Surface Engineering

Course description sheet

Basic information

Field of study Materials Science	**Didactic cycle** 2023/2024
Major All	**Course code** CIMAS.IIi1.03452.23
Organisational unit Faculty of Materials Science and Ceramics	**Lecture languages** English
Study level Second-cycle (engineer) programme	**Mandatoriness** Obligatory
Form of study Full-time studies	**Block** Foundation Modules
Profile General academic	**Course related to scientific research** Yes

Course coordinator	Karol Kyzioł
Lecturer	Karol Kyzioł, Elżbieta Godlewska, Krzysztof Mars, Marzena Mitoraj-Królikowska

Period	**Method of verification of the learning outcomes**	**Number of ECTS credits**
Semester 1	Completing the classes **Activities and hours** Lectures: 15 Workshop classes: 45	4

Goals

C1	Providing students with knowledge about the role of surface engineering in generating the functional properties of construction materials, as well as the properties and applications of selected layers and coatings in industry
C2	Providing students with knowledge about methods for surface modification of materials and principles for designing substrate-layer/coating systems
C3	Practical course (workshops) for students - providing students with practical knowledge about selected processes of layer and coating synthesis in plasmochemical reactors, with the help of immersion techniques (dip-coating, spin-coating), by electrophoresis, in anodizing processes, as well as selected methods of studying the physicochemical and functional properties of modified surfaces

Course's learning outcomes

Code	Outcomes in terms of	Learning outcomes prescribed to a field of study	Methods of verification
Knowledge – Student knows and understands:			
W1	Understands the influence of materials engineering on the development of modern technologies	IMT2A_W01	Activity during classes, Participation in a discussion, Report, Test results
W2	Has extended knowledge of solid state physics necessary to understand phenomena associated with the manufacturing of metallic, ceramic, polymeric materials and composites, their behaviour during operation and their physical degradation	IMT2A_W01, IMT2A_W04	Activity during classes, Involvement in teamwork, Test results, Completion of laboratory classes
W3	Has extended knowledge of chemistry necessary to understand phenomena associated with the manufacturing of metallic, ceramic, polymeric materials and composites, and to determine their chemical degradation	IMT2A_W01	Activity during classes, Participation in a discussion, Report, Involvement in teamwork
Skills – Student can:			
U1	Can search for necessary information in scientific journals, books, databases, and other available sources; can verify reliability, integrate and interpret the acquired data, draw and formulate conclusions from said data, as well as critically discuss opinions in the field of materials science.	IMT2A_U01	Activity during classes, Participation in a discussion, Report, Test results
U2	Can apply knowledge in the field of materials surface engineering, can properly select methods for modifying the outer layer of materials by means of choosing the optimal layer/coating materials and the appropriate fabrication processes	IMT2A_U04	Participation in a discussion, Report, Test results, Completion of laboratory classes
Social competences – Student is ready to:			
K1	Understands the importance of surface engineering in technological progress. Is aware of potential risks and adverse effects of industrial development on the environment and the responsibility that comes with such activities.	IMT2A_K03	Participation in a discussion, Report, Test results

Program content ensuring the achievement of the learning outcomes prescribed to the module

Acquires knowledge of the structure and properties of material surfaces, as well as surface modification methods used both on a laboratory scale and in industry.

Student workload

Activity form	Average amount of hours* needed to complete each activity form
Lectures	15
Preparation for classes	10
Realization of independently performed tasks	13
Contact hours	5
Preparation of project, presentation, essay, report	10
Workshop classes	45
Examination or final test/colloquium	2
Student workload	**Hours** 100
Workload involving teacher	**Hours** 60

* hour means 45 minutes

Program content

No.	Program content	Course's learning outcomes	Activities
1.	General scope: importance of surface engineering for industry, surface treatment methods, micro- and macroscale surface structure, adsorption, adhesion and mechanical stablility of surface layers, methods for depositing thin films and coatings (physical and chemical vapour deposition, thermal spraying, chemical and electrochemical deposition from solutions), selected testing methods (micromechanical measurements, evaluation of corrosion and oxidation resistance, evaluation of selected physical properties), selected applications/functions of thin films and coatings, nanostructured layers and their specific properties.	W1, W2, W3, U1, K1	Lectures

No.	Program content	Course's learning outcomes	Activities
2.	Workshop classes (15x3h), scope: - layer deposition using the magnetron method (incl. target synthesis using the Induction Hot Pressing method), obtaining metallic coatings using the electrochemical method, obtaining protective layers in RF CVD and MO CVD reactors, structure and synthesis of coatings for high-temperature applications, obtaining thin layers using the molecular beam method in UHV conditions, treatment of biomedical polymers using low-temperature plasma, the use of immersion techniques (spin-coating and dip-coating) to modify medical alloys in order to obtain coatings based on biopolymers - performing physical property measurements on layers and analysis of their chemical compositions, electrochemical methods of surface studies, application of X-ray reflectometry in the study of thin layers, using a profilometer and atomic force microscope to analyse the surface topography of metallic and polymeric materials Classes will be conducted in the form of workshops. During the first class, the students will choose their topics, which they will then realise in the following weeks. The student's duty is to pass 13 classes (from 15 possible), which, at the academic teacher discretion, will include a short theoretical introduction to the realised topic, laboratory or project classes (in order to acquire practical skills), as well as discussion/analysis of the research problem.	W3, U1, U2, K1	Workshop classes

Extended information/Additional elements

Teaching methods and techniques :

Lectures, Work with source text, Workshop, Discussion, Case study, Group work

Activities	Methods of verification	Credit conditions
Lectures	Activity during classes, Test results	Satisfactory results of final test.
Workshop	Activity during classes, Participation in a discussion, Report, Involvement in teamwork, Completion of laboratory classes	Completion of at least 13 workshop classes (from 15 possible), a positive assessment of the student's theoretical knowledge and the report.

