INHIBITION OF CORROSION OF THE Al-2.5Mg ALLOY BY MEANS OF VANILLIC ACID

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In anticorrosive pre-treatment of metals and alloys such as aluminum alloys chromates have been effectively used in wide industrial fields [1]. Because hexavalent chromium ion is highly toxic, treatments with chromium compounds are undesirable for safety control in industrial uses and protection of the environment. Hence, treatments with chromates tend to be eliminated from in the future.

The importance and wide application of alloys of aluminum with magnesium has provided an incentive for research into the possibility of inhibition of corrosion of unprotected Al-2.5Mg alloy using natural, non-toxic organic substances from rosemary leaves [2,3]. In this work examinations have been carried out of the efficiency of vanillic acid as inhibitor of corrosion of the Al-2.5Mg alloy. Vanillic acid is phenolic acid also isolated from rosemary (*Rosmarinus officinalis L.*).

Potentiodynamic polarization curves were performed using a potentiostat (PAR M273A) with the potential scanning rate of 2 mVs^{-1}. The electrochemical cell was of the usual type with a platinum counter electrode and a saturated calomel electrode (SCE) in contact with the working electrode via a Luggin capillary were used. The basic solution was deareated 3% NaCl (25°C) to which the additive was added in varying concentrations (from 1×10^{-7} to 1×10^{-3} M).

Figure 1 shows the potentiodynamic polarization curves for the Al-2.5Mg alloy in a 3% NaCl solution both with and without the vanillic acid in different concentrations. Fig.1 indicates that the addition of vanillic acid reduces the cathodic current density and affects anodic metal dissolution through the naturally formed oxide film. Since the measurements were carried out in deaerated solutions, the only cathodic reaction possible was hydrogen evolution, which takes place very slowly by dissociation of water molecules. The vanillic acid affects the cathodic hydrogen evolution, its effect weakening with the decrease in concentration.

The inhibition efficiency of the additive, *E*, and the surface coverage, Θ, were determined from the corrosion current density of the uninhibited and inhibited solution. Table 1 lists the values obtained. The observed changes in Θ are shown in Figure 2 as functions of concentrations of the vanillic acid. A plot of ln Θ against ln *C* is linear, which suggests that the Freundlich adsorption isotherm is obeyed. The value determined for standard free adsorption energy, ΔG^o_{ads}, of –10.93 KJ mol^{-1} indicates physical adsorption of an organic substance on the surface of the metal.

Vanillic acid readily donates a hydrogen atom (H^+ and e^-), thereby creating free phenoxy radicals, which form chelates together with Al^{3+} ions present in the solution. The chelates formed later precipitate on the surface of the metal, inhibiting its corrosion.

References:

(1) C.P. Dillon, Corrosion Control in the Chemical Process Industries, ed. McGraw-Hill, New York (1986), p.264.
(2) M. Kliškić, J. Radošević, S. Gudić, V. Katalinić, *J. Appl. Electrochem.*, **30** (2000) 823.
(3) J. Radošević, M. Kliškić, A. Višekruna, *Kem. Ind.*, 50 (2001) 537.

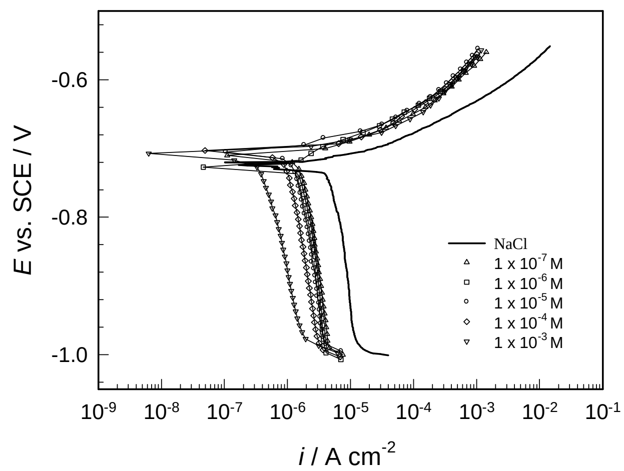

Fig. 1. Potentiodynamic polarization curves for Al-2.5Mg alloy in 3% NaCl in the absence and presence of varied concentrations of the vanillic acid.

Table 1. Surface coverage and efficiency for the Al-2.5Mg alloy in 3% NaCl solution in the presence of varied concentrations of the vanillic acid.

C / M	Θ	*E* / %
1×10^{-7}	0.6041	60.41
1×10^{-6}	0.6458	64.58
1×10^{-5}	0.6875	68.75
1×10^{-4}	0.7708	77.08
1×10^{-3}	0.8958	89.58

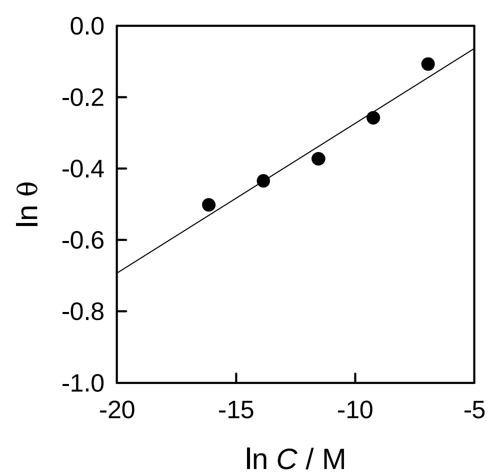

Fig. 2. Adsorption isotherm for the vanillic acid on the Al-2.5Mg alloy in 3% NaCl at 25°C.