AGH UNIVERSITY OF SCIENCE AND TECHNOLOGY

Module name: Physical Chemistry of Surfaces and Surface Analytical Techniques

Academic year: 2018/2019 Code: CIM-2-318-MN-s ECTS credits: 3

Faculty of: Materials Science and Ceramics

Field of study: Materials Science Specialty: Zaawansowane Materiały Ceramiczne

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: —

Responsible teacher: prof. nadzw. dr hab. inż. Jedliński Jerzy (jedlinsk@agh.edu.pl)

Academic teachers: prof. nadzw. dr hab. inż. Jedliński Jerzy (jedlinsk@agh.edu.pl)
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Module summary

Part I focuses on description of surfaces (physical and chemical), surface processes and surface-affected properties of materials, while part II deals with surface analytical methods

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	Potrafi pracować w zespole	IM2A_K02	
Skills			
M_U002	Potrafi scharakteryzować metody badania zjawisk i procesów zachodzących na powierzchni zewnętrznej i powierzchniach granicznych	IM2A_U06, IM2A_U01	
M_U003	Potrafi opisać procesy zachodzące na powierzchni zewnętrznej materiałów oraz na powierzchniach granicznych	IM2A_U05, IM2A_U02, IM2A_U09, IM2A_U01, IM2A_U11	
Knowledge			
M_W001	Zna najczęściej zachodzące zjawiska i procesy na powierzchni zewnętrznej oraz na powierzchnuach granicznych	IM2A_W03	

M_W002	Zna metody badania powierzchni zewnętrznej oraz powierzchni granicznych	IM2A_W02, IM2A_W08	
M_W003	Ma wiedzę w zakresie fizykochemicznego opisu procesów i zjawisk zachodzących na powierzchni zewnętrznej i powierzchniach granicznych i ich związku z właściwościami materiałów	IM2A_W03, IM2A_W02, IM2A_W09	
M_W004	Kształtuje odpowiedzialne podejście do wykonywanych zadań oraz rozumie potrzebę ciągłego aktualizowania swoich: wiedzy i umiejętności	IM2A_K03, IM2A_K08, IM2A_K02, IM2A_K06	

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	Potrafi pracować w zespole	-	-	-	-	-	+	-	-	-	-	-
Skills												
M_U002	Potrafi scharakteryzować metody badania zjawisk i procesów zachodzących na powierzchni zewnętrznej i powierzchniach granicznych	-	-	-	-	-	+	-	-	-	-	-
M_U003	Potrafi opisać procesy zachodzące na powierzchni zewnętrznej materiałów oraz na powierzchniach granicznych	-	-	-	-	-	+	-	-	-	-	-
Knowledge												
M_W001	Zna najczęściej zachodzące zjawiska i procesy na powierzchni zewnętrznej oraz na powierzchnuach granicznych	-	-	-	-	-	+	-	-	-	-	-
M_W002	Zna metody badania powierzchni zewnętrznej oraz powierzchni granicznych	-	-	-	-	-	+	-	-	-	-	-
M_W003	Ma wiedzę w zakresie fizykochemicznego opisu procesów i zjawisk zachodzących na powierzchni zewnętrznej i powierzchniach granicznych i ich związku z właściwościami materiałów	-	-	-	-	-	+	-	-	-	-	-

M_W004	Kształtuje odpowiedzialne podejście do wykonywanych zadań oraz rozumie potrzebę ciągłego aktualizowania swoich: wiedzy i umiejętności	-	-	-	-	-	+	-	-	-	-	-

Module content

Seminar classes

Physical chemistry of surfaces and surface analytical techniques
Content is divided into two following parts
Part I: Physical chemistry of surfaces:
1. Ideal and real surfaces
2. Thermodynamics of surfaces
3. The structure of surfaces.
4. Crystal thermodynamics (with relevance to surface)
5. Molecular and mechanical description of surfaces
6. Surface dynamics
7. Electrical properties of surfaces
8. Surface processes and properties (clean surface structure, reconstruction, solid-gas interface-general considerations, adsorption, catalysis by surfaces, mechanical properties of surfaces, friction, lubrication and adhesion, wetting, floating, detergency, growth of surface layers, catalytic growth of nanotubes and nanowires, structure formation by etching, various processes on solid surfaces, colloids and relevant processes)
Part II: Surface analytical techniques
9. Concept of selvedge
10. General description of the concept of surface analysis and approach
9. Interaction of the particles/radiation with matter: application to surface investigation
10. Parameters of surface methods
11. Electron spectroscopies: XPS (X-ray Photoelectron Spectroscopy), AES (Auger Electron Spectroscopy, SAM (Scanning Electron Microscopy)
12. Scattered Ion Mass Spectrometry of light ions: RBS (Rutherford Backscattering Spectrometry), ISS (Ion Scattered Spectrometry)
13. Ion-Beam Mass Spectrometry – emitted ions: SIMS (Secondary Ion Mass Spectrometry), SNMS (Sputtered Neutrals Mass Spectrometry)
14. Scanning Probe Microscopy (SPM): STM (Scanning Tunnelling Microscopy), AFM (Atomic Force Microscopy), other
15. Electron microscopies: SEM (Scanning Electron Microscopy), TEM (Transmission Electron Microscopy), Sample preparation methods to electron microscopy studies (FIB, ion-beam thinning, ...)
16. Glow Discharge Optical Emission Spectroscopy (GDOES)
27. Grazing Incidence X-Ray Methods

