

Department of Materials Science and Engineering
University of Maryland, College park, Maryland

ENMA 464: Environmental Effects on Materials (Elective)

Course Description: Principles and prevention of environmental degradation of materials.

Prerequisites: ENES 230 or permission of both instructor and the department.

Textbook: Jones, Denny A., "Principles and Prevention of Corrosion"

Course Objectives: The annual cost of metallic corrosion in the United States is estimated to be 4% of the Gross National Product. The use of known control measures, design, and the proper selection of materials based on service environments can save billions of dollars each year. The main objective of this course is to teach students the importance of environmental effects on the reliability and projected service life of newly engineered or existing materials so that this information can be used as part of the design and materials selection/development process. Upon completion of this course a student should demonstrate the ability to:

- Identify the eight major forms of metallic corrosion.
- Understand the basic electrochemical aspects of metallic corrosion.
- Understand the measure that can be taken to prevent or control metallic corrosion.
- Understand the experimental techniques used to determine corrosion behavior.
- Understand environmental degradation processes in ceramics and polymers.

Topics Covered:

- I. Evaluation of Metallic Corrosion
Eight forms of corrosion
- II. Thermodynamic Aspects of Metallic Corrosion
Nernst equation and its relevance
Pourbaix (Potential – pH) diagrams
Four necessary components of an electrochemical cell
- III. Kinetic Aspects of Metallic Corrosion
Mixed potential theory
Evan's diagrams
- IV. Passivity and its Breakdown
Localized corrosion
Active-passive behavior of metals
Anodic protection
- V. Methods to Determine the Corrosion Rates of Metals
Tafel extrapolation
Ohmic resistance
- VI. Galvanic Corrosion
Galvanic series
Anode/Cathode area relationships

- VII. Atmospheric Corrosion
 - Electronic materials
- VIII. Environmentally Induced Cracking
 - Metallurgical effects
 - Electrochemical effects
- IX. Effects of Metallurgical Structure on Corrosion
 - Intergranular corrosion
 - Dealloying
- X. Cathodic Protection
 - Principles and applications
- XI. Environmental Degradation of Polymers
 - UV-damage
 - Moisture uptake
- XII. Ceramics
 - High Temperature Oxidation

Class Schedule:

Course Goals to meet ABET 2005 Criteria:

1. The relationships between radiation, heat, chemistry and mechanical stress to material degradation
2. Effects of chemical environment on material performance
3. Relationships between materials degradation to material properties

Contributions of course to meeting professional component:

This course is a survey course on the environmental degradation of metals and other materials. The fundamentals of environmental degradation processes and means to control or prevent these processes will be taught. The importance of including environmental compatibility in the acceptance criteria for selecting or developing a material for a specific application will be emphasized as the environment is an important element in determining the reliability and the service life of the material.

Relationship of course to program objectives:

This course introduces an important element in the materials selection process, i.e., environmental degradation. It provides a fundamental understanding of the field and the ability to solve engineering problems and design more reliable components/structures using newly engineered or existing materials.

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Last revised: April 1999