INFLUENCE OF TIME AND TEMPERATURE ON THE ZINC LAYER COATING OF STAINLESS STEEL

Luan Kola[1], Artan Llozana[1], Altin Gjevori[2], Bashkim Ziberi[3]
[1] *University of Elbasan, Rruga Rinia, 3001 Elbasan, Albania*
[2] *Polytechnic University of Tirana, Boulevard "Dëshmorët e Kombit", Square "Mother Teresa", 4. 1000 Tirana, Albania*
[3] *State University of Tetova, State University of Tetova, Ilinden Street nn, 1200 Tetova, Macedonia*
Corresponding Author: kola.luan@yahoo.com

ABSTRACT

In this work the coating of Stainless Steel used in construction with a layer of Zinc will be presented. This layer of Zinc carbonate adheres very good with the inner zinc layer protecting it from further corrosion. The Steel coating is performed through the process of putting in a hot bath at temperatures between 440 °C and 450 °C. The morphology of the samples have been studied using the Optical Microscopy. The microhardness of the samples have been performed using Vickers Method. Furthermore the sensile tests are performed in order to study the mechanical properties of the produced samples.

Keywords: *Zinc, Steel, Microhardness, Mechanical Properties, Optical Microscopy.*

INTRODUCTION

The most widely used material for both domestic and industrial applications owing to its excellent properties remains steel. One of the foremost weaknesses of steel is its corrosion and wear behaviours [1,2,3,4,5,6,7,8,9,10,11,12,13,14,15]. Due to these disadvantages, many protection methods have been adopted to inprove the service life of steel against corrosion and wear attacks [5-12]. Among these, galvanizing method with metallic thin films of various interests has been worked upon. The interest in zinc coatings for the protection of steel is enormous in the engineering industries [1-15,16,17,18,19,20]. The stability of these coatings and their surface behaviour establishes further development of these coatings for environmental applications. Zinc is widely used as metallic coatings applied to steel surfaces to protect them from corrosion which can be obtained by different processes [10-15]. Many studies have been carried out to understand the characteristics of the deposition process of Zn [12-20,21]. It is found that the characteristics of the deposited coating depend on the deposition time, bath composition, additives and temperature [10-21]. The phases and microstructure of the surface of the deposited Zn is another important characteristic which controls the corrosion resistance and other mechanical properties [15-21]. Corrosion properties is however, very sensitive to surface inhomogeneities and segregation of deposition element.

In this work the coating of Stainless Steel used in construction with a layer of Zinc will be presented. The Steel coating is performed through the process of putting in a hot bath at temperatures between 440 °C and 450 °C for different times. The morphology of the samples have been studied using the Optical Microscopy. The microhardness of the samples have been performed using Vickers Method. Furthermore the sensile tests are performed in order to study the mechanical properties of the produced samples.

