سامية محمد مصطفى

شبكة المعلومات الجامعية

بسم الله الرحمن الرحيم

سامية محمد مصطفى

شبكة المعلومات الجامعية

شبكة المعلومات الجامعية

التوثيق الالكتروني والميكروفيلم

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سامية محمد مصطفى

جامعة عين شمس

التوثيق الإلكتروني والميكروفيلم

قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها علي هذه الأقراص المدمجة قد أعدت دون أية تغيرات

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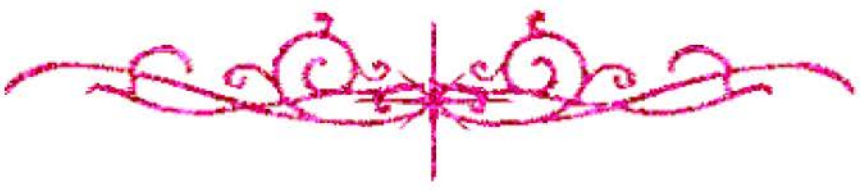
بعض الوثائق الأصلية تالفة



سامية محمد مصطفى

شبكة المعلومات الجامعية

بالرسالة صفحات لم ترد بالأصل

ELECTROCHEMICAL BEHAVIOR OF PASSIVE FILMS ON MOLYBDENUM-CONTAINING STAINLESS STEELS IN AQUEOUS SOLUTIONS

A Thesis

Presented to

Cairo University

By

Amany M. Fekry

(A.M.Fekry)

B. Sc.

Faculty of Science, Cairo University, 1999

In partial fulfillment of the requirements

For

The Degree of Master of Science(M. Sc.)

(Chemistry)

2003

Prof.Dr. Y.M. Issa
Vice Dean For Post Graduate Studies
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Approval Sheet

Title of the M. Sc. Thesis

Electrochemical Behavior of Passive Films on Molybdenum-Containing Stainless Steels in Aqueous Solutions

Name of the candidate: Amany M. Fekry

This thesis has been approved for submission by the supervisors:

1- Prof. Dr. Fakiha El-Taib Heakal

Signature: F. Heakal

2- Assistant Prof. Dr. Magda A. Ameer

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Faculty of Science-Cairo University.

Abstract

Name: Amany M. Fekry

Title of the thesis: Electrochemical Behavior of Passive Films on Molybdenum-Containing Stainless Steels in Aqueous Solutions.

Degree: M. Sc. Unpublished Master of Science Thesis
Faculty of Science-Cairo University, 2003.

This work has been carried out to study the behavior of passive films on molybdenum-containing austenitic stainless steels in aqueous universal buffer solutions with various pH values including acidic, neutral and basic ranges. Studies included also the effect of anion type and concentration of some corroding solutions, viz Na_2SO_4 and NaCl electrolytes, as well as the effect of N_2 gas. The techniques used are open-circuit, potentiodynamic (Tafel plots) and ac-electrochemical impedance spectroscopy (EIS).

Key Words: ac-impedance, Corrosion, Molybdenum, pH, Polarization, Stainless steel alloys, Tafel plots.

Supervisors: Prof. Dr. F. El-Taib Heakal, Assistant Prof. Dr. M. A. Ameer.

Prof. Dr. Sadek El-Said Abdo

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Statement

Beside the work carried out in this thesis, the candidate has attended and successfully passed a final examination of M. Sc. courses during the academic year 1999-2000 in non-organic chemistry covering the following topics:

1) Group symmetry
2) Quantum Chemistry
3) Adsorption
4) X-ray Analysis
5) Electrochemistry
6) Electrokinetic Phenomena
7) Molecular Structure Determination
8) Advanced Inorganic Chemistry
9) Non-Ionizing Solvents
10) Nuclear Chemistry
11) Metallurgy
12) Solar Energy
13) Chelatimetry
14) Molten Salts
15) Mathematical Modeling
16) Catalysis
17) Inorganic Reaction Mechanisms
18) Advanced Analytical Chemistry
19) Electrode kinetics
20) Statistical Thermodynamics
21) Physical Polymer
22) Solar Energy
23) Thermal Analysis
24) Mathematics
25) German Language

Prof. Dr. Sadek El-Said Abdo

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Contents

Section B

Section C

CHAPTER I

CHAPTER I

INTRODUCTION

AND LITERATURE REVIEW

English metallurgist Harry Brearly, working on a project to improve rifle barrels, accidentally discovered, in 1913, that adding chromium to low carbon steel gives it stain resistance. In addition to iron, carbon, and chromium, modern stainless steels may also contain other elements, such as nickel, niobium, molybdenum, and titanium. Nickel, molybdenum, niobium and chromium enhance the corrosion resistance of stainless steel. It is the addition of a minimum of 12 % chromium to the steel that makes it resists rust, or stain 'less' than other types of steel. The chromium in the steel combines with oxygen in the atmosphere to form a thin, invisible layer of chrome-containing oxide, called the passive film.

1- Types of stainless steels:

Stainless steels are generally subdivided according to their metallographic structures into three main categories, a) *Austenitic stainless steels* forming a family of stainless steels made up of two groups of materials [1] which are chromium-manganese-nickel types, or 200 series, and the chromium-nickel types, or 300 series. Austenitic steels have austenite as their primary phase (face centered cubic crystal). These are not hardenable by heat treatment (i.e. changing the structure and shape of steel by applying stress at low temperature). The most familiar stainless steel is probably Type 304, sometimes called T 304 or simply 304. Type 304 surgical stainless steel is an austenitic steel containing 18-20 % chromium and 8-10 % nickel, and Type 316 (similar to 304 with Mo added to increase opposition to various forms of deterioration), they offer the most resistance to corrosion in numerous standard services. Applications include cooking utensils, food processing

equipment, exterior architecture, equipment for the chemical industry, truck tailors, and kitchen sinks. b) *Ferritic stainless steels* which have ferrite (body centered cubic crystal) as their main phase. These steels contain iron and chromium, based on the type 430 composition of 17 % chromium. Ferritic steel is less ductile (i.e. ability to change shape without fracture) and is not hardenable by heat treatment. c) *Martensitic stainless steels* (orthorhombic martensite microstructure) are low carbon steels built around the type 410 composition of iron, 12 % chromium, and 0.12 % carbon. They may be tempered and hardened. Martensite gives steel great hardness, but it also reduces its toughness and makes it brittle, so few steels are fully hardened.

There are also other grades of stainless steels, such as precipitation-hardened, duplex, and cast stainless steels. Stainless steel can be produced in a variety of finishes and textures and can be tinted over a broad spectrum of colors. From the corrosion point of view, the austenitic alloys, especially those belonging to the 300 series exhibit resistance properties superior to those of the ferritic or martensitic steels.

2- Types of corrosion in stainless steels:

Johnson [2] reported that in the bioprocessing industry, stainless steels, because of the environment, would be subject to pitting corrosion, crevice corrosion and possibly stress corrosion cracking. It was shown that the resistance increased with an increase in the chromium, molybdenum, nitrogen and nickel content of the stainless steels.

Karlberg and Wranglen [3] studied the mechanism of crevice corrosion of stainless Cr steels in neutral 3 % NaCl solution. It was found that immediately after the start of an experiment, both pH and potential of steel