Conditions and the manner of completing each form of classes, including the rules of making retakes, as well as the conditions for admission to the exam

Consistent with general regulations at AGH UST. Details provided during the first meeting.

Method of determining the final grade

Final score = 0.5 final test + 0.4 workshop + 0.1 attendence in lectures

Manner and mode of making up for the backlog caused by a student justified absence from classes

To be decided individually with the lecturer.

Prerequisites and additional requirements

Students of the course are expected to have basic knowledge of materials chemistry and physics.

Rules of participation in given classes, indicating whether student presence at the lecture is obligatory

Students will attend lectures and get acquainted with consecutive topics listed in the syllabus. Students are expected to ask questions and participate in discussions, as well as systematically work on reading assignments recommended by the lecturer. Video or audio recording is not allowed without consent from the lecturer. Attendance is strongly recommended.

Literature

Obligatory

1. C.B. Alcock: Thermochemical Processes, Principles and Models, Butterworth Heinemann (2001)
2. Deborah D.L. Chung: Composite Materials/Functional Materials for Modern Technologies, Springer (2003)
3. J. Dereń, J. Haber, R. Pampuch, Chemia Ciała Stałego, PWN (1975)
4. T. Burakowski, T. Wierzchoń, Inżynieria powierzchni metali, PWN (1995)
5. C.B. Carter, M.G. Norton: Ceramic Materials Science and Engineering, Springer (2007)

Optional

1. Lecture notes and recommended reading assignments/research articles

Scientific research and publications

Research

1. Surface modification of engineering materials in plasma conditions and application of immersion techniques
2. Deposition of protective coatings using CVD and PVD methods, characteristics of modified surfaces
3. Diffusion and reactions in solids - thermodynamics and kinetics

Publications

1. M. Mitoraj-Królikowska, E. Godlewska, Oxidation resistance and micromechanical properties of a Ti–46Al–8Nb (at.%) alloy with Cr–Si magnetron-sputtered coatings, Surface and Coatings Technology, 350 (2018), 732 - 739, https://doi.org/10.1016/j.surfcoat.2018.07.073
2. R. Gaweł, K. Kyzioł, Z. Jurasz, Z. Grzesik, Oxidation resistance of valve steels covered with thin SiC coatings, obtained by RF CVD, Corrosion Science, 145 (2018) 16–25, https://doi.org/10.1016/j.corsci.2018.09.014
3. K. Kyzioł, J. Rajczyk, K. Wolski, A. Kyzioł, B. Handke, Ł. Kaczmarek, Z. Grzesik, Dual-purpose surface functionalization of Ti-6Al-7Nb involving oxygen plasma treatment and Si-DLC or chitosan-based coatings, Materials Science & Engineering C, 121 (2021) 111848, https://doi.org/10.1016/j.msec.2020.111848
4. M. Mitoraj, E. Godlewska, O. Heintz, N. Geoffroy, S. Fontana, S. Chevalier, Scale composition and oxidation mechanism of the Ti-46Al-8Nb alloy in air at 700 and 800C, Intermetallics, 19 (2011), 39–47, https://doi.org/10.1016/j.intermet.2010.09.006

Learning outcomes prescribed to a field of study

Code	Content
IMT2A_K03	Ma świadomość ważności i zrozumienia pozatechnicznych aspektów i skutków działalności inżynierskiej, w tym jej wpływu na środowisko i związanej z tym odpowiedzialności za podejmowane decyzje, przestrzega zasady etyki zawodowej oraz rozumie znaczenie wpływu inżynierii materiałowej na rozwój nowoczesnych technologii
IMT2A_U01	Potrafi pozyskiwać informacje z literatury, baz danych i innych źródeł; potrafi integrować uzyskane informacje, dokonywać ich interpretacji i krytycznej oceny, a także wyciągać wnioski oraz formułować i wyczerpująco uzasadniać opinie
IMT2A_U04	Potrafi optymalnie dobrać metody i narzędzia służące do rozwiązania zadań typowych dla inżynierii materiałowej uwzględniających kryteria doboru materiału i procesu wytwórczego
IMT2A_W01	Ma poszerzoną i pogłębioną wiedzę w zakresie nauk podstawowych niezbędną do zrozumienia zjawisk występujących przy wytwarzaniu, badaniu oraz eksploatacji materiałów inżynierskich
IMT2A_W04	Ma pogłębioną, podbudowaną teoretycznie wiedzę z zakresu różnych metod pomiarowych i technik badawczych stosowanych w inżynierii materiałowej