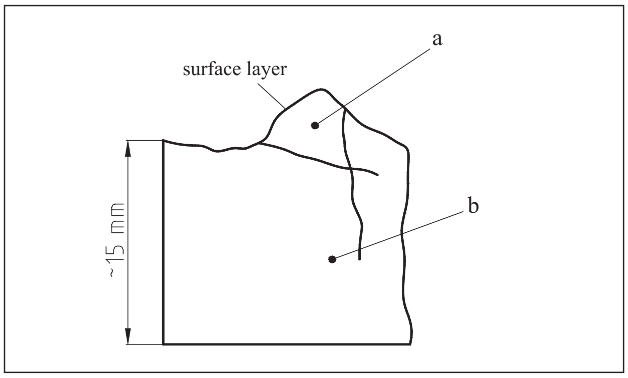

Figure 6 Sample form 2

Structural analysis of the sample number two will be made by metallographic microscope, by observation of material microstructure in two different points, (a) or (b).

Corresponding to the two points of analysis were obtained two different structures shown in Figure 7, for point a and Figure 8 for point b.

From structural analysis of sample 2 is observed that in the area where cracks appear is produced a transformation of gray cast iron white.

To analyze the structural changes for sample 3 is shown first in Figure 9 its form. Structural changes in the sample 3 are especially interesting because the position of which it is taken, namely that it is found in the

Figure 7 White iron with zone of its change to grey cast iron, point a

Figure 8 White and gray cast iron with highlighting in white to gray cast iron transformation, point b

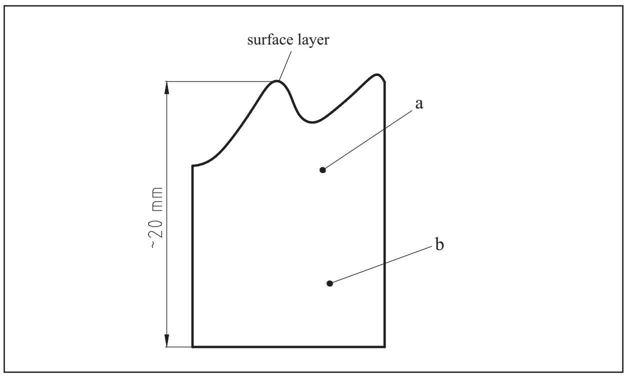

Figure 9 Form sample 3

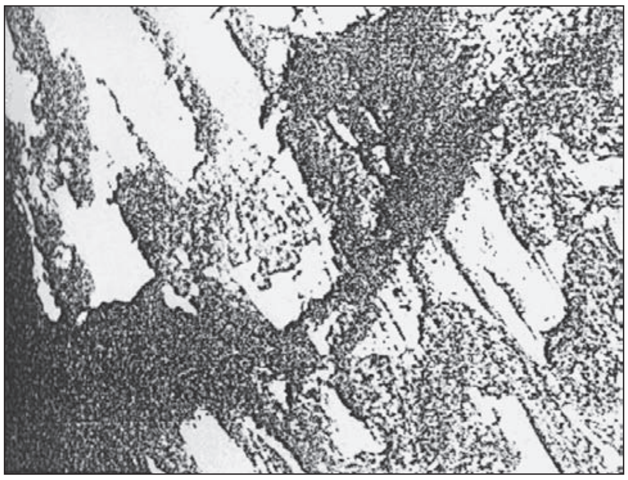

Figure 10 White and gray cast iron, respectively transformation areas in gray cast of white cast iron, point a

Figure 11 The transition zone from white to gray cast iron and gray iron modified structure, point b

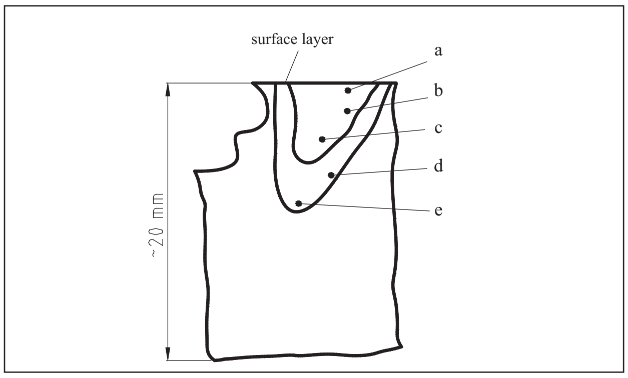

Figure 12 Sample form 4.

separate area of white cast iron and gray iron. Structural changes will be observed under the microscope in two distinct points of the sample. Corresponding two points in which the structural analysis is performed are presented in Figure 10 for the point a and Figure 11 for the point b.

Sample no. 4, Figure 12, was taken from another piece released from breaking tool (cylinder).

As shown in Figure 12 are present on the sample surface a series of cracks. Due to the fact that there appeared cracks, areas of structural analysis we have ranged from the surface layer to the last crack. Given that this area could give us very important information on structural changes, analysis was made for five points. Accordingly we have five different structures, shown in Figure 13 point a, Figure 14, point b, Figure 15, point c, Figure 16, point d and Figure 17, point e.

