

UNIT 5

NANOENERGETICS

Pre-reading discussion:

- 1) What does energetics deal with?
- 2) What types of energetics are there?
- 3) What can be attributed to energetic materials?
- 4) How can they be classified?

Task 1. *Skim the text; define the topic and the main idea of the text. Speak on the style and genre of the text, the writer, the reader and the purpose of the text.*

Task 2. *How many important points does the author make? What are they?*

Text 1

Nanoenergetic Materials

Energetic materials (EMs) are considered to be pure components or mixtures of chemical substances, which consist of both fuel and oxidizer that could release a large amount of energy or gas upon ignition. EMs can broadly be classified into propellants, explosives, and pyrotechnics with a wide range of applications in ordnance, rockets, missiles, space technology, fireworks, gas generators, automobile airbags, deconstruction, welding, and mining, to cite a few. Typically, EMs can be produced as either monomolecular materials or as composites. Several additives such as catalysts, coolants, stabilizers, and plasticizers, in few percent ratios, could be added to the EM formulations to improve their peculiar features and tailor their performance.

The advancement in the synthesis approaches and the advent of material characterization tools at multiple length scales have pushed the energetic materials community to explore new opportunities. During the past two decades, several significant achievements in research on nanoenergetic materials (nEMs) have been realized, thanks to the technological novelties in the field of nanoscience and nanotechnology. The principle of nanoenergetics is the enhancement of the specific surface area and intimacy with chemical components to improve the reaction rate while reducing the ignition delay at an acceptable level of safety. Nanoenergetics started with the manufacturing of nano-sized metal particles, mainly aluminum, which was mainly used for rocket propulsion, since the second half of the 20th century. During the last two decades, the physical mixing of oxidizers and fuels is considered as the second stage of the development of nanoenergetics at the nanoscale for which the diffusion distances between the chemical species is improved and the surface-over-volume ratio is enhanced, currently reaching the advanced third stage, where modern technologies, which allowed producing novel types of reactive nanocomposites structures and morphology with tunable features, are applied.

nEMs, which are composed of nano-sized fuel and oxidizer with or without additives, have been found to be potential sources of extremely high heat release rates and tailored

burning rates, reliability, and extraordinary combustion efficiency. Nowadays, they play a vital role in widespread applications such as miniaturized electro-explosive devices, the attitude control of micro/nano satellites, and actuation in lab-on-a-chip devices, to name a few. The improvement of properties and the discovery of new functionalities and methodologies are key goals that cannot be reached without a better understanding of the preparation, characterization, manufacturing, and properties that constitute the starting points of the design of specific and adequate systems. The investigation of nanoenergetic materials has demonstrated both academic as well as technological importance and offered great research opportunities within cross-disciplinary areas.

(Based on <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7759926/>)

Task 3. Phonetic drill.

Pronounce these words correctly: mixture ['mɪksʃə], oxidizer ['ɒksaɪzə], ignition [ɪg'niʃ(ə)n], ordnance ['ɔːdnəns], missile ['mɪsaɪl], generator ['dʒenəreɪtə], automobile ['ɔːtəməbiːl], mining ['maɪnɪŋ], plasticizer ['plæstɪsaɪzə], multiple ['mʌltɪp(ə)l], species ['spiːʃiːz], tunable ['tjuːnəb(ə)l], extraordinary [ɪk'strɔːd(ə)n(ə)rɪ], satellite ['sæt(ɪ)laɪt], actuation ['æktʃu'eɪʃ(ə)n], constitute ['kɒnstɪtjuːt], disciplinary ['dɪsɪplɪnəri].

Task 4. These are answers to questions about the text. Write the questions.

- They can be pure components or mixtures of chemical substances.
- A lot of applications in various fields.
- To improve their peculiar features.
- Thanks to the developments in the field of nanoelectronics.
- They were used for rocket propulsion.
- It is the second stage of the development of nanoenergetics.
- It has demonstrated both academic and technological importance.

Task 5. Provide synonyms of the following words used in the text:

- a) component (n), b) release (v), c) ratio (n), d) tailor (v), e) advent (n), f) novelty (n), g) delay (n), h) functionality (n), i) goal (n).

Task 6. Look back in the text to find words that have the opposite meaning to:

- a) pure (adj), b) broadly (adv), c) composite (n), d) peculiar (adj), e) significant (adj), f) enhancement (n), g) modern (adj), h) potential (adj), i) widespread (adj).

Task 7. Look back in the text to define and classify energetic and nanoenergetic materials.

Task 8. Make up a plan of the text in a question form.

Task 9. Make up a resume of text 1.

Task 10. *Translate the underlined sentences in text 1.*

Task 11. *Imagine you are a researcher in a Lab which develops materials for hydrogen energetics. Write an Introduction to an article (150-200 words) (see Appendix) on your research, its relevance and interdisciplinary character with materials science, chemistry, and physics.*

Task 12. *Translate from Russian into English:*

а) энергетические материалы, смесь, окислитель, воспламенение, реактивное топливо, взрывчатые вещества, боеприпасы, подушка безопасности, сварка, дополнительный компонент, катализатор, охлаждающее вещество, стабилизирующий компонент, пластифицирующая добавка, состав, новинка, улучшение, скорость реакции, задержка воспламенения, ракетный двигатель, междисциплинарный;

в) Нанотехнологии способствуют обеспечению новых возможностей для использования возобновляемых источников энергии и вносят существенный вклад в производство и сбережение энергии. Основными направлениями эффективного использования нанотехнологий в энергетике становятся использование возобновляемых источников (солнечные батареи, термоэлектрические приборы, топливные элементы); хранение энергии (перезаряжаемые батареи и суперконденсаторы, водородные баки); уменьшение потребления материалов (например, создание более легких и/или прочных конструкционных материалов или увеличение их активности); использование альтернативных (более распространенных) материалов (например, замена редкоземельных элементов на наноструктурированные оксиды металлов при катализе).

(Based on chrome-extension://efaidnbmninnibpcjpcglclefindmkaj/https://www.researchgate.net/publication/277553100_Nanotechnologies_Based_Alternative_Energy_Development_Forecast_Effects_for_Russian_Economy/fulltext/57a5ecaf08aee07544bbfa40/Nanotechnologies-Based-Alternative-Energy-Development-Forecast-Effects-for-Russian-Economy.pdf)

Task 13. *Make up a mind map on nanoenergetics (see Appendix). In pairs tell each other about your ideas.*