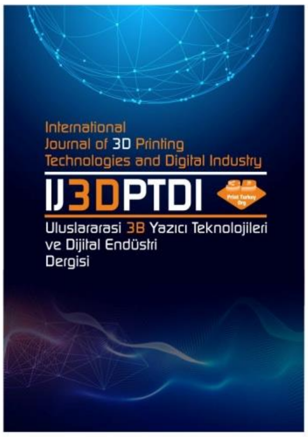

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ABSTRACT

It is possible to contribute to the economy at a remarkable level by extending the life of the cutting blades for rotary slashers with various heat treatment applications and manufacturing process. Extending the life of the cutting blades of rotary slashers will save material, energy, time and labor losses. In addition to those, the use of worn rotary slasher cutting blades will accelerate the uncut grass-plants and increase fuel consumption. In this study, the characterization of two different types of cutting blades for rotary slashers was carried out. Knowing mechanical properties and chemical composition of cutting blades discloses the information regarding how the blades are manufactured and react to forces applied in working conditions. Therefore, the prescription of manufacturing process can be easily identified and endurance & effectiveness of blades in operating conditions can be predicted. The cutting blades are the most replaced part and listed as one of the consumable parts since they are often broken, worn and bended. The chemical composition and structure of the metals, heat & manufacturing processes affect the wear, strength, hardness, and durability of the cutting blades. The samples were obtained from two different cutting blades using Laser Cutting Machine. Rockwell hardness test, SEM and Microscopic imaging were used to investigate mechanical and chemical composition of the materials. The results obtained from all analyses were used to optimize the manufacturing process.

Keywords: Rotary Slasher, Spring Steel, Hardness, SEM and Chemical Composition.

1. INTRODUCTION

Exposed to the most common high wear rate, the cutting blade for rotary slashers is one of the main parts. Determination of the wear loss of the slashers is necessary because it seriously affects the cutting quality, energy consumption and the production cost of agricultural products. The abrasion of the cutting tools depends upon the mechanical and microstructural properties of the material used for manufacturing cutter blades, grass/plant types, moisture content and the operation speeds such as rotation and forward for blades and vehicles, respectively. With the advanced tribology in agriculture, potential savings resulting from the reduction of friction and wear find huge amounts [1-5].

The longevity of the slashers' tools depends on the material abrasion resistance and strength, which is a factor that negatively affects the quality and efficiency of the machine parts. It is likely that the wear process of the cutting blades for rotary slashers depends mainly on the chemical composition, hardenability and heat treatment technologies of the materials used [6]. The aim of this study is to determine the relationship between the wear life of the cutting blades for rotary slashers produced from 55Cr3 steel and the material structure [7].
In addition to the mechanical and microstructural features of spring steels, surface faults such as cracks, scratches that may occur on the surface of the material during hot forming directly affect the fatigue performance of the produced part. Cracks occur on the material's surface during load changes and crack progresses during use and leads to breaks.

The paper investigated the power (Joule) consumption of the slasher with five cutter blades with different cutting angles at five different cutting speeds. [8]. The effect of heat treatment on the mechanical properties of medium carbon steel was examined. The medium carbon steel was heated to 900 °C and kept in the oven for 1 hour. The highest hardness sample was the quenched samples [9].

2. MATERIAL AND METHOD

2.1. Material

In this study, at 20x15x10 mm dimensions, 55Cr3 type steel was used. The spectral analysis was conducted and depicted in Table 1. Table 2 indicates the mechanical properties of 55Cr3 type steel. Sample has a thickness of 2.5 mm.

Table 1. Chemical composition of 55Cr3 steel [10].

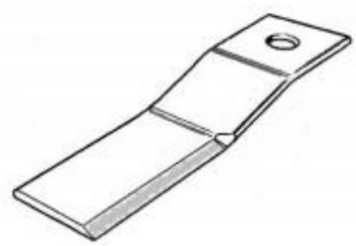
Type of Material	Fe	Mn	Cr	C	Si	P	S
55Cr3	97.27	0.90	0.85	0.55	0.38	0.025	0.025

Table 2. Mechanical properties of the investigated 55Cr3 steel [10].