MATERIALS AND METHODS

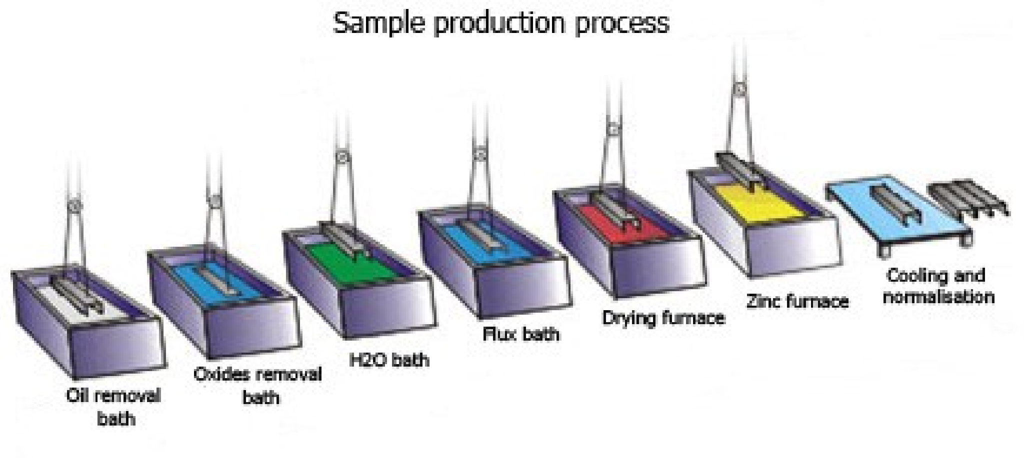

Fig. 1. Schematic representation of experimental setup used for sample production
a. Temperature: 442 °C (4 min / 8 min / 12 min / 15 min / 20 min)
b. Temperature: 445 °C (4 min / 8 min / 12 min / 15 min / 20 min)
c. Temperature: 448 °C (4 min / 8 min / 12 min / 15 min / 20 min)
d. Temperature: 450 °C (4 min / 8 min / 12 min / 15 min / 20 min)
e. Temperature: 452 °C (4 min / 8 min / 12 min / 15 min / 20 min)

Sample preparation has been done using the hot Zinc coating technology a method known as HDG (Hot Dip Galvanizing). This process belongs technically to the process of surface treatment. In this case the surface of the stainless steel is covered with a protective zinc layer, that protects the bulk material from corrosion and scratches.

Steps for sample cleaning prior to and sample coating:
- Cleaning to remove oils (degreasing to remove organic materials)
- Oxide removal bath to remove scale and rust
- Water cleaning
- Flux bath, to inhibit oxidation of the steel before dipping in the molten zinc
- Drying and preheating
- Process of Zinc coating through immersion into the zinc bath
- Cooling and normalization
- Chemical Composition of Stainless steel samples prior to immersion into Zinc bath:

C	Mn	S	P	Si	Cu	N	Ceq
0,17% max	1,4% max	0,04% max	0,04% max	0,15-0,25%	0,55% max	0,012% max	0,35% max

RESULT AND DISCUSSION

The variation of microhardness with temperature is depicted in Fig. 2. Steel coated with zinc resulted in hardness increase from 50 HV5 in 445 ^{o}C to approximately 70 HV5 for the coated zinc surface in 450 ^{o}C (see Figure 2). The hardness profile data for all the samples shows significant average increase. The average microhardness values for all the samples were calculated, with the highest value of hardness 70 HV5, (see Figure 2) this is due to the depth of Zn deposited on the sample. This improvement in hardness was attributed to the formation of adhesive properties on the substrate. The microhardness of the Zn deposited samples under different conditions were carefully observed and studied. Experimental results showed that the microhardness property of the samples depend on the temperature. Previous work by [17], had affirmed that the microstructure evolved in coating depends on the processing parameters and hence such metallurgical parameter influence the grain size which is paramount to the buildup of surface hardness. Also the microhardness of the Zn deposited samples clearly increases with increases in galvanization time.

