SYLLABUS

Name: ***Chemistry of explosives (WTCCXCSE-CoE)***
Name in Polish:
Name in English: ***Chemistry of explosives***

Information on course:

Course offered by department: Faculty of Advanced Technologies and Chemistry
Course for department: Faculty of Advanced Technologies and Chemistry
Term: Winter semester 2024/2025 Year
Cordinator of course edition: dr inż. Mateusz Szala

Default type of course examination report:

Exam

Language:

English

Short description:

Classification of explosives and basic terms. Nitration – methods and mechanisms. Nitration agents. C-nitration of aromatic and aliphatic compounds. Synthesis of nitrate esters (O-nitration) and nitramines (N-nitration). Other methods of synthesis of explosives. Structures and properties of basic explosives TNT, RDX, HMX, Nitroglycerin, DGDN, PETN, Nitrocellulose. Preparation of the explosives on a laboratory scale. Novel high-energetic explosives – HNIW, DADNE, NTO, TEX. Unconventional explosive compounds – without nitro group, explosive polymers, high-nitrogen compounds, explosives with reduced sensitivity. Practical preparation and characterization of NTO, DADNE and TEX samples. Synthesis and properties of primary explosives – fulminates, azides, tetrazene, lead styphnate, furoxane derivatives, complex salts, peroxides and others. Practical preparation of basic primary explosives. Non-regular (home made) explosives – compounds and mixtures.

Description:

The nature of explosions: physical, nuclear and chemical explosions. Types of explosive transfor-mations: burning, deflagration, detonation. Thermo-chemistry of explosives: oxygen balance, decom-position reactions, heat and temperature of explo-sion, explosive power.

Basic properties and test methods for explosives sensitivity, stability and performance of explosives.

Classification and general characterization of ex-plosives: the history, present and future develop-ment of explosives.

Nitration – reagents, methods and mechanisms: aromatic and aliphatic C-nitration, N-nitration, O-nitration, technological aspects of nitration process.

Manufacture, properties and application of the commoner explosives: TNT, TATB, HNS, DADNE, NTO, NG, NC, PETN, RDX, HMX, HNIW, ADN; pri-mary explosives: LA, LS, MF.

Introduction to propellants and pyrotechnics: composition, manufacture and properties of gun and rocket propellants, heat, smoke, light, gas, noise generating pyrotechnics.

Advanced energetic materials: new energetic CHNO compounds, coordination energetic compounds, all-nitrogen materials, thermobaric explosives, advanced propellants, nanomixtures and nanocomposites, reactive materials.

Commercial explosive compositions: dynamites, ANFO, ammonium nitrate slurries and emulsions, heavy ANFO, unconventional and home made explo-sives.

Seminar's subject matter:
1. Thermochemical calculations; 2. Energetic ionic liquids; 3. Indirect methods of nitration; 4. Nitro-cubanes; 5. Pyrotechnic mixtures; 6. Energetic nanocomposites and reactive mixtures; 7. Improvised explosives and explosive devices.

Bibliography:

Obligatory:
T. M. Klapotke, Chemistry of High-Energy Materials, De Gruyter, Berlin, 2011.
J. A. Conkling, Ch. J. Mocella, Chemistry of Pyrotechnics, CRC Press, Boca Raton, 2011.
J. Akhavan, The Chemistry of Explosives, RSC, Cambridge, 2008.

Complementary:
J. P. Agrawal, R. D. Hodgson, Organic Chemistry of Explosives, Wiley, Chichester, 2007.
N. Kubota, Propellants and Explosives, Thermochemical Aspects of Combustion, Wiley-VCH, 2007.
U. Teipel, ed., Energetic Materials, Particle Processing and Characterization, Wiley-VCH, 2005.
J. A. Zukas, W. P. Walters, eds, Explosive Effects and Applications, Springer, NY, 2003.

Learning outcomes:

K_W01 - global scientific and technological achievements covering theoretical foundations and general issues and selected specific issues - appropriate for a given scientific discipline
K_U01 - development trends in a scientific discipline
K_U01 - obtain necessary information related to the conducted research, using sources, including English-language ones
K_U01 - independent research expanding existing scientific and creative achievements

Assessment methods and assessment criteria:

The subject is accepted based on the positive result of examination procedure, which includes:
Homework problems that will be assigned with due dates throughout the course and some home-work assignments will be collected (announced and unannounced) for grading.
The participation in lectures, labs, and seminars
Final exam covering the theory and practice of energetic materials that has been presented during lectures, labs and seminars.

Practical placement:

There are no internships planned for this subject

Mode of study

full-time studies

Form of study

LLP Erasmus

Introductory subjects

Organic Chemistry; Prerequisites: structure, functional groups, reaction mechanisms
General and Inorganic Chemistry; Prerequisites: atomic structure and bonding
Physical Chemistry; Prerequisites: reaction kinetics and thermodynamics

Programs

General Education Content Group

Form of course / number of hours / final requirement

Lecture: 16h +
Seminari: 20 h +
Laboratory: 24h +

Author

dr Mateusz Szala

ECTS balance

1. Participation in lectures 20
2. Participation in seminars 10
3. Participation in laboratories 24
3. Independent study of lecture topics 15
4. Independent preparation for the seminar 10
5. Preparation for the exam 5
Total student workload: 90 / 3
Tasks with the participation of teachers: 60 / 3
Tasks related to scientific activity: 90 / 6.0 ECTS points

Information on course edition:

Default type of course examination report:

Exam

Bibliography:

missing bibliography in English