GOSPODARKA I INNOWACJE

LABORATORIUM WIEDZY Artur Borcuch

*Volume: 24 | 2022*

**ISSN: 2545-0573**

# THE APPLICATION OF RARE ELEMENTS IN MODERN MEDICAL DEVICES AND THEIR CONTEMPORARY SIGNIFICANCE

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**ARTICLEINFO.**

***Keywords:***
rare earth elements (REE); applications of rare earth elements, positron emission tomography (PET) imaging, ecology, Inductively Coupled Plasma – Optical Emission Spectrometry

**Abstract**

The review examines the value of rare earth elements (REE) for the modern medical equipments, the features of the global REE market, as well as new technological solutions in the field of REE production and the problems of diversification of their production regions are analyzed. Also based on the available data the medical applications of REE are summarized.



The 21st century is characterized by the advanced use of rare earth elements globally, including medical sphere. The rare earth elements are a cluster of metals comprised of 14 lanthanide elements lanthanum (La), cerium (Ce), praseodymium (Pr), neodymium (Nd), samarium (Sm), europium (Eu), promethium (Pm), gadolinium (Gd), terbium (Tb), holmium (Ho), dysprosium (Dy), erbium (Er), thulium (Tm), ytterbium (Yb), lutetium (Lu), yttrium (Y) and scandium (Sc).

**Methods**. Their exclusive physical and chemical properties have made them necessary for a rising number of high-tech technologies as high-performance permanent magnets, magnetic resonance image scanning systems, superconductors and laser technology. Lanthanides are also applied in many health and medical applications, such as in anti-tumor agent, kidney dialysis medicine and surgical equipment. Due to their optical properties, REE has been used in many imaging techniques such as computed tomography scans, magnetic resonance image (MRI), positron emission tomography (PET) imaging and X-rays [1-8].

Gadolinium is the most used REE in medical diagnosis in the MRI. Gd (III) ions enhance MRI images and have also been used in intravenous radio-contrast agents to improve the sensitivity and specificity of diagnostic images. In this technique, it is possible to visualize the morphology of the body

with a very high resolution once Gd (III) ions are the best paramagnetic compounds of the periodic table. The contrast of the images is dependent on magnetic relaxation of the nuclei, and this relaxation can be enhanced by Gd (III) ions, which improves the contrast in magnetic resonance imaging scans with very low toxicity.

In addition, a substantial variety of luminescent bioassays and sensors also have been developed based on lanthanides that preserve a relatively long-lived emission. Living tissue researchers rely on the Europium for the sensitive luminescence in molecular genetics to mark specific strands of DNA when attached as a tag to complex biochemicals. Nowadays, rare earth elements have also been applied on the anti-cancer treatment because of their therapeutic radioisotopes, especially as agents in radioimmunotherapy and photodynamic therapy [2-9].

The use of REE into health and medical applications is now well established. However, much of the future of diagnostic imaging analysis could depend on these paramagnetic elements. Demand for REE is expected to exceed its supply soon. It also considers the possibility of reclaiming the used or worn out REE and reutilizing them; highlighting some companies that have started to recycle the elements, those derived from medical use as well, reducing the demand for newly mined elements. The recycle of REE will be imperative to continue the advancement of RMI and radioisotopes technologies. The future holds many new innovative ideas.

In mid-May 2019, Forbes magazine published a list of the world’s largest manufacturers of medical equipment as part of the Forbes Global 2000 rating. It is compiled based on the cumulative assessment of revenue, profit, assets and market value of companies. The biggest manufacturers of the medical equipment. Ranging based on the market capitalization (Forbes): Johnson & Johnson was named the largest manufacturer of medical equipment and consumables for it, with a market capitalization of USD 366.2 billion by mid-May 2019. Medtronic took second place with a result of $113 billion, and Stryker closed the top three USD 67.3 billion).

Johnson & Johnson USD 366.2 billions; Medtronic USD 113 billions; Stryker USD 67,3 billion; Becton Dickinson USD 61,3 billion, Intuitive Surgical USD 60.9 USD; EssilorLuxottica USD 52,9 billion; Boston Scientific USD 58,8 billion; Baxter International USD 38 billion; Edward Lifesciences USD 36,9 billion; Fresenius 30,9 billion.

This has not only contributed to the fact that China has become the dominant producer of REE oxides and has constantly strengthened its position in the production chains of some REE, in particular NdFeB neodymium magnets, characterized by special power and high resistance to demagnetization, used in electronics, medical equipment and many other fields. By 2013, China was already producing 90% of the world's magnetic alloys and 75% of NdFeB magnets [3].

