

**AGH**AGH UNIVERSITY OF SCIENCE
AND TECHNOLOGY

Module name: Advanced Methods of Surface and Thin Films Investigation

Academic year: 2019/2020 Code: ZSDA-3-0133-s ECTS credits: 4

Faculty of: Szkoła Doktorska AGH

Field of study: Szkoła Doktorska AGH Specialty: —

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

Lecture language: English Profile of education: Academic (A) Semester: 0

Course homepage: —

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

Module summary

The first part will define the object of interest which will rely on description of ideal and real surfaces as well as of thin films in terms of formal approaches and the most important properties. Subsequently, the approach aimed at characterization of surfaces and thin films will be outlined. Afterwards, the methods and their selection rules will be described. Seminar will complete lectures with more practical issues, in particular with application of the methods in research approaches.

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)
Knowledge: he knows and understands			
M_W001	Description of ideal and real surfaces.	SDA3A_K01, SDA3A_W03, SDA3A_W01, SDA3A_U02, SDA3A_U05	Activity during classes
M_W002	Description of thin films	SDA3A_K01, SDA3A_W03, SDA3A_W02, SDA3A_U02, SDA3A_U05	Activity during classes
M_W003	Concepts of surface and thin films investigation	SDA3A_K01, SDA3A_W03, SDA3A_W01, SDA3A_U02, SDA3A_U05, SDA3A_U01	Activity during classes
M_W004	Description of analytical methods for surface and thin films investigation	SDA3A_K01, SDA3A_W03, SDA3A_W02, SDA3A_U02, SDA3A_U05, SDA3A_U01	Activity during classes
M_W005	Grasping the approach to selecting the analytical methods to research issues	SDA3A_K01, SDA3A_W03, SDA3A_W02, SDA3A_U06, SDA3A_U05	Activity during classes

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	18	0	0	0	0	12	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
Knowledge: he knows and understands												
M_W001	Description of ideal and real surfaces.	+	-	-	-	-	-	-	-	-	-	-
M_W002	Description of thin films	+	-	-	-	-	-	-	-	-	-	-
M_W003	Concepts of surface and thin films investigation	+	-	-	-	-	-	-	-	-	-	-
M_W004	Description of analytical methods for surface and thin films investigation	+	-	-	-	-	+	-	-	-	-	-
M_W005	Grasping the approach to selecting the analytical methods to research issues	+	-	-	-	-	+	-	-	-	-	-

Student workload (ECTS credits balance)

Student activity form	Student workload
Udział w zajęciach dydaktycznych/praktyka	30 h
Preparation for classes	15 h
przygotowanie projektu, prezentacji, pracy pisemnej, sprawozdania	20 h
Realization of independently performed tasks	10 h
Examination or Final test	2 h
Contact hours	2 h
Summary student workload	79 h
Module ECTS credits	4 ECTS

Additional information

Module content

Lectures

Ideal and real surfaces

1. General description
2. Thermodynamics of surfaces
3. The structure of surfaces

Thin films

1. General description and manufacturing methods
2. Examples

Methods of surface and thin films investigation

1. Concept of selvedge
2. General description of the concept and approach
3. Interaction of the particles/radiation with matter: application to surface investigation
4. Parameters of surface methods
5. Electron spectroscopies: XPS (X-ray Photoelectron Spectroscopy), AES (Auger Electron Spectroscopy), SAM (Scanning Electron Microscopy)
6. Scattered Ion Mass Spectrometry of light ions: RBS (Rutherford Backscattering Spectrometry), ISS (Ion Scattered Spectrometry)
7. Ion-Beam Mass Spectrometry - emitted ions: SIMS (Secondary Ion Mass Spectrometry), SNMS (Sputtered Neutrals Mass Spectrometry)
8. Scanning Probe Microscopy (SPM): STM (Scanning Tunnelling Microscopy), AFM (Atomic Force Microscopy), other
9. Auxiliary methods:
 - a. SEM (Scanning Electron Microscopy)
 - b. TEM (Transmission Electron Microscopy)
 - c. Sample preparation methods to electron microscopy studies (FIB, ion-beam thinning, ...)

Selection of the experimental methods

1. Selection rules
2. Examples

Seminar classes

Ideal and real surfaces

1. Molecular and mechanical description of surfaces
2. Surface dynamics
3. Electrical properties of surfaces

Thin films in materials

Surface processes in thin film devices

Methods of surface and thin films investigation

Examples of the application of surface and thin films analytical methods to materials science-related issues

Teaching methods and techniques:

Lectures: Lectures with numerous practical examples and discussion

Seminar classes: Individual and team work on specific topics, discussions

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

The activity of students as well as the quality of their work on specific topics (presentation or projects) will be assessed. If necessary: final test will be carried out.

Correction route will be tailored to the sort of backlogs.

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

Lectures:

- Attendance is mandatory: No

- Participation rules in classes: Non-obligatory

Seminar classes:

- Attendance is mandatory: Yes

- Participation rules in classes: Obligatory

Method of calculating the final grade

Results of individual work (presentation and/or project) : 80%, activity: 20%

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

Individual approach, depending on the number and sort of classes missed

Prerequisites and additional requirements

1. English skills enabling participation at classes

2. Knowledge relevant to master level of studies in: physics, chemistry, including crystallography, thermodynamics (reference: curricula of technological studies)

Recommended literature and teaching resources

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, Boca 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

K.W. Kolasinski, Surface Science, 2nd Edition, Wiley & Sons, 2008

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 1100°C", Materials at High Temperatures, 29 (2), 59-69 (2012)

2. J. Jedliński, 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. J. Jedliński, J.L. Grosseau-Poussard

„Zastosowanie spektroskopii fotoluminescencyjnej w badaniu zgorzelin tlenkowych narastających na materiałach z grupy alumina formers”

Ochrona przed korozją, 54 (2011) 308-310

4. H.J. Choi, J. Jedliński, 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

5. J. Jedliński

"Application of 18O₂ Exposure-Based Approach to Study the Failure Mechanisms of Oxide Scales on Alumina Formers"

Materials Science Forum, 513 (2006) 149-164

6. 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

7. 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

8. 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

9. 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

10. 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

11. 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

12. 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