AGH UNIVERSITY OF SCIENCE AND TECHNOLOGY

Module name: Light metals and alloys

Academic year: 2019/2020 Code: NIMN-2-212-s ECTS credits: 5

Faculty of: Non-Ferrous Metals

Field of study: Inżynieria Metali Nieżelaznych Specialty: —

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

Lecture language: English Profile of education: Academic (A) Semester: 2

Course homepage: —

Responsible teacher: dr hab. inż. Kula Anna (kula@agh.edu.pl)

Module summary

he course provides the basic knowledge in the field of light metals and its alloys. The course will be focused on light metals and alloys, which are perspective for structural applications in the different branches of industry. In particular, aluminum, magnesium and titanium alloys will be discussed in terms of its properties, microstructure and processing. Advantages and disadvantages will be emphasized and the possible solutions for alloys limitations will be provided.

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)
Skills: he can			
M_U001	Student understands significance of light metals and alloys in materials science and industrial applications	IMN2A_U02	Participation in a discussion, Presentation, Examination
M_U002	Student is able to perform and determine mechanical properties of light metals and alloys	IMN2A_U06	Completion of laboratory classes, Execution of laboratory classes, Report, Activity during classes
Knowledge: he knows and understands			
M_W001	Student has basic knowledge in the field of light metals such as: aluminum, magnesium and titanium	IMN2A_W03	Report, Project, Examination, Completion of laboratory classes, Activity during classes
M_W002	Student has extended knowledge on the manufacturing, processing and properties of the group of light metals and alloys	IMN2A_W05, IMN2A_W04	Execution of laboratory classes, Project, Examination, Activity during classes

Number of hours for each form of classes

	Form of classes										
Suma	Lectures	Auditorium classes	Laboratory classes	Project classes	Conversation seminar	Seminar classes	Practical classes	Fieldwork classes	Workshops	Prace kontrolne i przejściowe	Lektorat
60	30	0	15	0	0	15	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
Skills: he can												
M_U001	Student understands significance of light metals and alloys in materials science and industrial applications	+	-	+	-	-	-	-	-	-	-	-
M_U002	Student is able to perform and determine mechanical properties of light metals and alloys	-	-	+	-	-	+	-	-	-	-	-
Knowledge: he knows and understands												
M_W001	Student has basic knowledge in the field of light metals such as: aluminum, magnesium and titanium	+	-	-	-	-	+	-	-	-	-	-
M_W002	Student has extended knowledge on the manufacturing, processing and properties of the group of light metals and alloys	+	-	-	-	-	+	-	-	-	-	-

Student workload (ECTS credits balance)

Student activity form	Student workload
Udział w zajęciach dydaktycznych/praktyka	60 h
Preparation for classes	30 h
przygotowanie projektu, prezentacji, pracy pisemnej, sprawozdania	15 h
Realization of independently performed tasks	25 h
Examination or Final test	2 h
Contact hours	5 h
Summary student workload	137 h
Module ECTS credits	5 ECTS

Additional information

Module content

Lectures

Lecture Topics:

1. The light metals – general introduction
2. Aluminum alloys: Physical metallurgy of aluminum alloys
3. Classification of aluminum alloys based on different criterions:
a) Cast aluminum alloys
b) Wrought aluminum alloys
c) Non-heat treatable aluminum alloys
d) Heat-treatable aluminum alloys
4. Principle strengthening mechanisms operating in aluminum based alloys – examples to each aluminum alloy series
5. Magnesium and its alloys: Physical metallurgy of magnesium alloys
6. Classification of magnesium based alloys
a) Cast magnesium alloys
b) Wrought magnesium alloys
6. Deformation behaviour of magnesium and its alloys alloys
7. Titanium and its alloys
8. Novel-light based materials and processing methods

Laboratory classes

At laboratory classes students will be acquainted to novel materials processing technology like Rapid Solidification (RS). RS technique will be used to produced light based materials with enhanced mechanical properties with comparison to its traditionally cast counterparts. Detailed description of project classes:
1. Rapid solidification of light-based alloys combined with plastic consolidation by hot extrusion
2. Mechanical properties of as-extruded RS materials. In comparison purposes mechanical properties of traditionally cast and extruded (IM) light-based alloys will be studied as well.

3. SEM observations of RS ribbons and as extruded RS and IM materials.

Based on project classes students are obligated to prepare report, which include every step of experiments performed during classes.

Seminar classes

Presentations of students on chosen subject in the field of light metals and alloys. Students are encouraged to prepare their presentations based on ongoing research in the area of aluminum, magnesium and titanium alloys. Interesting research topics are provided in the scientific journals like: Materials Science and Engineering, Materials & Design, International Journal of Plasticity, Journal of Alloys and Compounds, Scientific Reports etc., thus students are encourage to chose presentation subject based on research papers.

Examples of the presentations topics:

1. Recycling of aluminum and its alloys
2. Recent progress in corrosion and protection of magnesium alloys
3. Recent development of magnesium alloys as biodegradable materials
4. Mechanisms for enhanced plasticity in magnesium alloys
5. Role of solute in the texture modification during hot deformation of Mg-rare earth alloys
6. Superplasticity of ultrafine-grained Al–Mg–Sc–Zr alloy
7. High strength beta titanium alloys: New design approach

Teaching methods and techniques:

Lectures: Treści prezentowane na wykładzie są przekazywane w formie prezentacji multimedialnej w połączeniu z klasycznym wykładem tablicowym wzbogaconymi o pokazy odnoszące się do prezentowanych zagadnień.
Laboratory classes: W trakcie zajęć laboratoryjnych studenci samodzielnie rozwiązują zadany problem praktyczny, dobierając odpowiednie narzędzia. Prowadzący stymuluje grupę do refleksji nad problemem, tak by otrzymane wyniki miały wysoką wartość merytoryczną.
Seminar classes: Na zajęciach seminaryjnych podstawą jest prezentacja multimedialna oraz ustna prowadzona przez studentów. Kolejnym ważnym elementem kształcenia są odpowiedzi na powstałe pytania, a także dyskusja studentów nad prezentowanymi treściami.

