GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

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| Subject name and code | Introduction to Materials Science, PG_00022717 | | |
| Field of study | Nanotechnology | | |
| Date of commencement of studies | October 2022 | Academic year of realisation of subject | 2022/2023 |
| Education level | first-cycle studies | Subject group | Obligatory subject group in the field of study<br>Subject group related to scientific research in the field of study |
| Mode of study | Full-time studies | Mode of delivery | at the university |
| Year of study | 1 | Language of instruction | Polish |
| Semester of study | 2 | ECTS credits | 2.0 |
| Learning profile | general academic profile | Assessment form | assessment |
| Conducting unit | Department of Materials Engineering and Bonding -> Faculty of Mechanical Engineering and Ship Technology | | |
| Name and surname of lecturer (lecturers) | Subject supervisor | prof. dr hab. inż. Maria Gazda | |
| | Teachers | prof. dr hab. inż. Maria Gazda | |

**Lesson types and methods of instruction**

| Lesson type | Lecture | Tutorial | Laboratory | Project | Seminar | SUM |
|---|---|---|---|---|---|---|
| Number of study hours | 30.0 | 0.0 | 0.0 | 0.0 | 0.0 | 30 |

E-learning hours included: 0.0

**Learning activity and number of study hours**

| Learning activity | Participation in didactic classes included in study plan | Participation in consultation hours | Self-study | SUM |
|---|---|---|---|---|
| Number of study hours | 30 | 1.0 | 19.0 | 50 |

**Subject objectives**

The aim of of the lecture is gaining the knowledge on fundamentals of materials engineering and construction and fucntional materials, particularly nanomaterials.

**Learning outcomes**

| Course outcome | Subject outcome | Method of verification |
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| K6_W07 | Student has a necessary knowledge in nanotechnologies` area, which concerns the characteristics of nanomaterials and their production. | [SW3] Assessment of knowledge contained in written work and projects<br>[SW1] Assessment of factual knowledge |
| K6_W06 | Student gains the knowledge on fabrication technologies of materials and nanomaterials. Student understands processes resulting in micro- and nanostructures. Student knows principal research methods of materials, inckuding those for nanometric area. | [SW1] Assessment of factual knowledge |