Method of calculating the final grade

Prezentacja/Presentation (50%) + Kolokwium końcowe/Final test (50%)

Prerequisites and additional requirements

1. English skills: general as well as field-related (scientific and technological)
2. Physics and chemistry at intermediate level (mainly solid state physics and chemistry)

Recommended literature and teaching resources

K.W. Kolasinski, Surface Science, 2nd Edition, Wiley & Sons, 2008
G.A. Somorjai, Introduction to Surface Chemistry and Catalysis, Wiley & Sons, 1994 or later
A.W. Adamson, A.P. Gast, Physical Chemistry of Surfaces 6th Edition, Wiley & Sons, 1997 or later
J.A. Venables, Introduction to surface and thin film processes, Cambridge University Press, 2000
G. Friedbacher, H. Bubert (Ed.), Surface and Thin Films Analysis, Wiley-VCH Verlag GmbH KGaA,Weinheim, 2011
S. Myhra, J.C. Rivere, Characterization of Nanostructures, CRC Press, Taylor & Francis Group, Bova Raton, 2012
D.J. O'Connor, B.A. Sexton, R.St.C. Smart, Surface Analysis Methods in Materials Science, Springer, Berlin-Heidelberg, 2nd Ed., 2003
Y. Leng, Materials Characterization, Wiley & Sons (Asia), Singapore, 2008
D. Brandon, W.D. Kaplan, Microstructural Characterization of Materials, 2nd Edition, John Wiley & Sons Ltd., Chichester, 2008
D.P. Woodruff, Modern Techniques of Surface Science, 3rd edition, Cambridge University Press, 2016

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

1. J. Jedliński, J.L. Grosseau Poussard, G. Smoła, G. Bonnet, M. Nocuń, K. Kowalski, and J. Dąbek, "The effect of alloyed and/or implanted yttrium on the mechanism of the scale development on β-NiAl at 1100oC", Materials at High Temperatures, 29 (2), 59-69 (2012)
2. J. Jedlinski, J.L. Grosseau-Poussard, M. Nocuń, G. Smoła, K. Kowalski, J. Dąbek, A. Rakowska, G. Bonnet "The Early Stages of the Scale Growth on FeCrAl(RE)-Type Alumina Formers"
Materials Science Forum, 696, 70-75 (2011)
3. H.J. Choi, J. Jedlinski, B. Yao, Y.H. Sohn
"Transmission electron microscopy observations on the phase composition and microstructure of the oxidation scale grown on as-polished and yttrium-implanted β-NiAl"
Surface & Coatings Technology, 205 (2010) 1206–1210
4. J. Jedlinski
"Application of 18O2 Exposure–Based Approach to Study the Failure Mechanisms of Oxide Scales on Alumina Formers"
Materials Science Forum, 513 (2006) 149-164
5. J. Jedliński, A. Bernasik, K. Kowalski and M. Nocun
"On the Application of SIMS to Study the Oxidation Behaviour of Alumina Formers"
Materials at High Temperatures, 22 (2005) 505-520
6. J. Jedliński
"Local and Microstructure-related Effects Affecting the High Temperature Oxidation of Alumina Formers: A Brief Survey"
Materials at High Temperatures, 22 (2005) 485-496
7. M. Nocuń, J. Jedliński, E. Leja
"Spectroscopic studies of hybrid glasses based on TEOS-cyclosiloxane systems"
Proc. XXth International Congress on Glass, Kyoto, 27.09-1.10.2004, Paper : P-11-031
8. J. Jedliński, M. Konopka, M. Goebel, A. Glazkov, A. Bernasik, M. Nocun, J. Camra, G. Borchardt
"The Use of XPS and SIMS in Studying the Early Oxidation Stages of FeCrAl-Based High Temperature Alloys"
Proc. 7th European Conference on Applications of Surface and Interface Analysis, ECASIA'97, Göteborg, 1997, Ed. I. Olefjord, L. Nyborg, D. Briggs, J. Wiley & Sons, Chichester, 1997, p. 259 – 262
9. K. Kowalski, A. Bernasik, A. Sadowski, J. Janowski, M. Radecka, J. Jedliński
"SIMS Investigation of Titanium Diffusion in Yttria Stabilised Zirconia"
Proc. 7th European Conference on Applications of Surface and Interface Analysis, ECASIA'97, Göteborg, 1997, Ed. I. Olefjord, L. Nyborg, D. Briggs, J. Wiley & Sons, Chichester, 1997, p. 259 – 262
10. A. Bernasik, K. Kowalski, A. Sadowski, J. Janowski, J. Jedliński
"XPS Study of the Surface Segregation in Yttria Stabilised Zirconia"
Proc. 7th European Conference on Applications of Surface and Interface Analysis, ECASIA'97, Göteborg, 1997, Ed. I. Olefjord, L. Nyborg, D. Briggs, J. Wiley & Sons, Chichester, 1997, p. 255 – 258
11. J. Jedliński, A. Glazkov, M. Konopka, G. Borchardt, E. Tscherkasova, M. Bronfin, M. Nocun
"An XPS/SEM/EDX study of the early oxidation stages of Fe19Cr5Al (Y) alumina-forming alloys at 1173 K"
Applied Surface Science, 103, 205 – 216 (1996)

Additional information
None

Student workload (ECTS credits balance)

Student activity form	Student workload
Participation in seminar classes	30 h
Examination or Final test	2 h
Realization of independently performed tasks	30 h
Preparation for classes	15 h
Summary student workload	77 h
Module ECTS credits	3 ECTS