THE EFFECTS OF PHOSPHATE CRYSTALS AND MICROSTRUCTURES IN VARIOUS SIZES ONTO THE COATING WEIGHT AND THE PRESSING-MOUNTING OPERATIONS

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Abstract - In this study, 4 microstructures in different types are obtained by forming phosphate crystals in different dimensions and microstructures during zinc phosphate coating operation performed onto the semi-finished product of C45Pb made of steel for increasing the corrosion resistance of it. Also, 2 microstructures in different types are obtained by forming phosphate crystals in different dimensions and microstructures on the semi-finished product of 11SMnPb30 made of steel, too. Here, the effects of these phosphate crystals in different dimensions and microstructures onto both the coating weight and the 8 distinct pressing-mounting combinations that will be applied on them are examined.

Index Terms - Zinc phosphate coating, phosphate crystals, Coating weight, Microstructure, Pressing, Mounting

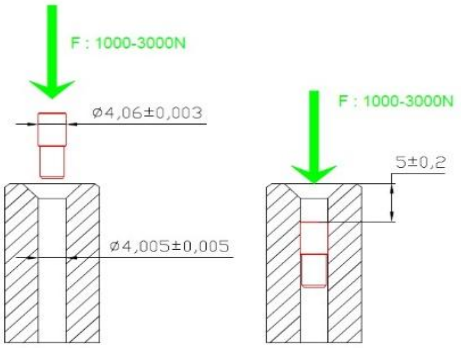
I. INTRODUCTION

C45 Pb is one of the popular steel types that are frequently used in machining sector. Thanks to its suitable mechanical structure and hardenability, it is used in many industrial applications. However, its weak resistance against corrosion is a serious problem which effects its resistance against oxidation and decreases its lifetime. Formation of both corrosion and oxidation on the steel is prevented by coating it with zinc phosphate. The zinc phosphate coating operation is also applied onto the outer hood steel sheets of vehicles. This application prevents the oxidation of steel hood surface during the time until painting operation. Besides, the phosphate layer of 1-1.5 micron formed on the steel sheet surface provides the better application of paint onto the surface. At the same time, it prevents formation of corrosion under the paint layer when the paint film is broken or stripped because of any reason. Our study, the semi-finished product manufactured for increasing its corrosion resistance is coated by applying onto it zinc phosphate coating process.

The suitable microstructure criteria for the semi-finished products that are manufactured;

- providing homogeneous distribution on the semi-finished product,
- having fine crystalline (<15 micron) structure,
- having circular crystalline structure.

In this study, microstructures in varying dimensions are obtained by coating the zinc phosphate onto two distinct semi-finished products that are manufactured. After the zinc phosphate coating process, it is aimed that the coating weight is between 2 and 5 gr/ m^2. Besides, as a process requirement these two semi-finished products are mounted by means of shrink fitting to each other by being pressed. During this operation, it is aimed that the pressing (pushing) force values are between 1000 and 3000 N. With the hypothesis presented at this study, it is observed step by step how the phosphate crystals and microstructures effect the coating weight and pressing forces that is applied during pressing operation.



II. EXPERIMENTAL PROCEDURE

A. Materials and Sample Preparation

Firstly, 1200 semi-finished products having the hole diameter tolerance as being maximum Ø4,005±0,005 are obtained from C45 Pb steel. Then, 1200 semi-finished products which have the outer diameter tolerance as being Ø4,06±0,003 and which will be mounted within mentioned first semi-finished product made of C45 Pb steel by pressing it, are obtained from 11SMnPb30 steel. The semi-finished products which are manufactured as two distinct products and

separated by measuring their hole diameters and outer diameters are sent to the plant for being coated by the zinc phosphate.

B. Zinc Phosphate Coating and Sample Preparation

During the operation of zinc phosphate coating at different microstructures, stated at our hypothesis, each 300 semi-finished products of C 45 Pb steel are coated with one of the 4 different microstructures of the zinc phosphate. Likewise, each 600 semi-finished products of 11SMnPb30 steel are coated with one of the 2 different microstructures of the zinc phosphate. These experimental groups are;

For the semi-finished product of C45 Pb:
1- Small, circular crystal structure
2- Large needlelike crystal structure
3- Mixed crystal structure (Needlelike - Circular)
4- Small needlelike crystal structure

For the semi-finished product of 11SMnPb30:
1- Needlelike crystal structure
2- Circular crystal structure

C. Sample Preparation and Experiment for Coating Weight Calculation

For calculation of coating weights, the zinc phosphate coat removing operation is performed for each 3 sample products taken from each mentioned 6 distinct crystal structures formed with the zinc phosphate coating operation.

This weight test is applied to each 3 sample products taken from each 6 distinct microstructures. Mentioned 3 pieces coated with the zinc phosphate are washed with alcohol, then dried and the after-coating weight (KS) value is obtained by measuring them on the analytical balance. Solvent liquid is prepared by adding 225 gr novastrip into 850 ml of pure water.

The 3 sample products whose coatings will be solved stay within the solvent liquid at 70 ^{o} C for 20 minutes. Then, these sample products are rinsed with alcohol and dried. The after-removing weight (SS) value is obtained by measuring them on the analytical balance again. Thus, the coating weights could be obtained by calculating the difference these KS and SS values.

