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The Effect of Electroplating Hard Chrome with Different Dissolvent Compositions to the Mechanical Properties of ST-37

Moh. Jufri[a], Yeshar Ego Ginola[b], Rr. Heni Hendaryati[c], Ali Saifullah[d], Daryono[e]
[a,b,c,d,e] Department of Mechanical engineering, Engineering Faculty
University of Muhammadiyah Malang
Jl. Raya Tlogomas No. 246, Malang, Indonesia
Telp. (0341) 464318-128 Fax. (0341) 460782
e-mail: jufri@umm.ac.id

Abstract

Electroplating hard chrome is a metal plating process with hard chrome which aims to not only coat as decorative, but also to coat metal surfaces more strongly, according to their use in the engineering world. In addition to decorative properties, the advantages of surface treatment techniques can also increase hardness, wear resistance, and corrosion resistance. The purpose of this research is generally to determine the effect of different solution compositions in the electroplating process of hard chrome on the impact strength of the structure on ST-37 steel. This time the specimens are 100mm x 6mm x 6mm and 50mm x 50mm as many as 3 pieces. In this study, the electroplating process of hard chrome was carried out using different parameters of the CrO_3 solution composition from previous studies, namely 200 gr/lt, 350 gr/lt, and 400 gr/lt with an immersion time of 22 minutes. The results of this electroplating process were tested by testing the impact strength and microstructure. The results of the study can be concluded that the more the composition of the solution, the higher the impact toughness. The highest impact toughness value is 0.998 joules/mm2 at a solution concentration of 400 grams/liter and the surface results on ST-37 steel after getting hard chrome electroplating treatment is that the surface has Cr elements attached and gets thicker with increasing concentration which is used as a variation with the same immersion time.

Keywords*: dissolvent compositions; electroplating hard chrome; impact; structure; ST-37*

1. INTRODUCTION

In the era of development, the use of steel has increased very rapidly. Steel is generally used in the industrial, construction, automotive and other sectors. The use of steel in addition to having advantages also has a weakness, which is susceptible to corrosion rates, especially low carbon steel. To prevent the corrosion rate can be done by electroplating hard chrome. The coating on hard chrome is thicker than on decorative chrome [1].

Electroplating hard chrome is a metal plating process with hard chrome which aims to not only coat as decorative, but also to coat metal surfaces more strongly, according to their use in the engineering world. In addition to decorative properties, the advantages of surface treatment techniques can also increase hardness, wear resistance, and corrosion resistance [2].

In his study, Alphanoda [3] regarded the effect of cathode anode distance and coating duration on corrosion rate on hard chrome electroplating results. In the research conducted using a solution of CrO¬3 with a solution concentration of 300 g/L. while research conducted by [4] regarding the effect of current and time of hard chrome plating

on coating thickness and microhardness level on low carbon steel plate AISI 1026 using CrO3 250 gr/ltd and H2SO4 2.5 gr/lt in the electroplating process. From previous research, the higher the concentration of CrO3 solution, the slower the corrosion rate and the thicker the metal surface. Meanwhile, if the concentration of CrO3 solution used is less, the corrosion rate will be faster, and the metal surface will be thinner.

In this study, the electroplating process of hard chrome was carried out using different parameters of the composition of the CrO3 solution from previous studies, namely 200 gr/lt, 350 gr/lt, and 400 gr/lt. The tests carried out were to determine the impact strength and structure where the previous test only found out variations in current density in the chromium plating process and to know the electroplating coating metal and this research was added to determine the impact strength and microstructure results of ST-37 steel in the hard chrome electroplating process.

