

MSE 597HT: HIGH TEMPERATURE CORROSION OF MATERIALS

Spring Semester, 2025

Objective: To introduce students to fundamental thermodynamic and kinetic phenomena associated with the high temperature corrosion of materials in reactive gases or liquids.

Instructor: Ken H. Sandhage
Reilly Professor of Materials Engineering
School of Materials Engineering
Office: Armstrong Hall (ARMS) 2319
Phone: (765) 496-8109
E-mail: sandhage@purdue.edu

Class Hours: Tuesdays/Thursdays from 10:30-11:45 am

Class Location: ARMS 3115

Prerequisites: MSE 260 (Thermodynamics) and MSE 340 (Transport Phenomena) or related courses with instructor permission

Textbook: No single textbook will be used. Typed lecture notes and supplemental reading (i.e., key journal papers, relevant books) will be provided for the particular topics of the course.

<u>Grading:</u>	Quizzes:	25%
	First Exam:	25%
	Second Exam:	25%
	Third Exam:	<u>25%</u>
	Total:	100%

Exams: The tentative dates/times of these exams are:

Exam #1: Tuesday, Feb. 11

Exam #2: Thursday, March 13

Exam #3: Thursday, May 1

Exceptions (for valid reasons) will require making prior arrangements with the instructor.

General Administrative Matters:

Mental Health/Wellness

If you're struggling and need mental health services, Purdue University is committed to advancing the mental health and well-being of its students. If you or someone you know is feeling overwhelmed, depressed, and/or in need of mental health support, services are available. For help, such individuals should contact Counseling and Psychological Services (CAPS) at 765-494-6995 during and after hours, on weekends and holidays, or by going to the CAPS offices in West Lafayette.

Campus Emergency Policy

General information on emergency preparedness at Purdue is available at: <http://www.purdue.edu/emergencypreparedness>. More specific information on emergency procedures for Armstrong Hall can be found at: <https://www.purdue.edu/ehps/emergency-preparedness/emergency-plans/bep/building-beps/arms-bep.html>. This information includes procedures for a fire alarm, tornado warning, and active threat (such as a shooting). In the event of a fire alarm, immediately evacuate Armstrong Hall and proceed to the Engineering Mall area away from the building. If a tornado warning has been issued for campus, move to the lowest level possible away from exterior doors and windows. Seek more information on storm conditions from National Weather Service weather radio or application on mobile device. Shelter in Place recommendation for an active threat such as a shooting: If one cannot get away, shelter in a room that is securable preferably without windows.

In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to change.

Academic Dishonesty

Purdue prohibits "dishonesty in connection with any University activity. Cheating, plagiarism, or knowingly furnishing false information to the University are examples of dishonesty." There are many dishonest ways to gain an advantage over another student in an assignment (including a quiz or exam). Rules cover any assignment for which the instructor will assign a grade.

The unauthorized reproduction of class notes, teaching material, quizzes, exams, and associated solutions will result in penalties that can include failing the class. No filming of lectures is authorized.

Class Topics:

- I. Introduction
 - A. Thermodynamics of High-Temperature Corrosion
 - B. Point Defect Chemistry of Corrosion Products
- II. Methods for Measurement of Corrosion Kinetics
- III. Common Oxidation Mechanisms and Associated Rate Laws
- IV. External Oxidation of Pure Metals
 - A. Parabolic Scaling
 - B. Short Circuit Diffusion
 - C. Oxidation of Oxygen-Soluble Metals
 - D. Oxidation with Multiple Oxide Scales
- V. Oxidation of Metallic Alloys
 - A. Internal Oxidation
 - B. Selective Planar External Oxidation
 - C. Stability of Planar Interfaces
- VI. Solid/Solid Displacement Reactions
- VII. Phase-Boundary-Controlled Oxidation
- VIII. Congruent Dissolution (Corrosion in Liquids)
 - A. Review of Polythermal (ternary) Phase Diagrams and Isothermal Projections
 - B. Molecular Diffusion (no convection) Dissolution
 - C. Convective Dissolution
- IX. Incongruent Dissolution (Corrosion in Liquids)