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

At the end of semester students knowledge will be evaluated by exam, which covers course programme delivered at lecture classes. Three exam dates will be provided. If all of the exam dates will be missed due to an unnotified miss a zero will be given for the exam test. Exceptional circumstances will be considered on an individual basis. Positive grades from laboratory and seminar classes are required in order to proceed exam.

Each of laboratory class starts with a test, which covers the basic principles assigned to particular laboratory subject. If a test result is negative, student is obligated to repeat the test during contact hours within two following weeks. Based on laboratory classes students are obligated to prepare report, which include every step of experimental procedure performed during classes including received results, discussion and conclusions. At the last laboratory classes, the comprehensive test is assigned, which covers all laboratory subjects and objectives delivered during classes.

Final mark of laboratory classes is evaluated as follows:

OL – 0.5• OZ + 0.5• OR
OL – final mark from laboratory class
OZ – test mark
OR – report mark

Positive mark from seminar classes (OS) is given for student who realizes and presents the project in the form of presentation based on selected subject in the field of light metals and alloys. Presentation is evaluated based on the following criterions:
1) The presentation content (scientific value), 25%
2) Discussion, 25%
3) Aesthetics value of presentation, 25%
4) Delivery of presentation, 25%

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

Lectures:
– Attendance is mandatory: No
– Participation rules in classes: Studenci uczestniczą w zajęciach poznając kolejne treści nauczania zgodnie z syllabusem przedmiotu. Studenci winni na bieżąco zadawać pytania i wyjaśniać wątpliwości. Rejestracja audiowizualna wykładu wymaga zgody prowadzącego.
Laboratory classes:
– Attendance is mandatory: Yes
– Participation rules in classes: Studenci wykonują ćwiczenia laboratoryjne zgodnie z materiałami udostępnionymi przez prowadzącego. Student jest zobowiązany do przygotowania się w przedmiocie wykonywanego ćwiczenia, co może zostać zweryfikowane kolokwium w formie ustnej lub pisemnej. Zaliczenie zajęć odbywa się na podstawie zaprezentowania rozwiązania postawionego problemu.
Seminar classes:
– Attendance is mandatory: Yes
– Participation rules in classes: Studenci prezentują na forum grupy temat wskazany przez prowadzącego oraz uczestniczą w dyskusji nad tym tematem. Ocenie podlega zarówno wartość merytoryczna prezentacji, jak i tzw. kompetencje miękkie.

Method of calculating the final grade

EVALUATION (Method & Grade Distribution):

OK = 0.3• OL + 0.2• OS + 0.5• OE

OK – Final Grade
OL – grade from laboratory classes
OS – grade from seminar classes
OE – grade from lecture exam

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

Lecture classes are not mandatory, thus the subject can be studied independently by student based on the available literature.

Seminar classes are mandatory and students are obligated to participate in that type of classes. Absence can be justify only in extreme circumstances. Classes which are missed can be countervailed by independent studies of the subject discussed during the student absence.

Laboratory classes are mandatory and students are obligated to participate in that type of classes. Absence can be justify only in extreme circumstances. Classes which are missed can be worked out by participating in the classes of another laboratory group which realizes the same laboratory subject or by individual studying of particular research subject.

Prerequisites and additional requirements

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Recommended literature and teaching resources

PRIMARY TEXT BOOK:
I. J. Polmear “Light alloys from traditional alloys to nanocrystals”, 4th edition, Elsviever, UK 2006

SUPLEMENTARY TEXT BOOKS:
C. S. Roberts “Magnesium and its Alloys”, Wiley, NJ, USA, 1960
G.E.Totten, D.S. MacKenzie “Handbook of Aluminium”, 2002
L. L. Rokhlin, “Magnesium alloys containing rare earth metals: Structure and properties”, Taylor & Francis, London, 2003
W. Sha & S. Malinov “Titanium Alloys, Modelling of Microstructure, Properties and Applications”, Woodhead Publishing 2009

and other available

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

1. A. Kula, M. Bronicki, J. Sobota, „Wpływ dodatków skandu oraz cyrkonu na strukturę i własności aluminium”, Rudy i Metale Nieżelazne, R 51 (2006) – 2, s. 97 – 105
2. M. Bugnet, A. Kula, M. Niewczas, G.L. Botton „Segregation and clustering of solutes at grain boundaries in Mg-rare earth solid solutions”, Acta Materialia (2014), 79, p. 66-73
3. A. Kula, K. Noble, R.K. Mishra, M. Niewczas „Plasticity of Mg–Gd alloys between 4 K and 298 K”, Philosophical Magazine (2016), vol. 96, p.134-165
4. A. Kula, X. Jia, R.K. Mishra, M. Niewczas „Flow stress and work-hardening of Mg-Y alloys between 4K and 298K”, International Journal of Plasticity (2017), vol. 92, 96-121
5. A. Kula, C. Silva, M. Niewczas “Grain size effect on deformation behaviour of Mg–Sc alloys” Journal of Alloys and Compounds (2017), vol. 727, p.642-657
6. L. Blaz, A. Kula “Mechaniczne i strukturalne aspekty szybkiej krystalizacji wybranych stopów aluminium”, Obróbka Plastyczna Metali; Metal Forming (2018), vol. XXIX no.1, p. 33-64

Additional information

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