Nitrogen implantation into steel wire coated with zinc used as reinforcement in power transmission conductors

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Abstract. In tropical environments, diversity of climatic factors such as temperature, relative humidity, deposition of environmental contaminants (such as sulfates and chlorides) affect a large proportion of materials exposed to the weather, and electrochemical corrosion is one of the phenomena that occur in the case of metals and alloys [1, 2]. It is therefore particularly important to study this behavior in the Zinc-coated steel, since this material is used for its economy in the industry specifically in the area of transport of electricity.

1. Introduction
Zinc coated steel is an important factor in the structural [3] part of power grids as it supports the efforts produced by the winds and the weight of the same line. The transmission and power distribution lines are basically composed of wire ACSR (aluminum conductor steel reinforced Zinc coated), Since the galvanized Steel wire confers (provides) good corrosion resistance, nevertheless, many cases have been reported in galvanized pipes, which have revealed an eventual corrosion process [4] In the same way, considering the advantages offered by the nitriding process, such as: increased surface hardness and reduction in the corrosion rate due to the formation of nitrides in the steel by the reaction of nitrogen with the iron and alloying elements . Furthermore, with nitriding an increased resistance to embrittlement caused by hydrogen is produced because this material is in a humid environment and in addition supporting mechanical stresses so that the water vapor reacting with fresh surfaces [5] created by fatigue, causes the hydrogen to react with the new surface producing atomic hydrogen diffusion later by placing ahead of the front of the fissure occurring failure [6, 7], the nitrogen thus blocks the interstitial spaces of preventing hydrogen diffusion.

2. Methodology
Samples of Zinc coated steel core wire for ACSR 1/0 trade were selected (see figure 1) which were measured corrosion rate, resting potential and polarization resistance through a potentiostat-galvanostat. The methodology used here is similar to that carried out in Huyuan Sun (e tál) y V. Padilla (et ál) paper (work). [4, 8] Subsequently these samples underwent an implantation nitriding

process and these variables were measured [9]. Additionally, samples nitrided and non-nitrided (see figure 2) were exposed to corrosive environments and mass loss determined gravimetrically.

Figure 1. Standard Cable ACSR.

Figure 2. Non-nitrided sample (top) Nitrided sample (bottom).

3. Results and discussion

A potentiometric study was made to each sample through which the corrosion rate measurements given in MPY (mils per year) and the passivation potential were obtained in mV (millivolts). Statistical methods were developed by the respective box and whisker plots where illustrates the variation of the data and the average for each variable of the same shape were arranged the mass loss data obtained by gravimetry (see figure 3). The nitrided samples were first subjected to a cleaning treatment by sputtering with argon gas to 5kV, subsequently to a surface modification 3DII IMPLATATION 20kV with nitrogen gas for 30 minutes (see figure 4) [10].

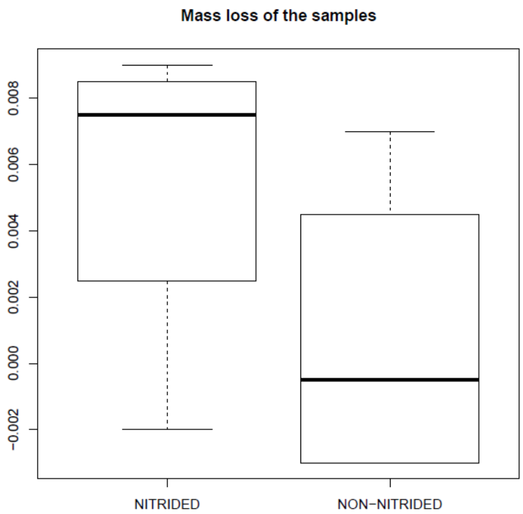

Figure 3. Mass loss of the samples.

Figure 4. 3DII Implantation process.

Based on studies with the potentiostat, specimens of non-nitrided and nitrided, it was evidenced an increase in the corrosion rate of the samples subjected to nitriding treatment by implantation surface, additionally it was noticed that nitriding favors a displacement passivation potential, then passivation phenomenon accelerates in the coating. It is noteworthy that according to Lisbeth Acosta [11] the galvanized zinc has a thickness of about 20 micrometers (see figure. 5). This thickness is insufficient for protecting base steel in aggressive corrosive environments. Moreover, the simulation performed with the code "TRIM" [12] to the nitrogen implantation conditions Zinc made sheds implantation depth of approximately 0.08 micrometers (see figure 6), indicating that the nitriding does not break through the zinc coating, in the event that a nitriding steel core by implantation were required, it must perform before galvanizing.

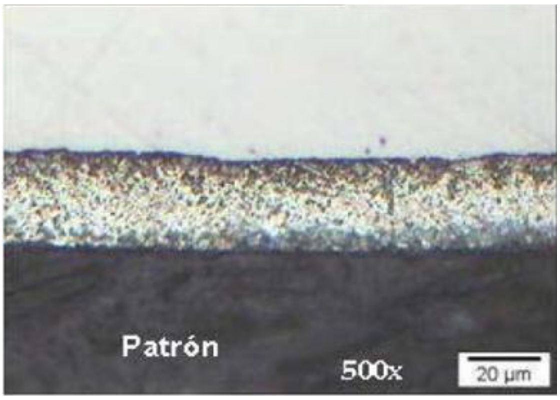

Figure 5. Zinc layer thickness.

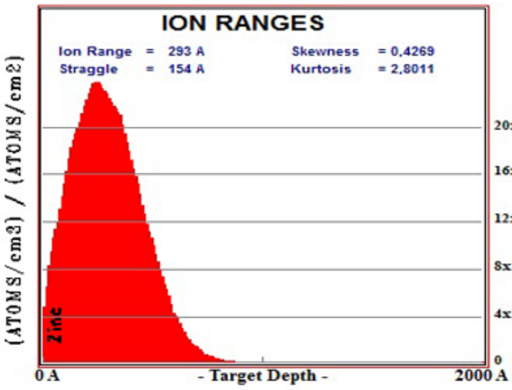

Figure 6. Implantation depth profiles of nitrogen within Zinc.

4. Conclusions

It was found that the nitride implanted galvanized steel samples exhibit a higher corrosion rate than non-nitride ones (samples). It could be due to the fact that nitrogenous implantation depth in zinc (depth in nitrogenous implantation in zinc) is much less than the thickness of the zinc coat in the galvanized steel, therefore Nitrogenous could affect the passivation properties of galvanization (galvanization passivation properties).

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