

**AGH**AGH UNIVERSITY OF SCIENCE  
AND TECHNOLOGY

Module name: Degradation of engineering materials

Academic year: 2019/2020 Code: CTCH-2-408-s ECTS credits: 3

Faculty of: Materials Science and Ceramics

Field of study: Chemical Technology Specialty: —

Study level: Second-cycle studies Form and type of study: Full-time studies

Lecture language: English Profile of education: Academic (A) Semester: 4

Course homepage: <http://home.agh.edu.pl/~zbgrzesik>

Responsible teacher: prof. dr hab. inż. Grzesik Zbigniew (grzesik@agh.edu.pl)

### Module summary

Students obtain basic information about degradation processes of engineering materials applied in different branches of industry. They will gain knowledge on protection methods against degradation.

### Description of learning outcomes for module

MLO code	Student after module completion has the knowledge/ knows how to/is able to	Connections with FLO	Method of learning outcomes verification (form of completion)
Social competence: is able to			
M_K001	He/she understands the need to reduce the degradation of engineering materials both economically and ecologically./ Rozumie potrzebę ograniczania degradacji materiałów inżynierskich zarówno w aspekcie ekonomicznym, jak i ekologicznym	TCH2A_K01	Activity during classes, Participation in a discussion
M_K002	He/she recognises the importance of basic research in the process of learning about physico-chemical phenomena occurring in the natural and industrial environment./ Dostrzega znaczenie badań podstawowych w procesie poznawania zjawisk fizykochemicznych, zachodzących w środowisku naturalnym i przemysłowym	TCH2A_K02	Activity during classes, Participation in a discussion
Skills: he can			
M_U001	The student is able to investigate the effects of degradation of materials and identify their causes./ Potrafi badać skutki degradacji materiałów i określać ich przyczyny	TCH2A_U01	Presentation, Participation in a discussion

M_U002	He/she is able to apply appropriate methods of limiting degradation of engineering materials./ Umie zastosować właściwe metody ograniczające degradację materiałów inżynierskich	TCH2A_U08	Activity during classes, Presentation, Participation in a discussion
Knowledge: he knows and understands			
M_W001	He/she knows the mechanisms of engineering material degradation processes./ Zna mechanizmy procesów degradacji materiałów inżynierskich	TCH2A_W01	Activity during classes, Presentation, Participation in a discussion, Test
M_W002	He/she knows thermodynamics of corrosion processes and methods of kinetics and mechanism of degradation of engineering materials./ Zna termodynamikę procesów korozji oraz metody badań kinetyki i mechanizmu degradacji materiałów inżynierskich	TCH2A_W01	Test, Presentation, Participation in a discussion

### Number of hours for each form of classes

Suma	Form of classes										
	Lectures	Auditorium classes	Laboratory classes	Project classes	Conversation seminar	Seminar classes	Practical classes	Fieldwork classes	Workshops	Prace kontrolne i przejściowe	Lektorat
30	0	0	0	0	0	30	0	0	0	0	0

### FLO matrix in relation to forms of classes

MLO code	Student after module completion has the knowledge/ knows how to/is able to	Form of classes										
		Lectures	Auditorium classes	Laboratory classes	Project classes	Conversation seminar	Seminar classes	Practical classes	Fieldwork classes	Workshops	Prace kontrolne i przejściowe	Lektorat
Social competence: is able to												
M_K001	He/she understands the need to reduce the degradation of engineering materials both economically and ecologically./ Rozumie potrzebę ograniczania degradacji materiałów inżynierskich zarówno w aspekcie ekonomicznym, jak i ekologicznym	-	-	-	-	-	-	+	-	-	-	-

M_K002	He/she recognises the importance of basic research in the process of learning about physico-chemical phenomena occurring in the natural and industrial environment./ Dostrzega znaczenie badań podstawowych w procesie poznawania zjawisk fizykochemicznych, zachodzących w środowisku naturalnym i przemysłowym	-	-	-	-	-	+	-	-	-	-	-
Skills: he can												
M_U001	The student is able to investigate the effects of degradation of materials and identify their causes./ Potrafi badać skutki degradacji materiałów i określać ich przyczyny	-	-	-	-	-	+	-	-	-	-	-
M_U002	He/she is able to apply appropriate methods of limiting degradation of engineering materials./ Umie zastosować właściwe metody ograniczające degradację materiałów inżynierskich	-	-	-	-	-	+	-	-	-	-	-
Knowledge: he knows and understands												
M_W001	He/she knows the mechanisms of engineering material degradation processes./ Zna mechanizmy procesów degradacji materiałów inżynierskich	-	-	-	-	-	+	-	-	-	-	-
M_W002	He/she knows thermodynamics of corrosion processes and methods of kinetics and mechanism of degradation of engineering materials./ Zna termodynamikę procesów korozji oraz metody badań kinetyki i mechanizmu degradacji materiałów inżynierskich	-	-	-	-	-	+	-	-	-	-	-

## Student workload (ECTS credits balance)

Student activity form	Student workload
Udział w zajęciach dydaktycznych/praktyka	30 h
Preparation for classes	20 h
przygotowanie projektu, prezentacji, pracy pisemnej, sprawozdania	15 h
Realization of independently performed tasks	7 h
Contact hours	5 h
Summary student workload	77 h
Module ECTS credits	3 ECTS

