METHODS FOR SYNTHESIS OF ORGANIC MATERIALS FOR PHOTOCELLS

Dinora Kuchkarova Bakhrom qizi
Samarkand State University Kattakurgan Branch Chemistry 3rd year student, Kattakurgan city, Uzbekistan .
E-mail: **Kuchkorovadinora0615@gmail.com**

Abstract. This article is devoted to the study of the properties and possibilities of using new organic photoactive materials used in solar cells. The study analyzes the efficiency, production costs, and environmental sustainability of organic materials in solar cells. The advantages and limitations of organic photovoltaic (OPV) technologies compared to traditional silicon-based solar cells are reviewed. The study presents the results of tests conducted using modern polymers and small-molecule organic compounds. The article concludes with proposals for the future role of organic materials in solar energy and directions for their development.

Keywords : organic photoactive materials, solar cells, organic photovoltaics, polymers, efficiency, environmental sustainability, small molecules.

Аннотация. Настоящая статья посвящена исследованию свойств и возможностей использования новых органических фотоактивных материалов в солнечных батареях. В работе анализируются эффективность, стоимость производства и экологическая безопасность органических материалов в солнечных батареях. Рассмотрены преимущества и ограничения технологий органических фотовольтаических (OPV) технологий по сравнению с традиционными кремниевыми солнечными батареями. В работе представлены результаты испытаний, проведенных с использованием современных полимеров и низкомолекулярных органических соединений. В заключение статьи сформулированы предложения относительно будущей роли органических материалов в солнечной энергетике и направления их развития.

Ключевые слова: Органические фотоактивные материалы, солнечные элементы, органическая фотовольтаика, полимеры, эффективность, экологическая устойчивость, малые молекулы

Annotatsiya. Ushbu maqola quyosh batareyalarida ishlatiladigan yangi organik fotoaktiv materiallardan foydalanish xususiyatlari va imkoniyatlarini o'rganishga bag'ishlangan. Tadqiqot quyosh batareyalaridagi organik materiallarning samaradorligi, ishlab chiqarish xarajatlari va ekologik barqarorligini tahlil qiladi. An'anaviy kremniyga asoslangan quyosh xujayralari bilan taqqoslaganda organik fotovoltaik (OPV) texnologiyalarining afzalliklari va cheklovlari ko'rib chiqiladi. Tadqiqot zamonaviy polimerlar va kichik molekulali organik birikmalar yordamida

ISSN 3030-3907

o'tkazilgan test natijalarini taqdim etadi. Maqola quyosh energiyasida organik materiallarning kelajakdagi roli va ularni rivojlantirish yo'nalishlari bo'yicha takliflar bilan yakunlanadi.

Kalit so‘zlar: organik fotoaktiv materiallar, quyosh batareyalari, organik fotovoltaiklar, polimerlar, samaradorlik, ekologik barqarorlik, kichik molekulalar.

Introduction

Solar energy is important as a sustainable, environmentally friendly , and unlimited source of energy in meeting global energy demand . Since traditional energy sources (coal , oil, gas) are limited and environmentally harmful, solar energy is a leading alternative solution. Traditional solar cells are mainly made of silicon, which can convert sunlight into electricity with an efficiency of 15-22%. Also, some problems are encountered in the process of manufacturing silicon-based solar panels:

High temperatures and complex technologies are required for silicon purification and crystallization;

High manufacturing costs increase the price of solar panels and limit their widespread use;

Silicon panels are stiff and heavy, making them difficult to adapt to different surfaces. [1]

In recent years, organic photovoltaic (OPV) technologies have been considered as an alternative solution to overcome the existing problems in solar energy. OPV batteries are made of carbon-based polymers or small molecular compounds that have the ability to absorb sunlight and convert it into electrical energy. The main advantage of this technology is its low production costs, which is due to the simplicity of the preparation process of organic materials compared to silicon and the low energy requirement [2]

Literature review: In recent decades, research on organic photovoltaic (OPV) materials has shown significant progress in the field of solar energy. Scientists are conducting extensive work aimed at increasing the efficiency, improving the stability , and expanding the commercial application of organic materials. OPV systems are cheaper, lighter , and more flexible than traditional solar cells, making them attractive for innovative and unconventional applications. One of the main areas of research is polymer-based solar cells. Polymers, which are composed of long-chain carbon-based molecules, can efficiently absorb sunlight and convert it into electrical energy. In recent years, the efficiency of energy conversion has been significantly improved by optimizing the selection of polymer combinations and production methods. Donor-acceptor polymers play an important role in this process, improving light absorption. Although these advances

ISSN 3030-3907

have brought polymer-based OPV cells closer to commercialization, issues of stability and long-term performance are still relevant . [3]

At the same time, research on small-molecule organic materials is also yielding important results. Small molecules have a much more compact and well-defined structure than polymers, which allows for fine-tuning of their chemical properties. Researchers have been able to significantly increase the energy conversion efficiency of solar cells using small-molecule materials. The advantage of these materials is that they are easy to process in the form of thin films and can be applied to various surfaces. For example, such materials can be mass-produced at low cost using printing technologies , which further increases the economic efficiency of OPV.