Type of Material	Tensile strength (MPa)	Yield strength (MPa)	Young's modulus (GPa)
55Cr3	1600	1250	207

2.2 Test Procedure

A standard design of cutting blade for rotary slasher is depicted in Figure 1.a Cutting Blades for rotary slasher used for this experimental study are shown in Figure 1.b The samples (Figure 2) were obtained from two different cutting blades using Laser Cutting Machine.



a

b

Figure 1. A stepped design of cutting blade for rotary slasher (a), Cutting Blades for rotary slasher (b).

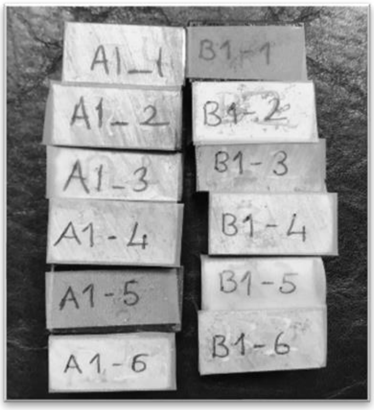


Figure 2. The samples obtained from cutting blades via Laser Cutting Machine.

In this study, annealing, quenching and tempering were applied as three types of heat treatment. In annealing process, the samples were heated at 900°C and hold in the furnace for 1 hour. The samples were then quenched in water and open air, respectively. The treatment was followed by tempering processes at 300°C, 450°C, and 600°C with a holding time of 2 hours for each temperature. After the heat treatment process completed, Rockwell hardness test were carried out.

Microstructure analysis such as SEM (Scanning Electron Microscope) and Optical Microscopy were performed. The results collected from the Rockwell hardness test and SEM analysis for the samples for both blade body and blade sharp side were compared and inspected.

3. RESULTS AND DISCUSSION

3.1 Hardness

Rockwell hardness is the hardness value that is measured by taking advantage of the depth of the track formed by a cone or ball shaped tip on a material under a certain load. It is defined as resistance to the indentation and the permanent depth of the indentation is determined by measuring. In Table 3, hardness test results of 55Cr3 material are presented. Hardness test of steel material (55Cr3) using 150 Kg load in hardness tester Rc hardness test was applied and 5 hardness values for each sample test was done and the values were averaged.

Table 3. Hardness test results.