## **Additional information**

### **Module content**

#### **Seminar classes**

- 1.The general introduction to the thermodynamics of gaseous corrosion at high temperatures.
- 2.Experimental methods used in studying oxidation of metals and oxidation rate equations.
- 3.Wagner's theory of metal oxidation and dissociation theory of scale growth.
- 4.High temperature corrosion of engineering materials in purely oxidizing environments.
- 5.Liquid oxides and oxide evaporation, catastrophic oxidation.
- 6.Sulphide corrosion of metals and alloys.
- 7.Oxidation in the presence of water vapor.
- 8.Hot corrosion and salt-induced corrosion.
- 9.Corrosion in carbon containing atmospheres.
- 10.Oxidation in complex atmospheres.
- 11.High temperature corrosion in automobile industry.
- 12.Corrosion of ceramic materials.
- 13.Corrosion in aqueous environments.
- 14.Atmospheric corrosion. Inhibitors of corrosion.
- 15.Coatings for corrosion protection.

#### **Teaching methods and techniques:**

Seminar classes: The seminar classes are based on the multimedia and oral presentation of the students. Other important elements are the answers given by the students to received questions and the discussion between the students on the presented topic.

#### **Warunki i sposób zaliczenia poszczególnych form zajęć, w tym zasady zaliczeń poprawkowych, a także warunki dopuszczenia do egzaminu:**

In order to complete the course, a presentation on a chosen subject must be given and the student must take part in a discussion, which will be positively graded. In order to pass the subject in the secondary term, a positive grade must be obtained from a test on the entirety of the theoretical material.

#### **Zasady udziału w poszczególnych zajęciach, ze wskazaniem, czy obecność studenta na zajęciach jest obowiązkowa:**

Seminar classes:

- Attendance is mandatory: Yes
- Participation rules in classes: Students will present a topic provided by the lecturer in front of the group and take part in a discussion on the topic. Both the merit and the visual presentation will be graded.

#### **Method of calculating the final grade**

Final grade = 0.8 x grade from oral presentation + 0.2 x grade from participation in discussions

#### **Sposób i tryb wyrównywania zaległości powstałych wskutek nieobecności studenta na zajęciach:**

If the requirements are met for obtaining a passing grade, the student is required to independently catch up with the material. If he/she fails to do so, he/she must obtain a positive grade on a test that pertains to the material discussed during his absence.

### **Prerequisites and additional requirements**

No additional requirements

### **Recommended literature and teaching resources**

- 1.N. Birks, G.H. Meier and F.S Pettit, Introduction to the high temperature oxidation of metals, Cambridge, University Press, 2009.
- 2.W. Gao, Z. Li, High-temperature Corrosion and Protection of Materials, Woodhead Publishing in Materials, Cambridge, England, 2008.
- 3.ASM Handbook, Volume 13A, Corrosion: Fundamentals, Testing, and Protection. Materials Park, Ohio, USA, 2003.
- 4.A.S. Khanna, Introduction to High Temperature Oxidation and Corrosion, ASM International, Materials Park, 2002.
- 5.P. Kofstad, High Temperature Corrosion, Elsevier Applied Science, London 1988.
- 6.M.G. Fontana, Corrosion Engineering. Mc-Graw-Hill, 1986.
- 7.S. Mrowec, An Introduction to the Theory of Metal Oxidation, National Bureau of Standards and National Science Foundation, Washington D.C., 1982.
- 8.S. Mrowec and T. Werber, Modern Scaling-Resistant Materials, National Bureau of Standards and National Science Foundation, Washington D.C., 1982.
- 9.M. Pourbaix, Atlas of Electrochemical Equilibria in Aqueous Solutions. NACE International, 1966.

### **Scientific publications of module course instructors related to the topic of the module**

- 1.Z. Grzesik, S. Mrowec, "The influence of lithium on the kinetics and mechanism of manganese sulphidation", Corrosion Science, 48, 3186-3195 (2006).
- 2.Z. Grzesik, S. Mrowec, "On the sulphidation mechanism of niobium and some Nb-alloys at high temperatures", Corrosion Science, 50, 605-613 (2008).
- 3.M. Danielewski, Z. Grzesik, S. Mrowec, „On the oxidation mechanism of Ni-Pt alloys at high temperatures”, Corrosion Science, 53, 2785-2792 (2011).
- 4.Z. Grzesik, G. Smola, K. Adamaszek, Z. Jurasz, S. Mrowec, „High Temperature corrosion of valve steels in combustion gases of petrol containing ethanol addition”, Corrosion Science, 77, 369-374 (2013).
- 5.Z. Grzesik, G. Smola, K. Adamaszek, Z. Jurasz, S. Mrowec, „Thermal shock corrosion of valve steels utilized in automobile industry”, Oxidation of Metals, 80, 147-159 (2013).
- 6.Z. Grzesik, M. Migdalska, S. Mrowec, „The influence of yttrium on high temperature oxidation of valve steels”, High Temperature Materials and Processes, 34, 115-121 (2015).

### **Additional information**

No additional information