

Corrosion Evaluation of Some Phosphated Thin Layers on Reinforcing Steel

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Abstract. In this work we studied the evaluation of corrosion of chemical deposited phosphate layers on the OB37 steel used in construction. The experimental determinations were performed for short term immersion, and the samples were characterized by scanning electron microscopy. By using electro-chemical impedance spectroscopy, the corrosion speed of the alloys was investigated. The corrosive resistance of the reinforcing steel is much improved.

1. Introduction

These materials are commercial alloys used commonly in civil and industrial buildings.

The prediction of the properties and performance of a metallic material performance is not easy to evaluate, being necessary numerous circumstances [1-6].

The corrosion behavior depends on numerous factors: the metal or alloy and its properties, the corrosive medium and its concentration, temperature, and other environmental factors [6-9].

The known anticorrosion procedures of iron object surfaces by chemical phosphatation consist in precipitation of low soluble pyrophosphate, as Zn(II), Ni(II), Mn(II), Ca(II) and, very rarely, Fe(II) in order to deposit thin layers [10-12].

These procedures have the disadvantage that involves a large number of cations in the composition of the in-situ obtained layers.

These are applied after degreasing and pickling [11-15].

Electrochemical methods (electro-chemical impedance spectroscopy) and surface imaging (SEM) were used to evaluate the average corrosion of coated reinforcing steel.

The electrochemical methods were used to determine the corrosion rate and microscopy was used to evaluate the surface [8, 10].

2. Materials and methods

The layers were obtained by chemical deposition, after immersion of the samples in a NaOH based solution for degreasing, respectively in a HCl based solution for pickling, in a solution made of H₃PO₄



and HNO_3 in which are added Zn chips and NaNO_2 and $\text{Na}_3\text{P}_3\text{O}_{10}$.

The samples are kept in solution for 30 mins at 80°C .

The morphology was performed using scanning electron microscopy coupled with energy dispersive X-ray spectroscopy (SEM-EDX) model Tescan Vega II LSH with a Bruker Quantax QX2 detector, being computer-controlled and was used to obtain the micrographs at 100x, 500x, 1000x, and 5000x for secondary (SE) and backscattered (BSE) electron detectors.

All the corrosion tests were done at room temperature (20°C), using a electrochemical cell with three electrodes connected to an Autolab PG STAT 302 (Metrohm Autolab) Potentiostat.

The reference electrode is saturated calomel (ECS), the auxiliary electrode is made of platinum and the third one was the tested sample.

The corrosion potential was calculated with the Nova 1.6 software.

3. Results and discussions

The surface imaging shows a dendritic structure (figure 1) with compact layers with high roughness, which provide good adesion to the concrete.

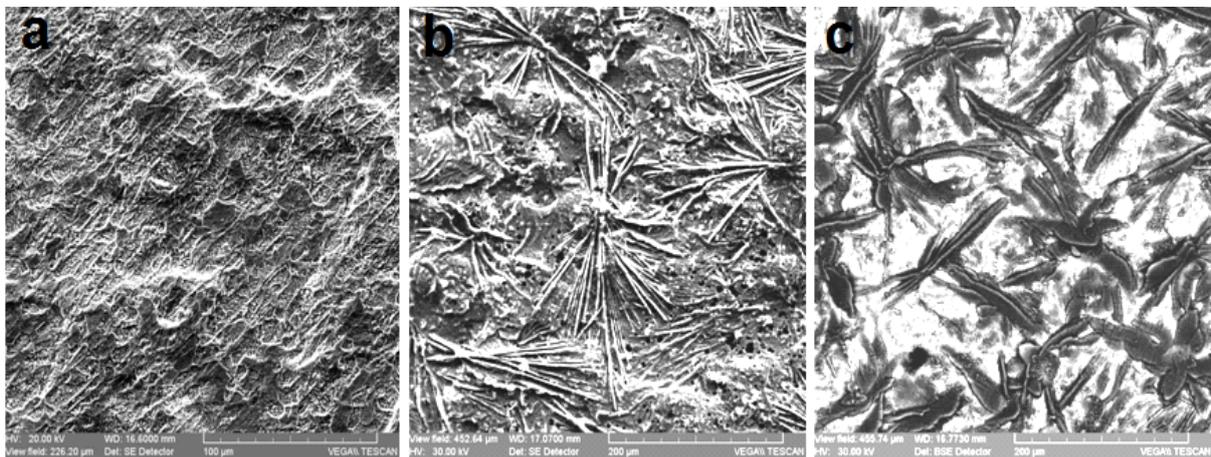


Figure 1. SEM images of the samples: a – the support (1000X), b – SE image of deposited layers (500X); c – BSE image of deposited layers (500X).

The chemical deposition allows obtaining of thin phosphate layers obtained from thin acicular dendritic cristallites, with visible germination centers.