Calculation of Zinc Phosphate Coating Weight at Unit Area:

KA = (KS - SS) / TOTAL AREA = Coating Weight at Unit Area (gr/m^2)

D. Sample Preparation for Analyzing the Effect of Pressing and Mounting

For usage at pressing ang mounting operation, the semi-finished products of C45 Pb and 11SMnPb30 are coated with the zinc phosphate at 4 and 2 different microstructures, respectively. The effects of these semi-finished products having different microstructures onto mounting operation are observed by combining them each other.

E. Methods

1) Surface Characterization

The semi-finished products whose different microstructures are formed as 4+2 by being coated with the zinc phosphate are examined under Nikon eclips150 microscope.

The suitable microstructures stated in experimental groups are observed under the scanning electron microscope (SEM) by taking photographing them.

2) Coating Weight

Measuring the coating weight by taking 3 sample products from each formed crystal structures 1, 2, 3, 4 is provided by means of an analytical balance.

3) Combinations of Pressing and Mounting

Table 1

C 45 Pb	11SMnPb30	Combinations
1	1	1.1
2	1	2.1
3	1	3.1
4	1	4.1
1	2	1.2
2	2	2.2
3	2	3.2
4	2	4.2

The pressing and mounting operation is performed by combining the semi-finished products (whose microstructures are formed) as shown in table 1.

4) Measuring the Pressing Force

During the pressing operation, measuring the force of the semi-finished products whose different combinations are provided is performed by means of KİSTLER DMF-P A310.
Tolerance (1000-3000N).

III. RESULTS

A. Surface Morphology Studies

1) SEM Analysis

The microstructures formed by coating the semi-finished products of C45 Pb ve 11SMnPb30 with the zinc phosphate are observed by means of SEM analysis.
Microstructures of the semi-finished product of C45 Pb:

a) Small, circular crystal structure

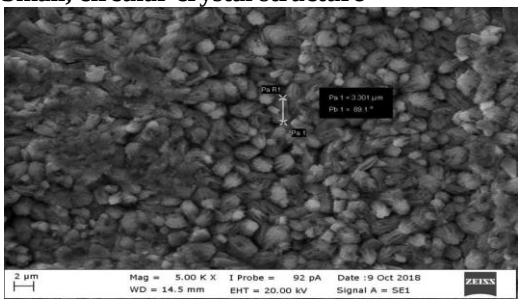


Figure 1 – In this SEM photograph, fine, homogeneous, circular crystal structure formed by coating operation is observed. Here, the crystal size is 3,301 □m.

b) Large needlelike crystal structure

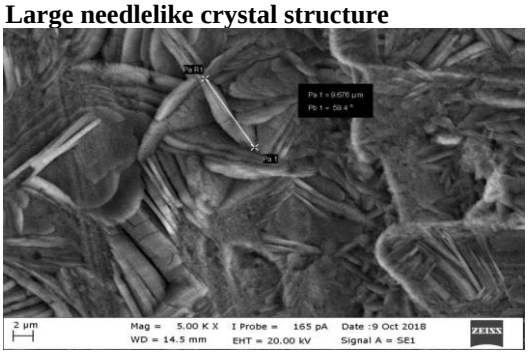


Figure 2 – In this SEM photograph, large, needlelike crystal structure formed by coating operation is observed. Here, the minimum crystal size is 9,676 □m.

c) Mixed crystal structure (Needlelike - Circular)

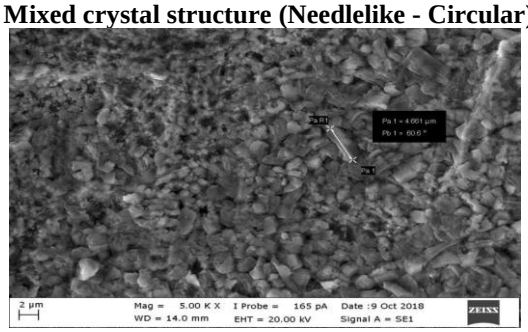


Figure 3 – In this SEM photograph, needlelike, circular crystal structure formed by coating operation is observed. Here, the crystal size is 4,661 □ m.

d) Small needlelike crystal structure

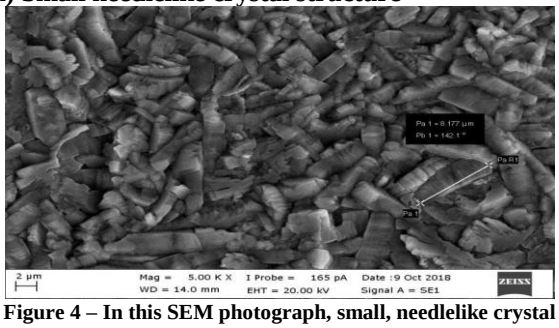


Figure 4 – In this SEM photograph, small, needlelike crystal structure formed by coating operation is observed. Here, the maximum crystal size is 8, 177 □ m.

