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RSC Advances

ARTICLE

Electrochemical and Surface Evaluation of Anti-Corrosion Property of Reduced Graphene Oxide

Received 00th January 20xx,
Accepted 00th January 20xx

DOI: 10.1039/x0xx00000x

www.rsc.org/

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Supporting information:

1. Chemical composition of carbon steel

The chemical composition of carbon steel sample is summarized in Table S1

2. Possible mechanism of deoxygenation at the anode during the EPD process:

The possible mechanism of deoxygenation during the EPD process at the anode well documented by Ruoff and coworkers [1]. In summery deoxygenation could be occurred in an electrolysis cell in a three steps process including; (a) oxidation of carboxylate groups of GO to produce carboxylate radicals (eq. I), (b) formation of unpaired electrons by CO_2 losing and production of aryl radicals, *R.*, (eq. II), and finally (c) dimerization of radicals and electrochemically formation of RGON as below;

RCOO- ⟶ RCOO. + e- (I)

RCOO. ⟶ R. + CO_2 (II)

2R. ⟶ R-R (III)

3. Corrosion of iron base alloy in saline environments

The corrosion and rust formation on steel involves several steps including oxidation/reduction reactions. However, Scheme S1 depicts the corrosion phenomenon of iron base alloy in a chloride containing environment.

Anodic reaction occurs inside the corrosion site;

$$Fe \rightarrow Fe^{2+} + 2e^{-} \text{ (dissolution of iron)}$$

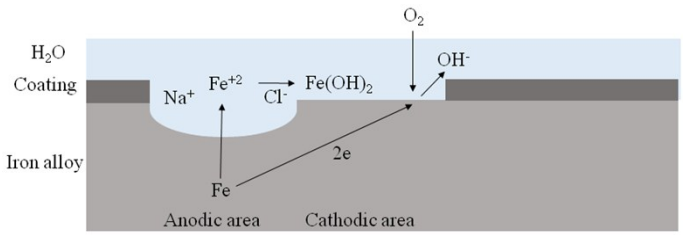
then, the electrons given up by the anode flow to the cathode (passivated surface) where they are discharged in the cathodic reaction;

$$O_2\,(g) + 2H_2O + 4e^{-} \rightarrow 4OH^{-}$$

As a result of these reactions the electrolyte enclosed in the corrosion site gains positive electrical charge in contrast to the electrolyte surrounding the corrosion site, which becomes negatively charged. The positively charged corrosion site attracts negative ions of chlorine Cl^{-} increasing acidity of the electrolyte according to the following reaction;

$$FeCl_2 + 2H_2O \rightarrow Fe(OH)_2 + 2HCl$$

Of course, it would be hardly possible to have all these reactions coexisting from a thermodynamics point of view. However, if any of these reactions is prevented, the corrosion will be inhibited [2].



Scheme S1: Schematic represent corrosion phenomenon of carbon steel in a chloride containing environment.

Table S1. Chemical composition of carbon steel sample used in this work other than Fe.

Composition of used carbon steel sample, elements other than Fe																
Element	C	Si	Mn	P	S	Cr	Mo	Ni	Cu	Nb	Ti	V	Sn	As	Ca	B
%	0.180	0.0828	0.459	0.0108	0.0210	0.0402	0.0032	0.0341	0.0566	0.0023	0.0017	0.0035	0.0022	0.0021	0.00092	0.00025

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[2] R. T. Loto, *J. Mater. Environ. Sci.,* 2013, 4 (4), 448-459.

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