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| Subject contents | Matter and its components. Atomic bonds. Technical materials: natural and engineering effects of structure, poperties, applications. Crystalline, amorphous, glassy materials. Basic characteristics of the main groups of engineering materials. Technological processes of metals and alloys production. The basic types of metal alloys. Ceramic materials: fabrication and application. Polymers: construction and application. Characteristics of composite materials. Structures of materials. Description of crystalline materials: a network of spatial nodes, crystalline lines and planes. Types of spatial networks. Miller index. Spatial networks of metals. Structures of ceramic materials. Structures of polymeric materials. Defects in crystal structure. Point defects: Frenkel and Schottky defects, vacancies. Diffusion: diffusion equation, diffusion mechanisms interstitial, vacant, rotation (replacement). Influence of point defects on diffusion and types of application. Linear defects: dislocations and stacking faults. Perfect (unit) and imperfect (partial) dislocations, edge and screw dislocations. Movement of edge dislocations. Burgers contour and vector. High- and low-angle grain boundaries, misorientation angle, conjugated and half conjugate grain boundaries. Influence of point defects on mechanical properties. Structure of metal alloys. Solid solutions - substitional and interstitial, continuous and discontinuous. Hume-Rothery criteria. Superstructures. Strengthening of solid solutions in technological processes. Intermetallic phases: Laves, electron, Kagome nets. Interstitial phases. Phase equilibrium systems. Thermodynamic equilibrium. The concept of a component and a phase. Lever rule. Gibbs phase rule. Phase equilibrium systems. Two-component phase equilibrium systems. The phase system with total non-solubility of elements in solid and liquid. The phase system with total non-solubility of elements in the solid state. The phase system with with excellent mutual solubility in the solid state. The phase system with partial solubility of elements in the solid state with an eutectics or an eutectoid. The phase system with partial solubility of elements in the solid state with a peritectic and peritektoid. Ternary phase equilibrium systems. Fourfold integrated phase equilibrium. The phase system of iron-carbon and iron-cementite alloy. Phase and structural components: ferrite, austenite, cementite primary, secondary and tertiary, pearlite and ledeburite. Phase transformations during cooling of iron-carbon alloys. Preparation of materials. Crystallization. Thermodynamic equilibrium of crystallization and undercooling. Nuclei of crystallization. Homogeneous and heterogeneous nucleation. Mechanisms of crystal growth: stepped, screw, terrace. Crystallization kinetics. Dendritic growth. Manufacturing technologies: casting and powder metallurgy. Manufacture of high purity metals. Manufacturing of monocrystals. Plastic processing. Plastic deformation mechanisms: slip and twinning. Recrystallization and recovery. Principles of heat treatment. Forms of heat treatment. Heat treatment of steels. Transformation of steels during cooling. Martensitic, bainitic and pearlitic transformation. CTP curves. Transformation of steel during heating. Selection of heating time and environment. Bainitic and martensitic hardening. Surface hardening. The concept of hardenability. Tempering. Structure of tempered steel. Under zero treatment. Supersaturation and aging. Properties of materials. Physical properties: density, magnetic properties. Chemical properties: corrosion resistance. Mechanical properties: tensile, compression, bending, fatigue tests. Tests of hardness and microhardness. Degradation of materials. Brittle fracture. Fatigue of materials. High temperature degradation. Chemical, electrochemical and biological corrosion. Forms of corrosion: general, local, galvanic, selective, intergranular, gaseous, stress, fatigue, hydrogen, impimgement attack, cavitation erosion. Alloys. Alloyed and unalloyed steels. Carbon and alloy cast steels. Carbon and alloy cast irons. Structure and application. Copper alloys: brass, bronze, Cu-Ni alloys. Structure and application. Aluminum alloys. Structure and application. Types of other non-ferrous metals: nickel, titanium, cobalt, beryllium, magnesium, zinc, metal melting, low melting metals. Structure and application. Ceramic materials, polymeric and composite construction. |
| Prerequisites and co-requisites | No requirements |
| Assessment methods and criteria | |

| Subject passing criteria | Passing threshold | Percentage of the final grade |
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| Written exam | 50.0% | 100.0% |

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| Recommended reading | Basic literature | 1. Metaloznawstwo. M. Głowacka (red.). Politechnika Gdańska, Gdańsk, 1996 (także: strona sieciowa PG). 2. Przybyłowicz K.: Metaloznawstwo. WNT, Warszawa, 1992. 3. Dobrzański L.A.: Podstawy nauki o materiałach i metaloznawstwo. WNT, Warszawa, 2002. 4. Dobrzański L.A.: Materiały inżynierskie i projektowanie materiałowe. WNT, Warszawa, 2005. 5. Przybyłowicz K., Przybyłowicz J.: Materiałoznawstwo w pytaniach i odpowiedziach. WNT, Warszawa, 2007. |
| | Supplementary literature | Literatura uzupełniajšca: 1. Ashby F.A., Jones D.R.: Materiały inżynierskie. Tom I i II. WNT, Warszawa, 1995. 2. Callister W.D.: Materials Science and Engineering. Wiley and Sons, 2000-2006. 3. Dobrzański L.A.: Metalowe materiały inżynierskie. WNT, Warszawa, 2004. |
| | eResources addresses | Adresy na platformie eNauczanie:<br>Podstawy nauki o materiałach - Moodle ID: 27779<br>https://enauczanie.pg.edu.pl/moodle/course/view.php?id=27779 |
| Example issues/ example questions/ tasks being completed | 1. Effect of crystallisation rate on grain size. 2. Mechanism of deformation of nanomaterials. 3. Draw a phase diagram of the metallic Cu-Zn system in area in which no intermetallic phases are formed. | |
| Work placement | Not applicable | |

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