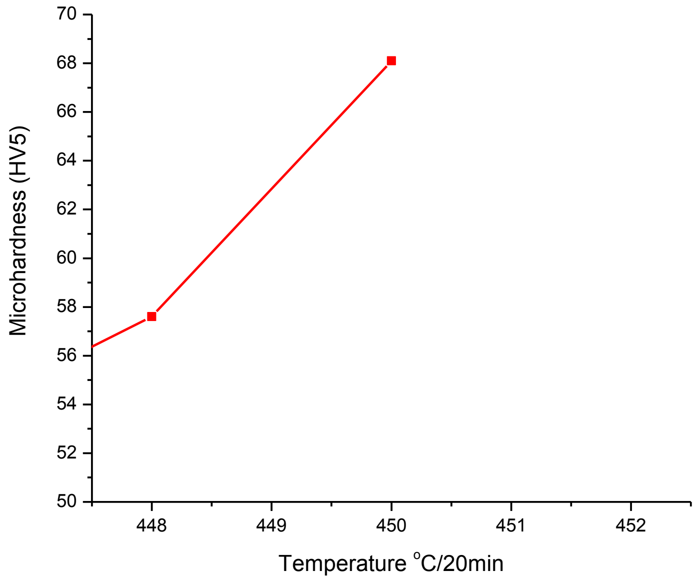

Fig. 2. Microhardeness in function of temperature for equal treatment time

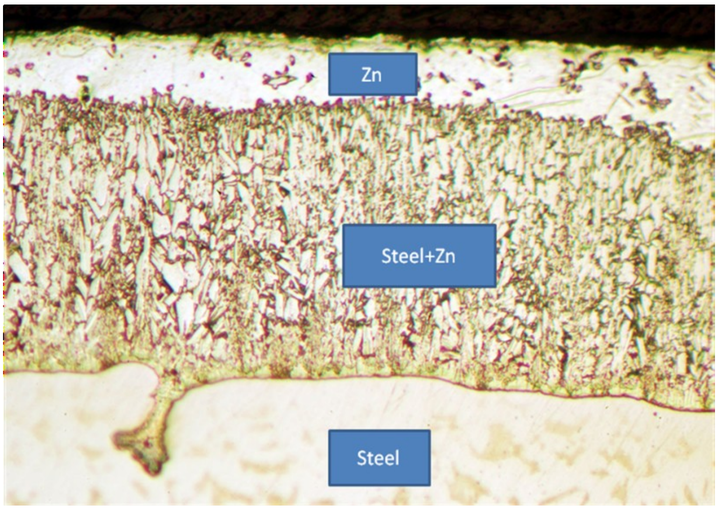

Fig. 3. Optical Microscopy micrograph of cross section of the sample

The Zinc layer adheres very good with the inner zinc layer protecting it from further corrosion. Figure 3 illustrates the cross section features of the Zn coated sample on 450 ^{o}C. In this micrograph, it can be observed that the Zn film completely covered the substrate. The nature of crystal growth indicates a coarse–grained deposit having non uniform crystal size. According to [13, 14 and 15] deposit composition can be influence by bath control parameter. Increase in temperature, regulates the uniform arrangement of crystals and hence results in the fine grained deposits exhibiting coalesced crystallites.

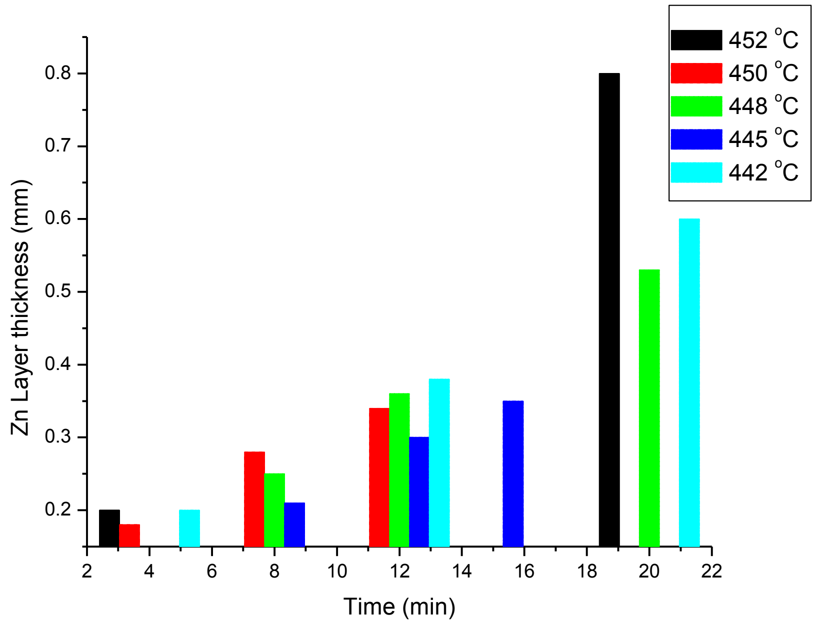

Fig. 4. Zn Layer thickness for different treatement times and temperatures

In figure 4 the variation of Zn layer thickness with temperature and time is presented. The variation of thickness with temperature and time is quite linear with maksimum value obtained for sample prepared for 20 min in 452 ^{o}C.

SUMMARY AND CONCLUSIONS

Surface coating of stainless steel with a layer of Zinc is performed using the HDG method.

• The samples used have a purity of more than 95 % Fe.

• The percentage of Silicon is between 0.15 % up to 0,25 %, indicating that the thickness of the Zinc layer should increase slowly with the immersing time.

• Results show that there is an increase of the layer thickness related to the immersion temperature. There is a increase in the layer thickness while changing the bath temperature from 442 °C and reaches a maximum at a temperature of about 452 °C at almost 450 μm.

• Zinc layer covers the surface completely, however there are impurities that interrupt the Zinc layer and are areas where the corrosion of the coated material can be developed.

• However further investigations are needed to clarify these findings.

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