REE includes a group of 17 metals: 15 elements of the lanthanide family, as well as yttrium and scandium. In most cases, REE are in nature in a dispersed state and form refractory, practically insoluble in water oxides, from which it is difficult to isolate pure metal, which seriously complicates them production on an industrial scale. These elements are used as the most important components of innovative materials and in products with unique characteristics. REE is used in low-carbon energy technologies, electronic and defense industries, metallurgy, healthcare.

In 2015, after the settlement of disputes on REE in the WTO, China came back to normal trade application and still provides more than 80% of the world's REE production, including almost the entire world production of some of them, for example, dysprosium used in metal smelting, conventional and nuclear energy, medical lasers, etc [4-5].

Iridium is one of the rarest metals in the Earth's crust, with annual production of just three tonnes. Medical device producers employ platinum-iridium alloys in cardiac rhythm management devices,

catheters and stents, neuromodulation devices, and other medical devices.

Palladium and platinum and also participate active roles in cancer radiation therapy. Palladium-103, a radioactive isotope of palladium, shows promise for the handling of prostate and breast tumors. The procedure involves permanently implanting small time-release seeds of palladium-103 directly into the tumor to deliver the highest possible dose directly to the source while sparing the surrounding tissue. [3-6]

**Medical devices and implants.** Platinum is inert, rarely causes allergic reactions, has good electrical conductivity, and can be implanted into tiny components, all characteristics that make it an ideal material for pacemakers, stents, implantable defibrillators, and catheters. Most pacemakers contain at least two platinum-iridium electrodes. Platinum marker bands and guide wires are commonly used to place stents, and now even the stents themselves may be made with platinum alloys. Platinum marker bands are also placed on catheters and guide wires to help surgeons with device placement. Platinum-iridium electrodes are used in neuromodulators such as aural and retinal implants, devices used to treat Parkinson's disease and chronic pain.

**Dental.** Palladium and occasionally platinum, ruthenium or iridium are applied to enhance the might and resilience of dental crowns, bridges and inlays. The PGMs are usually mixed with silver, gold, zinc or copper to produce alloys for dentistry.

**Testing Technologies.** Many electronic and automotive devices containing PGMs are recycled to recover and reuse the metal, but some of the medical devices mentioned above, such as defibrillators, are recyclable as well. Whether from primary or secondary sources, PGMs must be meticulously refined to separate the PGMs from base metals and contaminants, analyzed for purity, and fabricated to produce medical-grade material. Lab-based PGM analysis includes careful sample preparation and multi-step assaying to detect all minor and trace elements and to ensure the PGM is of pure enough quality for medical applications. Testing technologies to determine precious metal concentrations may include:

ICP-OES: Inductively Coupled Plasma – Optical Emission Spectrometry (ICP-OES), known also as ICP-AES, is an analytical modus operandi applied to distinguish trace and minor elements in a variety of sample types. ICP-MS ICP-MS is a technique for the sampling and quantification of trace elements in both solid and liquid samples. X-ray fluorescence (XRF): XRF a non-destructive analytical technique used to determine the qualitative and quantitative elemental composition of materials.

In the field, platinum instruments are sterilized in the flame of an alcohol burner. Platinum is also often used to create implants for people with hearing impairments. In addition, there is an opinion that this material helps to fight cancer. Many drugs that help people overcome cancer are made on the basis of this metal. The use of platinum in the medical industry helps to save the lives of thousands of patients. The fact is that there are simply no analogues of this material. Products made of other metals are unstable to oxidation, therefore they are not suitable for such a reaction.

**Discussion.** With an aging and growing world population, there is expected to be a growing demand for healthcare products and services that use components made from platinum, other platinum group metals (PGMs), and their alloys. Among the implications of this growth trend is increased use of platinum in medical technology. Since the early 1970s, platinum has been used internationally in a variety of medical devices to treat ailments such as stroke, heart disease, chronic pain, neurological disorders, and other life-threatening conditions. The metal is used to make essential components for implantable defibrillators, pacemakers, stents, catheters, and neuromodulation devices among others. The properties of platinum that make it attractive for such applications include its biocompatibility, inertness within the body, durability, electrical conductivity, and radiopacity.

**Conclusion**

In the meantime, the rapid use of the RRE in medical devices are enhancing the quality of the medical services rendered to the population. The establishment of the Nuclear medical services clinics in Tashkent is aimed at the improvement of the quality of available medical services in the Republic of Uzbekistan.