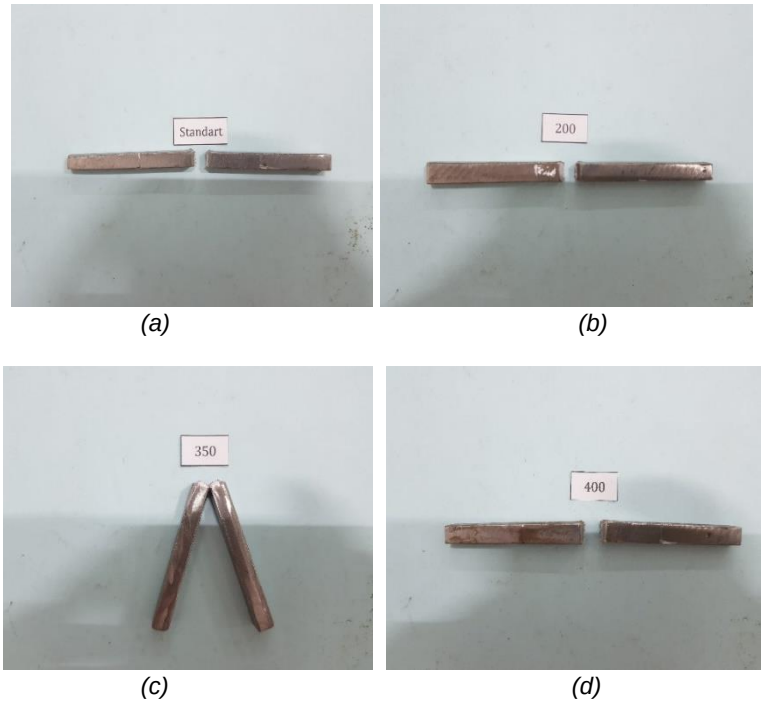
2. METHODS

In this research, hard chrome electroplating process will be carried out. With an immersion time of 22 minutes [5] and the anode used is pure tin. The tests that will be carried out in this research are the impact strength test and microstructure where the impact test with a testing angle of 60¬o and an impact load of 300 joules and testing of the microstructure with a surface test (morphology).

The process of electroplating was conducted with three variations of dissolvent compositions. The dissolvent was $CrCO_3$ that was determined in 200 gr/lt, 350 gr/lr, 400 gr/lt. ST-37 that has been merged in the dissolvent were tested with impact testing and microstructure testing. Those tests were conducted to know the mechanical properties of ST-37 after treatment. For further details, ST-37 was tested to find out the value of the metal toughness and the change in structure.

3. RESULT AND DISCUSSION

The impact test was using the Charpy method, while for the morphology test, the test was conducted by using an application installed in a testing device of microstructure.



(a) *(b)*

(c) *(d)*

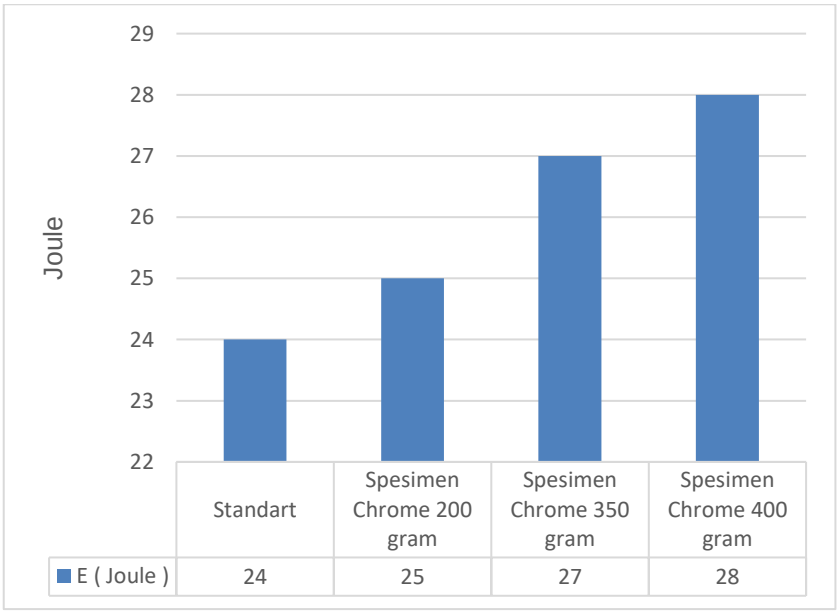
Figure 1. The result of impact test. (a) Without coating, (b) Coated with 200 gr/L of $CrCO_3$ dissolvent, (c) Coated with 350 gr/L of $CrCO_3$, and (d) Coated with 400 gr/L of $CrCO_3$

