

Module 5 : Electrochemistry

Lecture 25 : Corrosion

Objectives

After studying this Lecture, you will be able to

- Outline the electrochemical basis for corrosion.
- Illustrate the use Pourbaix diagrams
- Outline the kinetic features involved in the corrosion process
- List the protective measures against corrosion and highlight the mechanisms involved in the protection.

25.1 Introduction

When common metals such as Fe, Cu and Zn are exposed to the environment, the surface of these materials gets deteriorated due to its interaction with the oxygen, moisture and other substances present in the environment. This process is referred to as corrosion. In the case of iron, the process is referred to as rusting. Due to corrosion, the surface of iron gets covered with brownish ferric oxide, Cu gets coated with a green deposit and Zn is covered with a white deposit. About 20% of production of these metals is to make up for the loss of these metals due to corrosion. The need for environmentally friendly technologies to combat corrosion can not be over emphasized.

The process of corrosion has an electrochemical (thermodynamic) basis. The surfaces of metals such as Fe, Cu, contain impurities and lattice defects and are reactive when they come in contact with air, moisture, acidic and or basic environments. One part of the surface acts as the anode of a galvanic cell and oxidation that occurs in this part results in the formation of $\text{Fe}^{2+}/\text{Cu}^{2+}$ ions. These ions go into the solution formed by the condensed water vapour or the acidic / basic fluids which come into contact with this part of the surface. The electrons released in this oxidation $\text{Fe} \rightarrow \text{Fe}^{2+} + 2e$, $\text{Cu} \rightarrow \text{Cu}^{2+} + 2e$ easily travel through the conducting medium of the metal until they come into contact with H^+ of an acidic neighborhood or $\text{O}_2/\text{H}_2\text{O}$ in a neutral or basic neighborhood and react with them. The reactions involved in these reduction processes are

Table 25.1 : Reduction reactions involved in corrosion

Reaction	Nature of the solution	E° / V
$\text{H}^+ + e \rightleftharpoons 1/2 \text{H}_2 (\text{g})$	acidic	0
$\text{O}_2 + 4\text{H}^+ + 4e \rightleftharpoons 2\text{H}_2\text{O}$	Acidic	1.23
$\text{O}_2 + 2\text{H}_2\text{O} + 4e \rightleftharpoons 4\text{OH}^-$	Neutral / basic	0.40

The movement/migrations of ions in the surrounding medium completes the "circuit" consisting of production of cations, electron flow (inside the metallic medium) and ionic movement.

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Handbook of Nanocomposite Supercapacitor Materials III Kamal K. Kar, 2021-04-25 This book covers the selection of nanocomposite supercapacitor materials. It describes the most important criteria behind the selection of materials for the electrode, electrolytes, separator, and current collectors, which comprise the key components of supercapacitors for advanced energy storage. It discusses the influence of each material on the unique electrochemical properties of nanocomposite supercapacitors with respect to their energy storage mechanism and stability under extreme and unpredictable conditions. This book is part of the Handbook of Nanocomposite Supercapacitor Materials. Supercapacitors have emerged as promising devices for electrochemical energy storage, playing an important role in energy harvesting for meeting the current demands of increasing global energy consumption. The handbook covers the materials science and engineering of nanocomposite supercapacitors, ranging from their general characteristics and performance to materials selection, design, and construction. Covering both fundamentals and recent developments, this handbook serves a readership encompassing students, professionals, and researchers throughout academia and industry, particularly in the fields of materials chemistry, electrochemistry, and energy storage and conversion. It is ideal as a reference work and primary resource for any introductory, senior level undergraduate, or beginning graduate course covering supercapacitors.

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