**REFERENCES**


1. https://cyberleninka.ru/article/n/redkozemelnye-elementy-klyuchevoy-faktor-tehnologicheskogo-progressa-xxi-v/viewer
2. The Sustainable Importance of Platinum in Biomedical Applications https://www.mddionline.com/ivd/sustainable-importance-platinum-biomedical-applications
3. Could Platinum Group Metals Save Your Life? https://www.thermofisher.com/blog/metals/could-platinum-group-metals-save-your-life/
4. www.klinika.uz/klinika/new-life-medikal-yadro-tibbiyot-markazi
5. Файзиев Ш. Ш., Саидов К. С., Низомова Ш. К. К. Электронная структура основного мультиплета иона диспрозия в ортоалюминате //Academy. – 2020. – №. 11 (62). – С. 4-6.
6. Шарипов М. З., Файзиев Ш. Ш., Низомова Ш. К. К. ОСОБЕННОСТИ МАГНИТООПТИЧЕСКИХ СВОЙСТВ МОНОКРИСТАЛЛА БОРАТА ЖЕЛЕЗА //Наука, техника и образование. – 2021. – №. 2-2 (77). – С. 5-9.
7. Ismatovna A. Y. Using the Moodle Platform in Extreme Cases //Central asian journal of mathematical theory and computer sciences. – 2021. – Т. 2. – №. 6. – С. 13-19.
8. Ismatovna A. Y. Passing the Traditional Lesson with the Help of Open Moodle Platforms. – 2021.
9. Асадова Ю. The use of Moodle platform in the traditional transition of Information Technology Science in medicine to foreign students accepted on the basis of MBBS program at Bukhara State Medical Institute //Общество и инновации. – 2021. – Т. 2. – №. 7/S. – С. 35-43.
10. Ismatovna A. Y. The Method of Using the Moodle Platform for the Organization of Teaching in Education (The Introduction of Distance Learning Technologies in the Educational Process) //International Journal of Innovative Analyses and Emerging Technology. – 2021. – Т. 1. – №. 4. – С. 30-46.
11. Юлдуз А. ИСПОЛЬЗОВАНИЕ СОВРЕМЕННОЙ ПЛАТФОРМЫ MOODLE ДЛЯ САМОСТОЯТЕЛЬНОГО ОБУЧЕНИЯ СТУДЕНТОВ НА ТРАДИЦИОННЫХ УЧЕБНЫХ ЗАНЯТИЯХ //ЦЕНТР НАУЧНЫХ ПУБЛИКАЦИЙ (buxdu. uz). – 2021. – Т. 4. – №. 4.
12. Ismatovna A. Y. TODAY'S ROLE OF ELECTRON EDUCATION IN TEACHING THE SCIENCE OF INFORMATION TECHNOLOGY IN MEDICINE //Gospodarka i Innowacje. – 2022. – Т. 22. – С. 518-522.
13. Ismatovna A. Y. The method of organizing the pedagogical process of application of Information Technology in the Independent Education of students in the science of Information Technology in medicine using information technologies //Texas Journal of Engineering and Technology. – 2022. – Т. 7. – С. 70-73.
14. Ismatovna A. Y. Using the Moodle Platform for Organizing Training in Education //" ONLINE-CONFERENCES" PLATFORM. – 2021. – С. 15-18.
15. Sobirovich T. B. National and universal principles of democracy //Asian Journal of Research in Social Sciences and Humanities. – 2022. – Т. 12. – №. 1. – С. 334-338.