The impact testing was conducted with the testing angle of 60° and the impact load was 300 joule. The test was conducted to the four specimens with four characteristics. They were determined without non-coated specimen and coated specimens, where the coated specimens were coated with 200, 350, and 400 gr/L of $CrCO_3$ dissolvent. Result of the impact test shows the different values. The impact value is the number that shows the energy to break the specimen from the different of mass height in the upper position and the lower position (falling height).

Table 1. The result of impact test

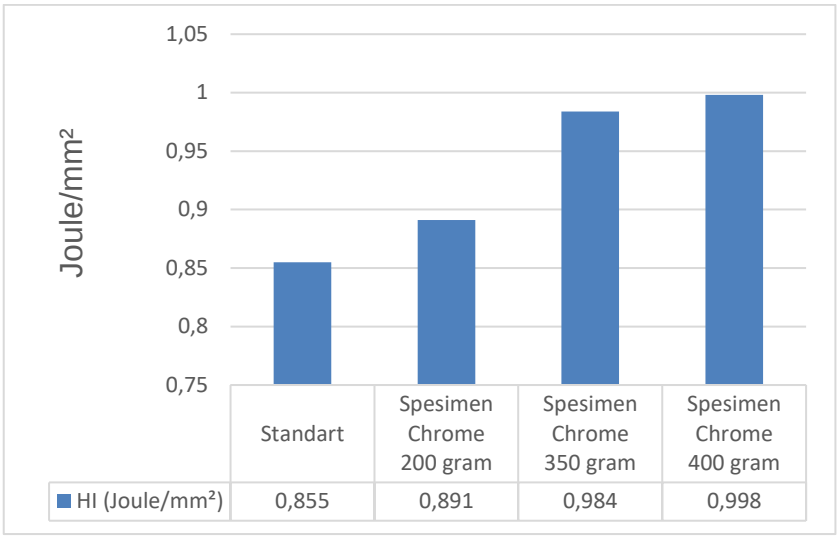
Specimen	a	b	A	E	HI
	(mm)	(mm)	(mm^2)	(Joule)	(Joule/mm^2)
Without coating	4,6	6,1	28	24	0,855
Dissolvent composition of 200 gr/L	4,6	6,1	28	25	0,891
Dissolvent composition of 350 gr/L	4,5	6,1	27	27	0,984
Dissolvent composition of 400 gr/L	4,6	6,1	28	28	0,998

In the form of graphic, the difference of specimens with different coating has the different toughness. The energy used to break the specimen increased with the additional dissolvent. The specimen without coating needed more energy to be broken. It needed 24 joules of energy, while the bigger energy was needed by the specimen with 200 gram of coating dissolvent. It needed 25 joule of energy and it increased gradually to 28 joules. The increase of energy used to break the specimen was because of the attached elements on the specimen that the surface is hard.



Graph 1. Impact Energy

From the graph, the difference of energy needs is almost in average. The standard specimen and the specimen with 400 gram of chrome coating has 4 joules difference, while for specimen with 200 gram and 350 gram of chrome coating have 2 joules of difference.



Graph 2. Toughness

The test results obtained the highest impact strength value in the variation of the solution with a value of 0.998 J/mm2 and the lowest value with an impact strength of 0.855 J/mm2. In the impact test, the maximum energy absorption occurred in the specimen with a solution variation of 400 grams/L. Impact toughness is directly proportional to the addition of the amount of Cr which is varied, the more Cr given to the solution the higher the impact strength that occurs.