CONCLUSIONS

From structural analysis performed for different samples of used tools allows drawing the following conclusions:

- Heat gain in time produces in tools material a transformation of white iron from shallow layer in gray iron, and the transformation direction of white to gray cast iron is from the inside out.

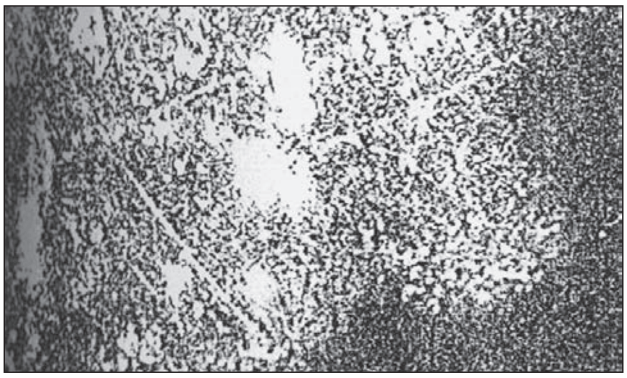

Figure 13 Pearlitic structure with an uneven distribution of ferrite and cementite

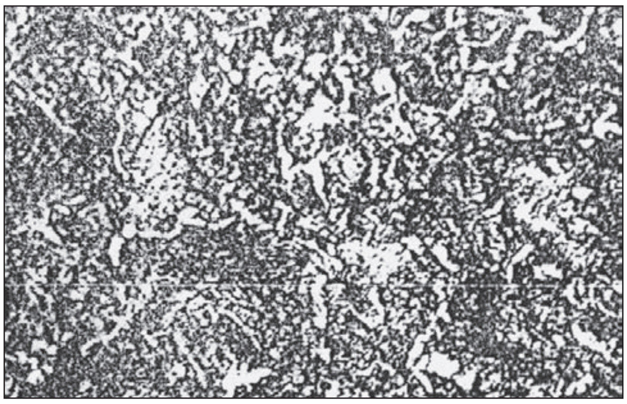

Figure 14 Pearlitic structure with a uniform distribution of ferrite and cementite

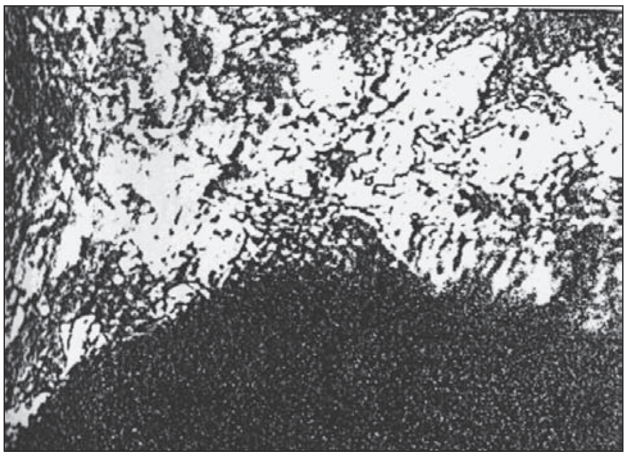

Figure 15 Perlito-ferritic structure highlighting areas of the ferrite and pearlite

- Presence of gray cast iron in the surface layer causes a deterioration of mechanical characteristics of the material constituting the cylinder, and separation of carbon graphite causes the crack and create conditions of developing corrosion cracking;
- Structural transformations occur due to heat released in the shredding of rubber, but also because of diffusion of sulfur from waste rubber material towards tools;

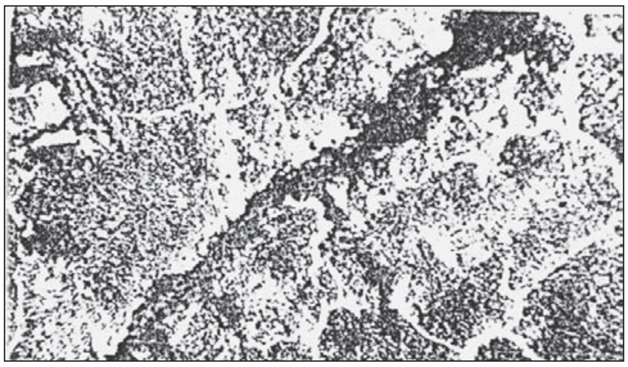

Figure 16 Crack results from the conversion of white iron to gray cast iron, and the pearlitic structure

Figure 17 Area of transition from gray cast iron to white iron

- To avoid structural changes are necessary following measures: implementation of appropriate heat treatment for cylinders material; using new materials that have a better behavior in exploitation; optimization of process parameters based on characteristics of the materials subject to shred.

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Note: The responsible translator for English language is S.C. PURTRAD S.R.L., Targu Jiu, Romania