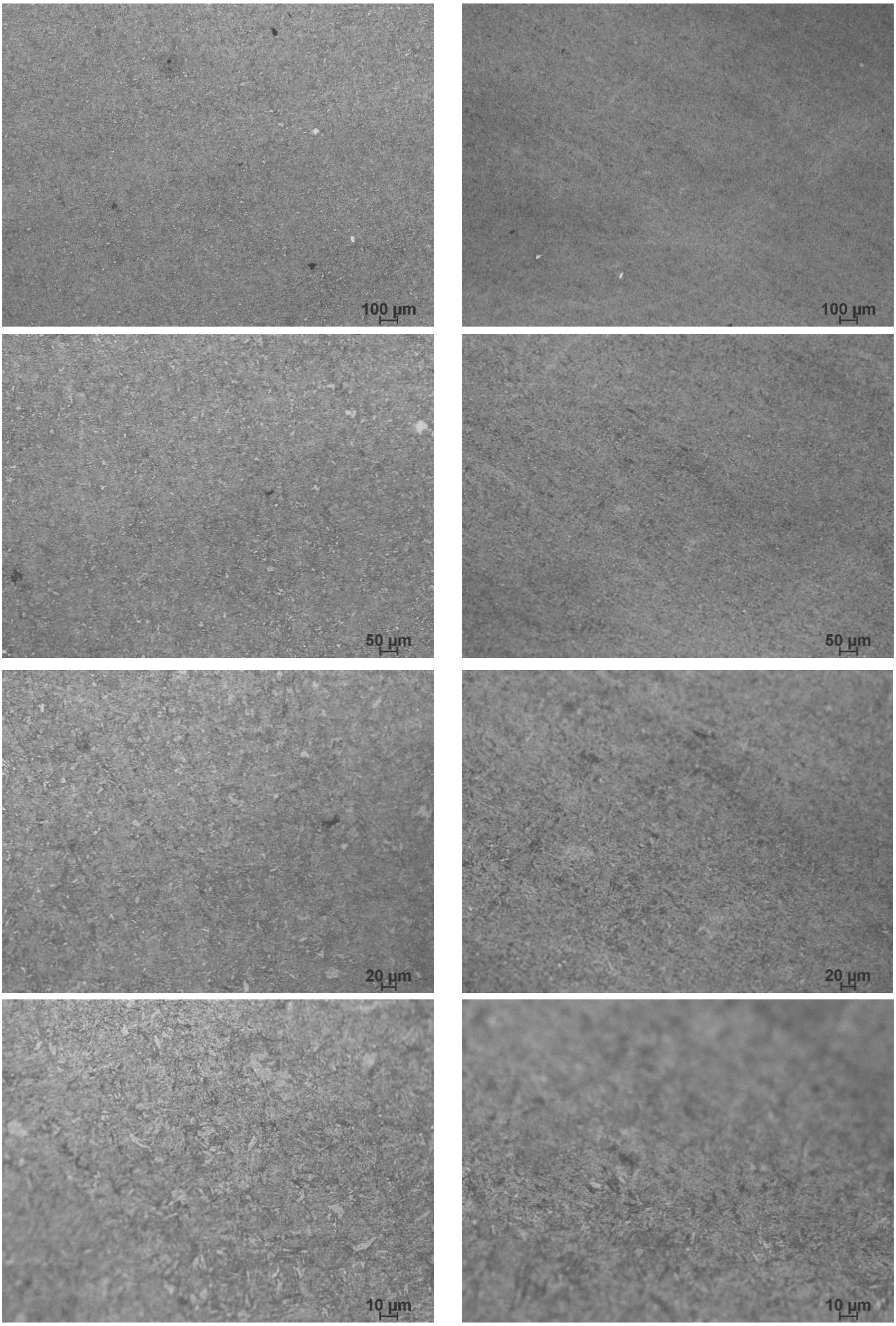
Measurement Region	Hardness
Blade Sharp Side	48.7
Blade Body	37.5

The hardness of the sharp side of the blade was higher than the blade body, so the blade absorbed impact energy during operation. Since the hardness values of the body of the blade's surfaces were almost the same, it could not absorb impact energy and broke when the blade encountered an impact during operation.