The 400 gram/L solution has the highest chrome content so that during the coating process the distribution of the Cr structure will be more even and thicker with the amount of Cr content in the solution. This is in accordance with previous research [6] which said that the presence of the Cr element with the longer the immersion time the intensity will increase this is because the Cr element will be stronger if the longer the immersion time the precipitate in Cr the longer the time will be more a lot, this also shows that Cr is well deposited on the substrate.

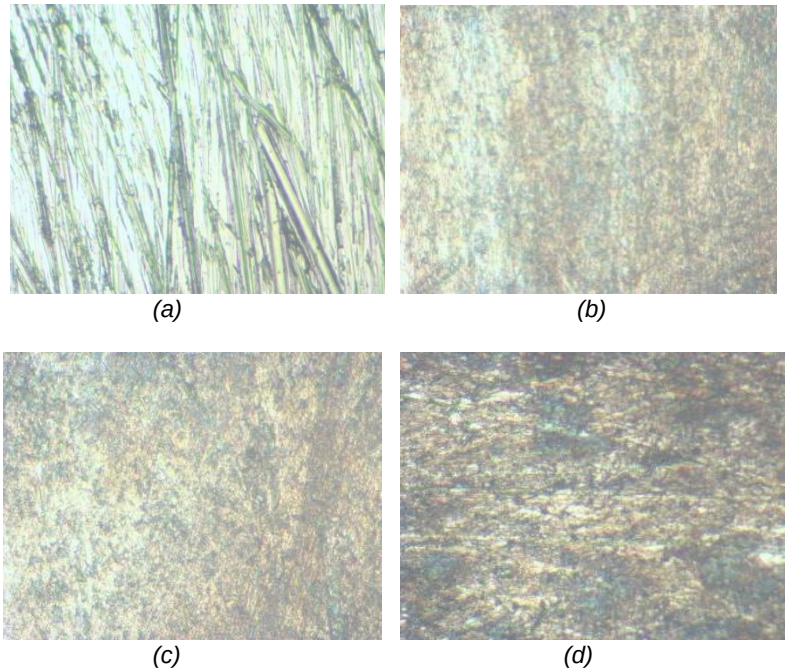


Figure 2. Surface morphology. (a) Without coating, (b) Coated with 200 gr/L of $CrCO_3$ dissolvent, (c) Coated with 350 gr/L of $CrCO_3$, and (d) Coated with 400 gr/L of $CrCO_3$

In specimen (a) the surface shows scratches from sanding marks. In this case, it shows that on the surface of the specimen that has not gone through the electroplating process, there are no elements attached to the surface. On the surface (b) seen a collection of Cr granules that cover part of the surface using a mixture of 200 grams/liter solution. Then in Figures (c) and (d) they experience the same condition, namely the grains that cover the surface are getting thicker and more numerous [7-9]. It can be concluded that by increasing the concentration of the solution used in the chrome process at the same time, the coating process experienced a big difference.

This is in accordance with previous research conducted by [6] stated. Along with the increase in the variation of the immersion time in the electroplating process, the chrome has covered the substrate surface, this can be seen from the Figure above where in the SEM test results, the surface layer of the substrate has been covered by chromium due to chromium deposition which increases according to the increase in immersion time and occurs grain formation. Deposited chrome grains so that cover the substrate surface.

4. CONCLUSION

From the results of research and tests that have been carried out, it can be concluded that with the variation of the solution, the more Cr content in 1 liter of solution, the toughness of the material as evidenced by impact testing is directly proportional to the increase. In materials that have not undergone the hard chrome plating process, 0.855 jaoule/mm2 continues to increase to 0.998 joules/mm2 at a solution concentration of 400 grams/liter. On the surface structure of ST-37 steel after getting hard chrome electroplating treatment is the surface there are Cr elements attached and getting thicker with increasing concentration which is used as a variation with the same immersion time.

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