

The University of Western Ontario  
Chemistry 9525, Winter 2021  
Corrosion

**Instructor:**

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**Enrollment:**

To be capped at 20 students

**Description:**

The main objective of the course is to develop fundamental and deep knowledge in the theory for degradation and corrosion of materials in various environments. The course is targeted toward students who want to better understand corrosion mechanisms, design corrosion studies, mitigate or predict corrosion processes. Basics in thermodynamics, kinetics, and electrochemical reactions determining the corrosion mechanism of metals and alloys in aqueous systems will be given, however, for fundamental knowledge in electrochemistry, students are referred to the course 9452A (Electrochemistry). This course will specially focus on the recognition and understanding of different corrosion types, specific to certain metals, material designs, and environments. Depending on students' interests, non-metallic materials, such as polymers and textiles, high temperature corrosion, and atmospheric corrosion can also be covered. Basic knowledge in corrosion protection will also be covered.

**Topics:**

1. Thermodynamics of importance for the corrosion of metals in aqueous systems. Consideration and calculation of standard potentials, chemical dissociation constants, Nernst equation, and equilibrium potential-pH diagrams (Pourbaix diagrams).
2. Electrochemical reactions of metals in aqueous systems.
3. Corrosion kinetics. Activation polarization, concentration polarization, and resistance polarization.
4. Prerequisites, initiation, propagation, and failure for specific corrosion types:
  - a. Uniform corrosion
  - b. Localized corrosion types: crevice and pitting corrosion
  - c. Microstructure involved, and localized, types: selective corrosion, intergranular corrosion, dealloying
  - d. Galvanic corrosion
  - e. Mechanically induced corrosion types: Stress corrosion cracking, fatigue corrosion, fretting corrosion, erosion corrosion
  - f. Microbiologically induced corrosion and protein-induced corrosion
  - g. Atmospheric corrosion (tentative)

- h. High temperature corrosion (tentative)
  - i. Degradation of polymers (tentative)
5. Recognizing the most probable corrosion causes for a given material and environment. Analysis of corrosion cases, and special corrosion susceptibilities for different metallic materials.
6. Different tools to analyze corrosion: electrochemical methods, surface analytical tools, solution analytical tools, simple predictions, and chemical speciation models.
7. The most common corrosion protection methods and their individual advantages and risks.

### **Learning outcomes:**

1. Describe, identify, analyze, and compare different corrosion types on metals and alloys in different environments.
2. Explain why corrosion takes place using knowledge of the surrounding environment and the properties of the metallic materials.
3. Explain electrochemical reactions governing corrosion of metals and alloys and make simple calculations and estimations on corrosion rates in solution.
4. Suggest a strategy for corrosion testing and prediction for a given metallic material and surrounding.

### **Resources:**

An electronic copy of the course notes will be provided. Much useful information can also be found in:

- L.L. Shreir, Jarman, R.A., Burstein, G.T. (Eds.) Corrosion Metal/Environment Reactions, Butterworth Heinemann, 1994. [Link to e-book](#)
- E. McCafferty, Introduction to corrosion science, Springer Science & Business Media, 2010. [Link to e-book](#)
- Z. Ahmad, Principles of Corrosion Engineering and Corrosion Control, 1st ed., Elsevier Ltd, Oxford, 2006. [Link to e-book](#)
- D.E.J. Talbot, J.D.R. Talbot, Corrosion Science and Technology, 2nd ed. ed., CRC Press, Boca Raton, FL, 2007. [Link to e-book](#)
- N. Birks, G.H. Meier, F.S. Pettit, Introduction to the High Temperature Oxidation of Metals, 2 ed., Cambridge University Press, Cambridge, 2006. [Link to e-book](#)
- C. Leygraf, I. Odnevall Wallinder, J. Tidblad, T. Graedel, Atmospheric corrosion, John Wiley & Sons, 2016. [Link to e-book](#)
- D.W. Van Krevelen, K. Te Nijenhuis, Chapter 22 - Chemical Degradation, in: D.W. Van Krevelen, K. Te Nijenhuis (Eds.) Properties of Polymers (Fourth Edition), Elsevier, Amsterdam, 2009, pp. 779-786. [Link to chapter](#)

### **Lectures / seminars:**

3 h/week; Synchronous online format (live on Zoom), Tuesdays, 0930-1230 h

### **Evaluation** (tentative)

Four approved tasks (assignment or multimedia presentation), 25% each.

### **Course attendance and missed/late assignments**

If you are unable to meet a course requirement due to illness or other serious circumstances, you must provide valid medical or other supporting documentation to your instructor immediately. It is the student's responsibility to make alternative arrangements with their instructor once the accommodation has been approved and the instructor has been informed.

### **Notes on Academic Honesty**

Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at the following Web site:

[www.uwo.ca/univsec/pdf/academic\\_policies/appeals/scholastic\\_discipline\\_grad.pdf](http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_grad.pdf)

All required papers may be subject to submission for textual similarity review to the commercial plagiarism detection software under license to the University for detection of plagiarism. All papers submitted for such checking will be included as source documents in the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between The University of Western Ontario and Turnitin.com (<http://www.turnitin.com>).

### **Health and Wellness**

As part of a successful graduate student experience at Western, we encourage students to make their health and wellness a priority. Western provides several on campus health-related services to help you achieve optimum health and engage in healthy living while pursuing your graduate degree. For example, to support physical activity, all students, as part of their registration, receive membership in Western's Campus Recreation Centre.

Numerous cultural events are offered throughout the year. For example, please check out the Faculty of Music web page <http://www.music.uwo.ca/>, and our own McIntosh Gallery <http://www.mcintoshgallery.ca/>. Information regarding health- and wellness-related services available to students may be found at <http://www.health.uwo.ca/>. Students seeking help regarding mental health concerns are advised to speak to someone they feel comfortable confiding in, such as their faculty supervisor, their program director (graduate chair), or other relevant administrators in their unit. Campus mental health resources may be found at [http://www.health.uwo.ca/mental\\_health/resources.html](http://www.health.uwo.ca/mental_health/resources.html).