

Environmental Degradation of Materials - Video course

COURSE OUTLINE

The course will begin with emphasis on the importance of studying environmental degradation of materials. Fundamentals of environmental degradation of materials will be addressed beginning with thermodynamics and kinetics of electrochemical phenomena. Different forms of corrosion related to materials, environment and stress will be familiarized. Corrosion occurring in major environments will be treated. Experimental methods to assess and predict the rate of corrosion will be introduced. Fundamentals of high temperature oxidation of metals will be treated. This will be followed by principles and methodology of corrosion control. Degradation of various material classes such as polymers, composites and electronic materials will be discussed. In the end, future outlook in this important field of engineering will be presented.

COURSE DETAIL

Module Number	Module Title	Module Contents
1.	INTRODUCTION	Definitions Different forms of Environmental degradation Cost of Corrosion Electrochemical Nature Aims
2.	THERMODYNAMICS	Process at Interface Free Energy and Electrochemical Potential EMF Series Nernst Relationship Important Reactions Cell Potential Reference Electrodes Advanced Thermodynamics (E-pH Diagrams)
3.	KINETICS	Current Density and Corrosion Rate Corrosion Rate Expressions Exchange Current Density Polarization Experimental Techniques
4.	MIXED POTENTIAL THEORY	Postulates Applications to Active Metals
5.	PASSIVATION	Historical Interest Polarization Behaviour



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<http://nptel.iitm.ac.in>

Metallurgy and Material Science

Pre-requisites:

Introductory courses in materials science and physical chemistry.

Additional Reading:

1. Electrochemical Techniques in Corrosion Science and Engineering By R. G. Kelly, CRC Press, 2002.
2. ASM Handbook Volume 13A: Corrosion: Fundamentals, Testing, and Protection, ASM International 2003

Hyperlinks:

<http://www.nace.org/>

Coordinators:

Dr.Kallol Mondal
Department of Materials
and Metallurgical
Engineering IIT Kanpur

		Application of Mixed Potential Theory
6.	FORMS OF CORROSION: DIFFERENT FACTORS	Metal Purity Crystal Defects Grain Structure Concentration cells Velocity Temperature Humidity Stress Microbial effect Liquid metal effect
7.	FORMS OF CORROSION:	Uniform Galvanic Intergranular Crevice Pitting Dealloying Erosion Stress related corrosion
8.	CORROSION MEASUREMENT AND FAILURE ANALYSIS	Philosophy Laboratory Tests Test Specimens Electronic Probes
9.	HIGH TEMPERATURE OXIDATION	Reactions Thermodynamics Oxide Structure Oxide Growth Hot Corrosion
10.	CORROSION CONTROL: PHILOSOPHY	
11.	CORROSION CONTROL: MATERIALS SELECTION	Stainless Steels Nickel and Nickel Alloys Other Metal Alloys Plastics Nonmetallics
12.	CORROSION CONTROL: PROTECTIVE COATINGS	Metallic Coatings Conversion Coatings Organic Coatings Ceramic Coatings
13.	CORROSION CONTROL: INHIBITORS	Passivators Barrier Inhibitors Poisons Scavengers Neutralizers Mixed Potential Theory Approach
14.	CORROSION CONTROL: ELECTRICAL METHODS	Sacrificial Anode Cathodic Protection Impressed Current Cathodic Protection

		Anodic Protection Mixed Potential Theory Analysis
15.	CORROSION CONTROL BY DESIGN	Establishing Uniform Corrosion Minimization of Moisture Condensation Prevention of Galvanic Cells Prevention of Environment Cells Prevention of Corrosion-Mechanical Interactions Design for Inspection and Maintenance
16.	DEGRADATION OF POLYMERIC MATERIALS	Swelling and Dissolution Bond Rupture Weathering Other Processes Polymer Cycling and Degradation
17.	CORROSION OF COMPOSITE MATERIALS	Galvanic Effects Matrix Nature Reinforcement Nature Prevention
18.	FUTURE OUTLOOK	Corrosion and Society Research Industry

References:

1. Principles and Prevention of Corrosion (2nd Edition) By Denny A. Jones Prentice Hall, 1995.
2. Environmental Degradation of Materials, R Balasubramaniam, Cengage International, 2010.
3. Corrosion and Corrosion Control, H.H. Uhlig and W. Revie, Wiley, New York, 2007.
4. Corrosion Science and Technology, By David Talbot, James Talbot, CRC Press, 1998.
5. Corrosion Engineering By Mars. G. Fontana, Third ed., TMH.
6. Corrosion Basics: An Introduction By Pierre R. Roberge, 2nd Edition, NACE Press Book, 2006.