Microstructures of the semi-finished product of 11SMnPb30:

e) Needlelike crystal structure

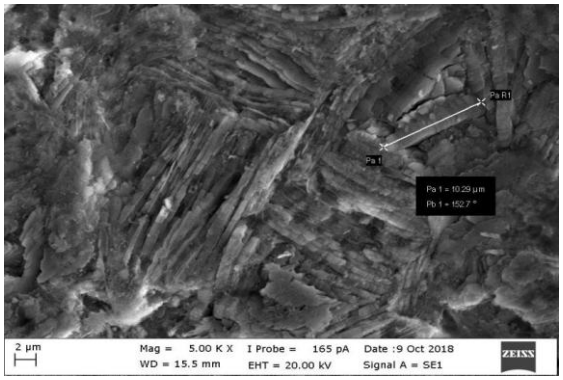


Figure 5 – In this SEM photograph, large, needlelike crystal structure formed by coating operation is observed. Here, the crystal size is 10,29 □ m.

e) Circular crystal structure

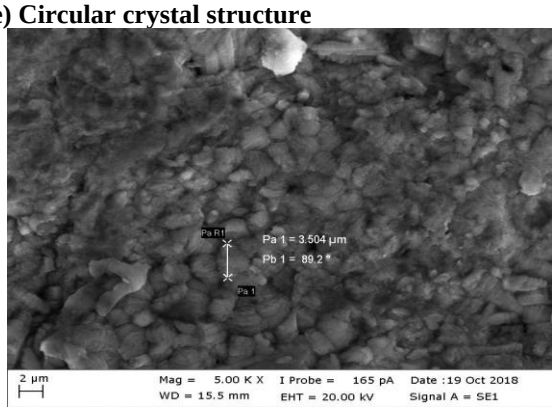


Figure 6 – In this SEM photograph, small, circular crystal structure formed by coating operation is observed. Here, the crystal size is 3,50 □ m.

2) Evaluation of Coating Weight

The coating weights are measured by taking 3 sample products from each 6 different microstructures. The results are given in table 2.

Table 2

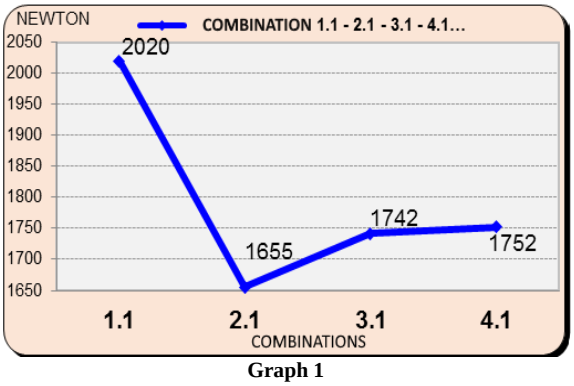
Microstructure No	Desired Value (gr/m 2)	Measurement Result (gr/m2)
1 (C45 Pb)	2 – 5	3,5313
2 (C45 Pb)	2 – 5	4,3031
3 (C45 Pb)	2 – 5	4,5592
4 (C45 Pb)	2 – 5	4,0166
1 (11SMnPb30)	2 – 5	3,0112
2 (11SMnPb30)	2 – 5	2,6400

According to the table 2, the coating weights decrease as the size of the crystal structure gets smaller, and the coating weights increase as the size of the crystal structure gets bigger.

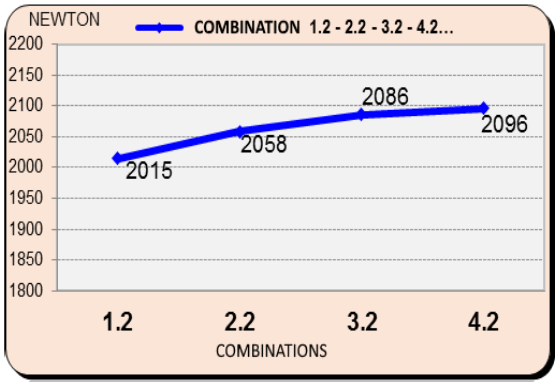
Besides, increasement is observed in the coating weight of the non-homogeneous structures. (For example: The structure shown in figure 3)

3) Evaluation of Pressing Force Measurement

The semi-finished products whose microstructures are formed are separated into their combinations by matching as stated in table 1. For observing the pressing force of different microstructures, the tight pressing operation is performed. (The force values at the graphs given below are the average of the pressing force belong to 50 sample products.)



Graph 1



Graph 2

As understood from the graph 1 and 2, it is observed that the average tight pressing force values vary depending on the combinations of the microstructures.

CONCLUSION

With the experimental procedure presented in this study, the microstructures of different sizes and types are formed by coating 2 different steel semi-finished products with the zinc phosphate, then the effects of these formations onto both the coating weight and pressing forces are observed.

Results are given below;

1. The coating weights decrease as the size of the crystal structure gets smaller, and the coating weights increase as the size of the crystal structure gets bigger.
2. İncreasement is observed in the coating weight of the non-homogeneous structures.
3. A significant decrease is observed in the pressing forces when both products have needlelike crystal structure.
4. It is observed that force changes are minimized in the pressing process when one of the 2 products has a circular crystal structure.

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