Distribution of the atoms on surface highlight two processes of structural reformation by sequential co-precipitation, first subtractive – the formation of iron phosphate and second the formation of zinc phosphate [12].

The corrosion speed can be correlated with the intensity of the corrosion current or with the current density based on the general law of electrolysis.

The superficial corrosion speed is defined as the weight loss on time unit on surface unit [10].

Figure 2 presents the Evans diagram of the standard sample – not deposited and respectively the phosphated reinforcing steel.

Corrosion speed of the samples in 0.1M NaCl solution was indicated as following: untreated sample: $45 \cdot 10^{-3}$ mm/year compared to coated sample with $1.6 \cdot 10^{-3}$ mm/year.

It is known in literature that on the coprecipitation process a thin ceramic layer of iron and zinc phosphate is formed ($\text{Zn}_2\text{Fe}(\text{PO}_4)_2 \cdot 4\text{H}_2\text{O}$), which assures a good corrosion resistance and as a suport layer for concrete [9-13].

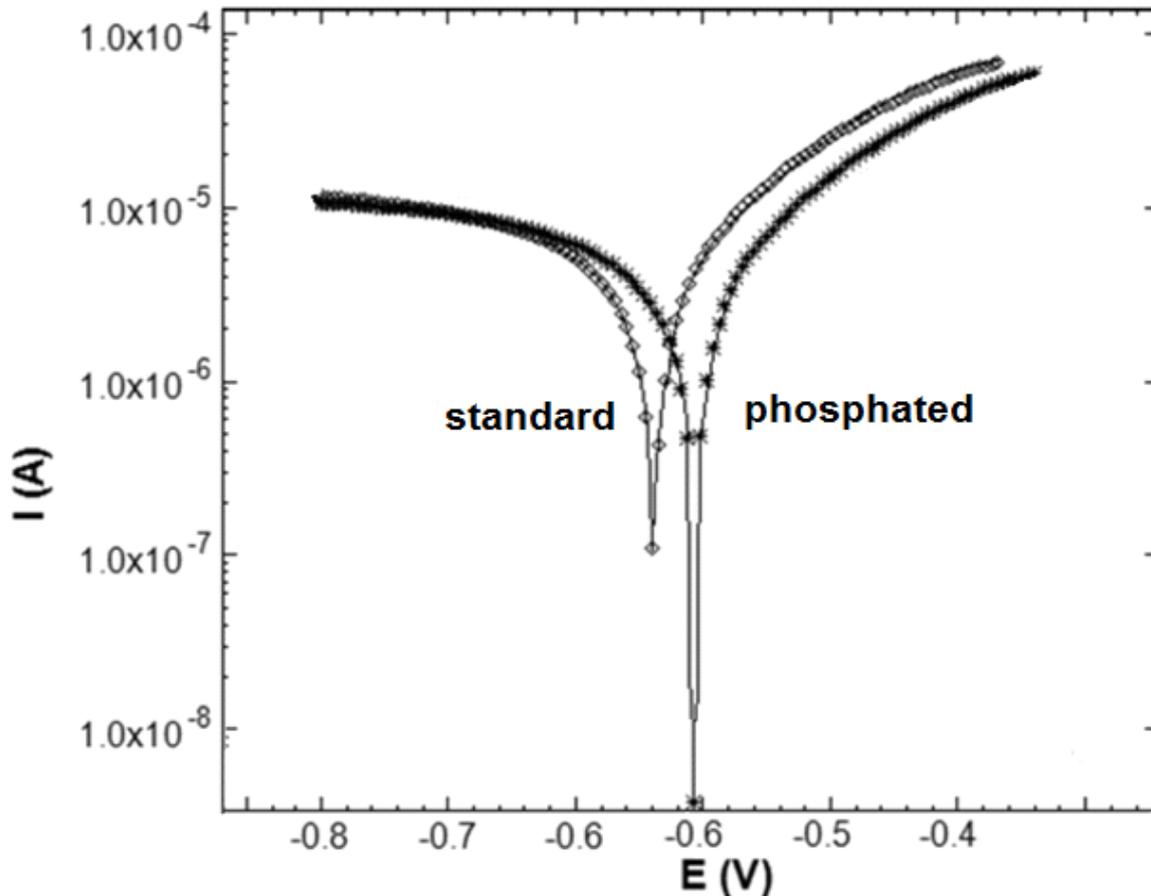


Figure 2. Evans diagram of the samples: in 0.1m NaCl.

4. Conclusions

The result obtained from present work indicate that phosphate layers can be used for enhancing the corrosion resistance of reinforcing steel.

Assessed with previous studies we can say that the obtained structures present a compact layer, results confirmed by the corrosion evaluation.

The phosphate coated reinforcing steel bars can be successfully used on concrete for enhancing the life of buildings.

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