16. Sobirovich T. B. The implementation of human indicator reforms in Uzbekistan //Asian Journal of Multidimensional Research. – 2021. – Т. 10. – №. 9. – С. 197-202.
17. Sobirovich T. B. Issues of gender equality in uzbekistan: Strategy of reforms //Asian Journal of Multidimensional Research. – 2021. – Т. 10. – №. 9. – С. 203-207.
18. Sobirovich T. B. National Principles of Democracy in Uzbekistan //Mediterranean Journal of Basic and Applied Sciences (MJBAS). – 2021. – Т. 5. – №. 3. – С. 131-135.
19. Sobirovich T. B. Philosophical Dialectics of National and Universal Cultural Development //Irish Interdisciplinary Journal of Science & Research (IIJSR). – 2021.
20. Turdiyev B. S. The role of national harmony in the strategy of spiritual renewal //Scientific Bulletin of Namangan State University. – 2019. – Т. 1. – №. 6. – С. 229-233.
21. Sobirovich T. B. Strategy of Renewal of National Spirituality of Uzbekistan //International Journal on Integrated Education. – 2020. – Т. 3. – №. 8. – С. 122-126.
22. Sobirovich T. B., Murodogli I. S. The strategy for the implementation of the modern governance system in Uzbekistan //ACADEMICIA: An International Multidisciplinary Research Journal. – 2020. – Т. 10. – №. 5. – С. 741-748.
23. Sobirovich T. B. Strategy of spiritual renewal in Uzbekistan //International Journal of Psychosocial Rehabilitation. – 2020. – Т. 24. – №. 06.
24. Sobirovich T. B. The criterion of human indicators in development and renewals in Uzbekistan //EPRA International Journal of Multidisciplinary Research (IJMR). – 2020. – Т. 6. – №. 8. – С. 509-511.
25. Sobirovich T. B. O‟ zbekiston demokratik jamiyat taraqqiyoti rivojida ma‟ naviy yangilanishlar strategiyasining roli //Imom Buxoriy saboqlari. – 2020. – №. 2. – С. 118-121.
26. Turdiev B. S., Yuldashev B. T. THE ISSUE OF AVOIDING CRIMES AMONG YOUNGSTERS IN UZBEKISTAN //Экономика и социум. – 2019. – №. 1-1. – С. 119-122.
27. Turdiyev B. S. SPIRITUAL RENEWAL AND INTERETHNIC RELATIONS IN THE STRATEGY OF ACTIONS //Теория и практика современной науки. – 2018. – №. 3. – С. 85-89.
28. Sobirovich T. B. The development of democratic society and spiritual renewal in the views of Eastern and Western thinkers //INTERNATIONAL JOURNAL OF ADVANCED RESEARCH AND REVIEW. – 2020. – Т. 5. – №. 10. – С. 60-65.
29. Turdiyev Б. The development of democratic society and spiritual renewal in the views of eastern and western thinkers //Общество и инновации. – 2020. – Т. 1. – №. 1/s. – С. 710-717.
30. Sobirovich T. B. The development of democratic society and spiritual renewal in the views of Eastern and Western thinkers //INTERNATIONAL JOURNAL OF ADVANCED RESEARCH AND REVIEW. – 2020. – Т. 5. – №. 10. – С. 60-65.
31. Sobirovich T. B. The Strategy of Cultural Development in Central Asia During Amir Temur and the Temurids Dynasty //Int. J. Sci. Res. in Multidisciplinary Studies. – 2021. – Т. 2021.
32. Sobirovich T. B. The Strategy of Cultural Development in Central Asia during Amir Temur and Temurids Dynasty Reign //Irish Interdisciplinary Journal of Science & Research (IIJSR). – 2021. – Т. 5. – №. 1. – С. 18-22.
33. Sobirovich T. B. Strategy of development of pilgrimage tourism in Uzbekistan //MODERNIZATION OF ISLAMIC CULTURE IN BUKHARA AND PROSPECTS FOR THE DEVELOPMENT OF SUSTAINABLE TOURISM" International Scientific and Practical Conference, Bukhara. – 2020. – Т. 2. – С. 24.

34. Sobirovich T. B. O ‘zbekistonning ma’naviy yangilanish strategiyasi //Buxoro:“Sadriddin Salim Buxoriy” Durdona nashriyoti. – 2020. – С. 48.
35. Sobirovich T. B. Evolution of ideas and views on the development of democratic society and spiritual renewals //Scientific Bulletin of Namangan State University. – №. 10. – С. 243-250.
36. Sobirovich T. B. Tourism in Central Asian context //ВЕСТНИК ИНСТИТУТА/СОКРОВИЩНИЦА НАУКИ. – 2019. – №. 2. – С. 732-733.
37. Sobirovich T. B. The national and universal principles of democracy in the Central Asian context //INTERNATIONAL JOURNAL OF ADVANCED RESEARCH AND REVIEW. – 2021. – Т. 6. – №. 1. – С. 30-34.
38. Turdiyev B. S. CULTURAL AND EDUCATIONAL DEVELOPMENT OF SOCIETY IN THE SCIENTIFIC HERITAGE OF WORLD PHILOSOPHERS //Academic research in educational sciences. – 2021. – Т. 2. – №. 4. – С. 443-451.
39. Sobirovich T. B., Sharipovna A. F. NEW UZBEKISTAN–NEW STRATEGY OF ADMINISTRATIVE REFORMS //researchgate. net.
40. Sobirovich T. B. Ma’naviy yangilanishlar strategiyasining hayotbaxsh islohotlari: nazariya va amaliyot, O’zbekiston Milliy axborot agentligi–O’zA Ilm-fan bo’limi (elektron jurnal) //Tashkent, UzA. – С. 1-12.