Application of zeolite/phoshate pigments for corrosion inhibition

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Introduction

Aluminum alloys are commonly used as a construction material in different industries due to their high mechanical properties. They contain various intermetallics, that ensure strength and hardness. Though, the intermetallics increase alloys sensibility to corrosion due to the difference in potentials of alloying components and the aluminum matrix [1]. One of the common and effective methods used to protect aluminium alloys from corrosion destruction is application of paint coatings [2]. Anticorrosion paints contain inorganic pigments which inhibit corrosion by electrochemical and chemical reactions. Environmental friendly zeolites are promising inhibiting pigments for corrosion protection of the aluminum alloys [1]. Zeolites are nanocrystalline aluminosilicate with 3D porous structure, which use as containers in paint coating [3]. Corrosion protection performance zeolites increased by different phosphate pigments.

The aims: In this study, a zeolite with phosphate was invastigated as an anticorrosion pigment to enhance the corrosion protection of the aluminum alloy.

Methods

The zeolite/phosphate mixture was milled by high energy planetary ball mill.The composite pigments were added in 0.1% NaCl solution at concentration of 1 g/l. The electrochemical behavior of the aluminum alloy with milled complex zeolite/phosphate pigment was studied by potentiodynamic polarization method. The polarization characteristics were recorded by a Cor–500 potentiostat, using a saturated Ag/AgCl reference electrode and a counter platinum electrode. The potential scan rate during experiments was 1 mV/s. Aluminium alloy sample working area was 1 cm^2.

The EIS-measurements were carried out close to corrosion potential by using Gill AC potentiostat, a saturated Ag/AgCl reference electrode and a platinum auxiliary electrode in the current frequency range from 10000 to 0.1 Hz and with the signal amplitude of 20 mV.

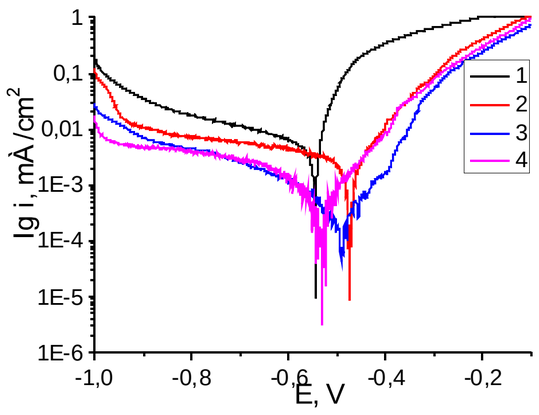

Fig.1. Potentiodynamic polarization curves of D16T aluminium alloy: 1 - 0.1 % NaCl solution; 2 - 0.1 % NaCl solution with the addition of milled zeolite; 3 - 0.1 % NaCl solution with the addition of zeolite milled with $Zn(H_2PO_4)_2$; 4 - 0.1 % NaCl solution with the addition of zeolite milled with $CaHPO_4$

Results

The free corrosion potential of the D16T alloy is ~ - 0.57 - -0.58 V, regardless of the solution composition. Potentiodynamic polarization studies of the D16T alloy in 0.1% NaCl solution with pigments suspensions showed (table 1, fig. 1), that the complex "milled zeolite/ $Zn(H_2PO_4)_2$" is significantly effective compared to solution with the addition of separate milled zeolite or complex "milled zeolite/$CaHPO_4$".

Table 1. The electrochemical characteristics of the D16T alloy.

Medium	E_{corr}, V	i_{corr}, mA/cm^2
0.1% NaCl solution	-0,54	$0{,}45 \cdot 10^{-2}$
0.1% NaCl solution with the addition of milled zeolite	-0,48	$0{,}22 \cdot 10^{-2}$
0.1% NaCl solution with the addition of zeolite milled with $Zn(H_2PO_4)_2$	-0,49	$0{,}03 \cdot 10^{-2}$
0.1% NaCl solution with the addition of zeolite milled with $CaHPO_4$	-0,52	$0{,}07 \cdot 10^{-2}$

Corrosion resistance of the aluminum alloy in 0,1% NaCl solution inhibited by complex zeolite/phosphate was studied by electrochemical impedance spectroscopy (EIS). The EIS results showed (fig. 2), that the effectiveness of zeolite/phosphate pigments in 0,1% NaCl solution is higher than addition only of milled zeolite.

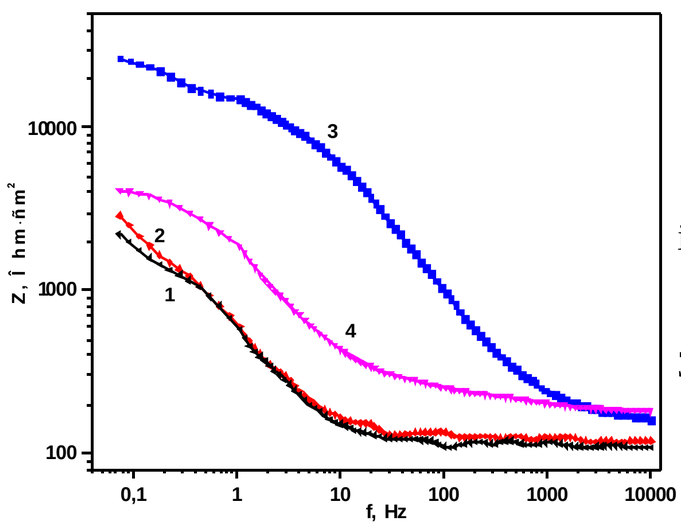

Fig. 2. Frequency dependences of the impedance modulus of D16T alloy: 1 - 0,1% NaCl, 2 - 0.1 % NaCl solution with the addition of milled zeolite, 3 - 0.1 % NaCl solution with the addition of zeolite milled with $Zn(H_2PO_4)_2$, 4 - 0.1 % NaCl solution with the addition of zeolite milled with $CaHPO_4$.

References

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Conclusion

The zeolite/ phosphate pigments effectively inhibits aluminum alloy corrosion in 0.1% NaCl solution.

The corrosion resistance of the D16T aluminum alloy in suspensions of complex zeolite/phosphate pigments is increased in about 6-15 times compared with the uninhibited corrosion medium.

The investigated pigments are characterized by mixed corrosion control of the aluminum alloy, showing the formation of corrosion-resistant film.

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