LEARNING MODULE DESCRIPTION

LUMINESCENCE OF RARE EARTH ELEMENTS. APPLICATION IN CHEMISTRY AND BIOLOGY

GENERAL INFORMATION

1. Module title: **Luminescence of rare earth elements. Application in chemistry and biology**
2. Module code: **LRE**
3. Module type – compulsory or optional
   optional
4. Programme title
   Chemistry
5. Cycle of studies (1st or 2nd cycle of studies or full master's programme)
   2nd
6. Year of studies (where relevant)
   first year
7. Terms in which taught (summer/winter term)
   summer
8. Type of classes and the number of contact hours (e.g. lectures: 15 hours; practical classes: 30 hours)
   Lecture: 15 hrs, laboratory: 30 hrs
9. Number of ECTS credits
   5
10. Name, surname, academic degree/title of the module lecturer/other teaching staff/ e-mail
    Stefan Lis, prof. dr hab., blis@amu.edu.pl
    Agata Szczeszak, PhD. agata_is@amu.edu.pl
11. Language of classes
    English

DETAILED INFORMATION

1. Module aim (aims)

   The main goal of the module is: to get acquainted with the basic properties and use of 4f elements (lanthanides, Ln), understand the spectroscopic, luminescent (photo- and chemiluminescence) properties of the Ln trivalent 4f ions, learn about the design of molecular and supramolecular luminescent probes in chemistry and biology, get familiar with modern nanomaterials (nanoluminophors) based on trivalent 4f ions, have an idea about potential new applications involving 4f ions

2. Pre-requisites in terms of knowledge, skills and social competences (where relevant)

   Basic knowledge related to inorganic chemistry and spectroscopic characterization of inorganic compounds

READING LIST

1. W.T. Carnall, Handbook on the Physics and Chemistry of Rare Earths, K.A.Gschneider, L.R.Eyring (Ed.), Vol.3, Vol. 9, Vol. 15, North Holland, Amsterdam 1996.
2. J-C.G.Bünzli, G.R. Choppin, „Lanthanide Probes in Life, Chemical and Earths Sciences", Elsevier, Amsterdam 1989.
3. S. Cotton, Lanthanide and Actinide Chemistry, John Wiley @ Sons Ltd, Chichester, England 2006.
4. D.T. Xueyuan Chen, Yongsheng Liu, Lanthanide-Doped Luminescent Nanomaterials, Springer, Berlin, 2014.
5. S. Lis, J. Alloys Comp., 341 (2002) 45-50, "Luminescence Studies of Lanthanide(III) Ions in Solution"
6. A. Szczeszak, T. Grzyb, Z. Śniadecki, N. Andrzejewska, S. Lis, M. Matczak, G. Nowaczyk, S. Jurga, B. Idzikowski, Inorg. Chem., 53 (2014)12243−12252, "Structural, spectroscopic and magnetic analysis of $Gd_{1-x}Eu_xVO_4$ nanocrystals synthesized in situ by hydrothermal method".
7. M. Runowski, S. Goderski, J. Paczesny, M. Księżopolska-Gocalska, A. Ekner-Grzyb, T. Grzyb, J. D. Rybka, M. Giersig, S. Lis, J. Phys. Chem. C, 120 (2016) 23788−23798, "Preparation of Biocompatible, Luminescent-Plasmonic Core/Shell Nanomaterials Based on Lanthanide and Gold Nanoparticles Exhibiting SERS Effects".

SYLLABUS:

Week 1: Introduction: the elements - from their discovery to modern uses

Week 2: Electronic structure and physicochemical properties of rare earths

Week 3: Main groups of the f-element compounds, their synthesis methods and structural characterization

Week 4: Complexation and hydration of rare earths ions, coordination numbers of compounds and their structure

Week 5: Lanthanides in supramolecular chemistry. Classes of cyclic and acyclic ligands, ion selective (host –guest) complexes, non-covalent interactions and macrocyclic effect

Week 6: Spectroscopic properties, luminescence (photoluminescence, chemiluminescence) processes of lanthanide systems, their effectiveness and applications

Week 7: Mechanisms of the intramolecular and intramolecular energy transfer in lanthanide chelates. The antenna effect, light conversion molecular devices

Week 8: Lanthanide(III) ion based functional materials. Photochemical stability applications for optics and optoelectronics.

Week 9: Lanthanide-containing luminescent probes. Utilization of the Eu(III) and Tb(III) ions as luminescence probes in studies of biochemical systems

Week 10: Gadolinium complexes as MRI agents. DELFIA (Dissociation Enhanced Lanthanide Fluoroimmunoassay) system (based on use of stable lanthanide chelates)

Week 11: Inorganic nanomaterials based on lanthanide ions, strategies of synthesis, structural and spectroscopic characterization

Week 12: Nanoluminophores based on inorganic matrices doped with Ln(III) ions, detailed characterization, factors affecting their luminescence effectiveness.

Week 13: Lanthanide-doped luminescent upconverting nanoparticles - novel luminescent probes for bioapplications

Week 14: Core-shell and surface functionalized nanomaterials, multifunctional (luminescent-magnetic) hybrids and their applications as biosensor.

Week 15: Surface functionalized nanohybrids. SERS-effect in nanomaterials Cytotoxicity and exotoxicity of functionalized nanomaterials.
Applications of Ln(III) ions based (nano)materials at present and in the future.

STUDENT WORKLOAD (ECTS credits)

Module title:	
Activity types	Mean number of hours* spent on each activity type
Contact hours with the teacher as specified in the programme	45
Preparation for laboratory project	20
Study of the results from laboratory	15
Reading of the indicated literature	10
Writting of the reports	15
Preparation for exam	20
Total hours	125
Total ECTS credits for the module	5

** Class hours – 1 hour means 45 minutes*

#Independent study – examples of activity types: (1) preparation for classes, (2) data analysis, (3) library-based work, (4)writing a class report, (5) exam preparation, etc.

GRADING SYSTEM:

5	EXCELLENT – outstanding performance	(91-100%)
4+	VERY GOOD – above the average standard with only minor errors	(81-90%)
4	GOOD – generally sound work with some minor errors	(71-80%)
3+	SATISFACTORY – fair but with a number of notable errors	(61-70%)
3	SUFFICIENT – fair but with significant shortcomings	(51-60%)
2	FAIL	below 51%