

**AGH**AGH UNIVERSITY OF SCIENCE  
AND TECHNOLOGY

Module name: Degradation of engineering materials

Academic year: 2018/2019 Code: CTC-2-310-AK-s ECTS credits: 3

Faculty of: Materials Science and Ceramics

Field of study: Chemical Technology Specjalty: Analityka i kontrola jakości

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

Lecture language: English Profile of education: Academic (A) Semester: 3

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

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

Academic teachers: prof. nadzw. dr hab. inż. Deja Jan (deja@agh.edu.pl)  
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			
M_K001	Rozumie potrzebę ograniczania degradacji materiałów inżynierskich zarówno w aspekcie ekonomicznym, jak i ekologicznym	TC2A_K01	Activity during classes, Participation in a discussion
M_K002	Dostrzega znaczenie badań podstawowych w procesie poznawania zjawisk fizykochemicznych, zachodzących w środowisku naturalnym i przemysłowym	TC2A_K06	Activity during classes, Participation in a discussion
Skills			
M_U001	Potrafi badać skutki degradacji materiałów i określać ich przyczyny	TC2A_U04	Presentation, Participation in a discussion
M_U002	Umie zastosować właściwe metody ograniczające degradację materiałów inżynierskich	TC2A_U23	Activity during classes, Presentation, Participation in a discussion
Knowledge			

M_W001	Zna mechanizmy procesów degradacji materiałów inżynierskich	TC2A_W01	Activity during classes, Presentation, Participation in a discussion, Test
M_W002	Zna termodynamikę procesów korozji oraz metody badań kinetyki i mechanizmu degradacji materiałów inżynierskich	TC2A_W01	Test, Presentation, Participation in a discussion

## 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	Others	E-learning
Social competence												
M_K001	Rozumie potrzebę ograniczania degradacji materiałów inżynierskich zarówno w aspekcie ekonomicznym, jak i ekologicznym	-	-	-	-	-	+	-	-	-	-	-
M_K002	Dostrzega znaczenie badań podstawowych w procesie poznawania zjawisk fizykochemicznych, zachodzących w środowisku naturalnym i przemysłowym	-	-	-	-	-	+	-	-	-	-	-
Skills												
M_U001	Potrafi badać skutki degradacji materiałów i określać ich przyczyny	-	-	-	-	-	+	-	-	-	-	-
M_U002	Umie zastosować właściwe metody ograniczające degradację materiałów inżynierskich	-	-	-	-	-	+	-	-	-	-	-
Knowledge												
M_W001	Zna mechanizmy procesów degradacji materiałów inżynierskich	-	-	-	-	-	+	-	-	-	-	-
M_W002	Zna termodynamikę procesów korozji oraz metody badań kinetyki i mechanizmu degradacji materiałów inżynierskich	-	-	-	-	-	+	-	-	-	-	-

## 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.

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

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

### **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

### **Student workload (ECTS credits balance)**

Student activity form	Student workload
Participation in seminar classes	30 h
Realization of independently performed tasks	7 h
Preparation for classes	20 h
Preparation of a report, presentation, written work, etc.	15 h
Contact hours	5 h
Summary student workload	77 h
Module ECTS credits	3 ECTS