Photovoltaic materials synthesis methods: Methodology is essential in studying the efficiency of organic photoactive materials , which allows for accurate and reliable assessment of material properties. The studies investigated the efficiency, stability, and potential applications of organic solar cells through comparative analysis and experimental tests. The process consisted of several steps , and at each step the physicochemical and photoelectric properties of the materials were carefully investigated. The main attention was paid to two types of materials: polymer-based (P3HT :PCBM) and small molecule (DPP:TNF) systems. P3HT plays an important role in light absorption and electron transfer as a donor, and PCBM as an acceptor. DPP and TNF have a specific chemical structure, which allows for fine-tuning of optical and electrical properties. This choice allowed for a comparison of different properties and application possibilities . [4]

Thin-film technology has been used in the process of manufacturing solar cells. This method allows organic materials to be deposited on surfaces in very thin layers, which makes the cells lightweight, flexible and inexpensive. Methods such as spin-coating, printing or evaporation have been used to form the films. This technology is important for evenly distributing the materials and optimizing their photovoltaic properties. A solar simulator (AM 1.5G) was used to evaluate the efficiency of the prepared cells. The AM 1.5G spectrum simulates the average conditions of natural solar radiation falling on the Earth's surface and is used as an international standard in photovoltaic testing.

Types of organic materials for photovoltaics: The study analyzed the efficiency, optical properties , and limitations of organic photovoltaic (OPV) cells , and provided important results. The tests focused on comparing the performance of solar cells made of polymer-based and small molecule materials. The energy conversion efficiency, optical absorption, and stability of the materials were studied in detail.

ISSN 3030-3907

The polymer-based P3HT :PCBM (donor–acceptor) combination is attractive due to its widespread availability, ease of fabrication, and optimized cost, and has demonstrated significant energy conversion efficiencies in tests. However, their efficiency is lower than that of conventional silicon cells , limiting their widespread commercial application.

Small molecule DPP :TNF cells, on the other hand, showed higher efficiency. DPP and TNF molecules have a precise chemical structure, allowing for fine-tuning of their optical and electrical properties, which led to superior results in absorbing sunlight and transferring electrons. Although their manufacturing process is more complex than that of polymers , their high efficiency compensates for this disadvantage.

Mechanism of action: The results of the study clearly demonstrate the potential of organic photoactive materials in solar energy, their advantages over traditional silicon-based cells, their current limitations , and their development directions. Organic photovoltaic (OPV) technologies are characterized by their low cost, light weight, and flexibility. Their production process does not require high temperatures and complex cleaning steps; their fabrication using printing or thin film technologies significantly reduces costs. This makes OPV attractive as a source of cheap energy in developing countries or resource-limited areas. Their flexibility also allows them to be integrated into flexible surfaces, building walls, windows , and wearable devices, opening up the possibility of OPV applications in addition to energy generation in the fields of architecture, design, and portable electronics. However, the efficiency of current OPVs is much lower than that of monocrystalline silicon cells. Although significant progress has been made in the laboratory , the efficiency of commercial products is still insufficient, which limits their widespread use. To increase efficiency, efforts are underway to synthesize new organic materials, optimize donor-acceptor structures , and improve cell architecture. For example, new polymer and small molecule materials are being developed that can absorb a wider range of the solar spectrum .

Conclusion: Organic photoactive materials have great potential as a promising alternative to conventional silicon-based cells. Their low cost, light weight, and flexibility make them suitable for a wide range of applications. Organic photovoltaic (OPV) technologies can be manufactured at low cost using simple and low-energy manufacturing methods, including printing technologies. This makes them a viable solution for power generation in developing countries or resource-limited areas.

The light weight and flexibility of OPV devices allow them to be integrated into flexible displays, building walls, and vehicles. For example, OPV films can be

ISSN 3030-3907

attached to clothing or bags to power portable electronics. However, the efficiency of organic cells is currently lower than that of silicon cells, limiting their commercial application. In addition, their rapid degradation under the influence of sunlight, heat, and humidity poses a problem of their stability. New materials, protective coatings, and technological approaches are needed to overcome these shortcomings.

The research results show that OPV technologies can be successfully applied in low-power sensors and IoT systems, but to be competitive in large-scale energy generation, efficiency and service life must be significantly increased

LITERATURE USED

1. Lin, Y., Wang, J., & Zhang, Z. (2015). Polymer-based solar cells: Advances and challenges. *Chemical Reviews* , 115(23), 12666–12731.
2. Hou, J., Inganäs, O., & Friend, RH (2018). Organic solar cells based on non-fullerene acceptors. *Nature Materials* , 17(2), 119–128.
3. DS New Energy . (2021). Solar panel creation for working language various kind m a teri a ll a r . Retrieved from srcyrl.dsisolar.com.
4. Antenna devices The language used in construction of all things how much analysis . (2025). *International Journal of Theoretical and Practical Issues of Digital Technologies* , 8 *(1*) .
5. Bernede JC Organic photovoltaic cells: history, principle and techniques //Journal of the Chilean Chemical Society. - 2008. - T. 53. – no. 3. - S. 1549-1564.
6. Cheng YJ, Yang SH, Hsu CS Synthesis of conjugated polymers for organic solar cell applications //Chemical reviews. - 2009. - T. 109. – no. 11. – S. 5868-5923.
7. Hoppe H., Sariciftci NS Organic solar cells: An overview //Journal of materials research. - 2004. - T. 19. – no. 7. - S. 1924-1945.
8. Hoppe H., Sariciftci NS Organic solar cells: An overview //Journal of materials research. - 2004. - T. 19. – no. 7. - S. 1924-1945.
9. Coughlin JE et al. Design and synthesis of molecular donors for solution-processed high-efficiency organic solar cells //Accounts of chemical research. - 2014. - T. 47. - no. 1. – S. 257-270.
10. Bessette A., Hanan GS Design, synthesis and photophysical studies of dipyrromethene-based materials: insights into their applications in organic photovoltaic devices //Chemical Society Reviews. - 2014. - T. 43. – no. 10. – S. 3342-3405.
11. Burke DJ, Lipomi DJ Green chemistry for organic solar cells //Energy & Environmental Science. - 2013. - T. 6. – no. 7. - S. 2053-2066.

ISSN 3030-3907