3.2 Microstructure

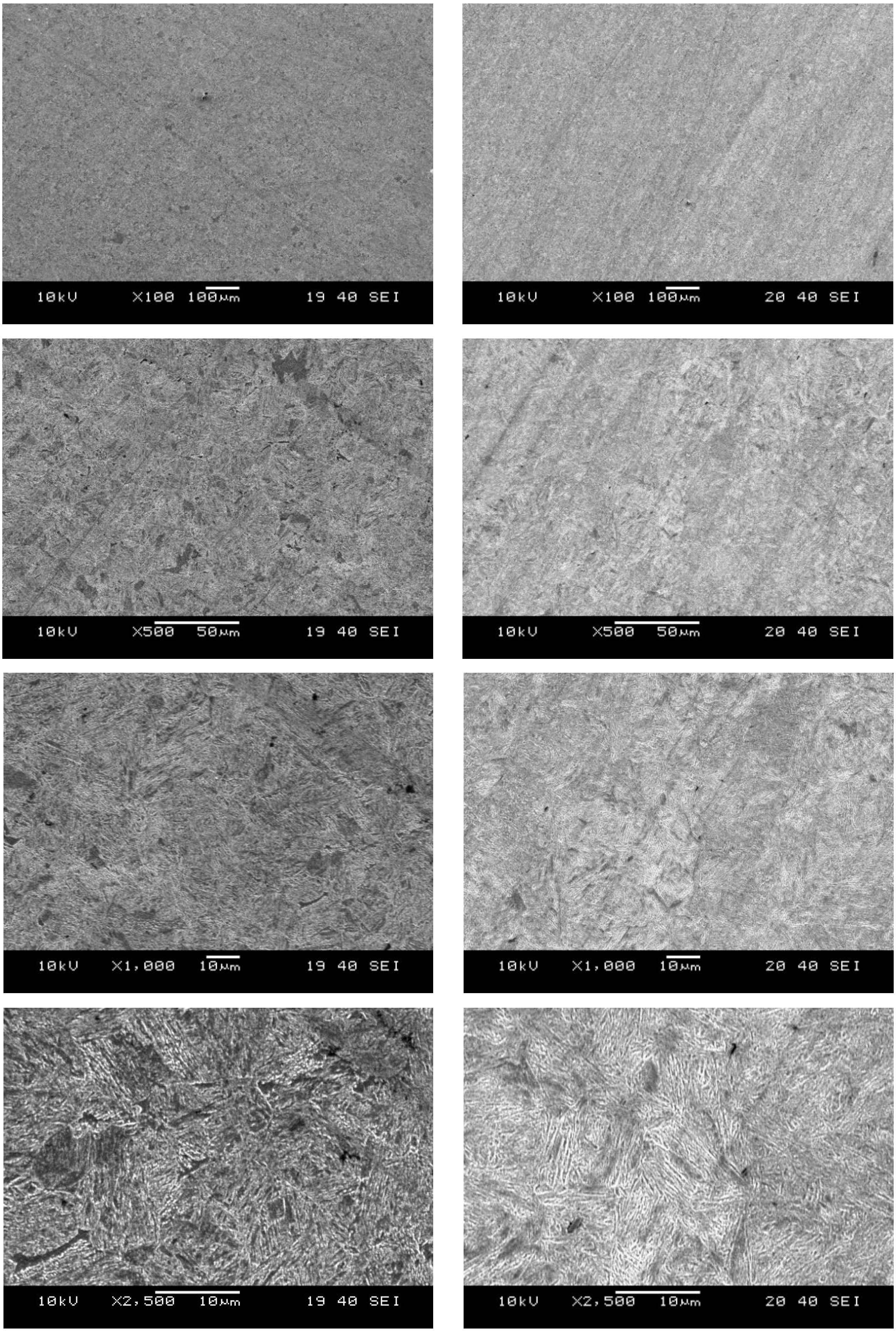
The microstructures of the specimens were studied using a Nikon MA100 inverted metallurgical microscope. SEM images of spring steel samples were also captured.

The optical microstructures were observed using an inverted metallurgical microscope. The optical microstructure (micrograph) of the 55Cr3 steel is shown in Figure 3. SEM images of the 55Cr3 steel showed that dislocation errors were more on the surface of blade body, due to hot forming (Figure 4).



Blade Body Blade Sharp Side

Figure 3. Microstructure of Spring Steel (Micrograph).



Blade Body Blade Sharp Side

Figure 4. Microstructure of Spring Steels (SEM Images).

4. CONCLUSION

The following results were obtained in this study;

- When the microstructure photos were examined, dislocation errors were more on the surface of blade body, due to hot forming. Intergranular fracture occurred and the surface had a bright appearance.
- Five (5) hardness values for each sample test was done and the values were averaged. Parallel to the results of the microstructure, the averaged hardness values which was 48.7HRC for blade sharp side and 37.5HRC for blade body some HRC value was reached by preserving its hardness as a result of removing the stresses in the material.
- The hardness of the sharp side of the blade was higher than the blade body, so the blade absorbed impact energy during operation. Since the hardness values of the body of the blade's surfaces were almost the same, it could not absorb impact energy and broke when the blade encountered an impact during operation.

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