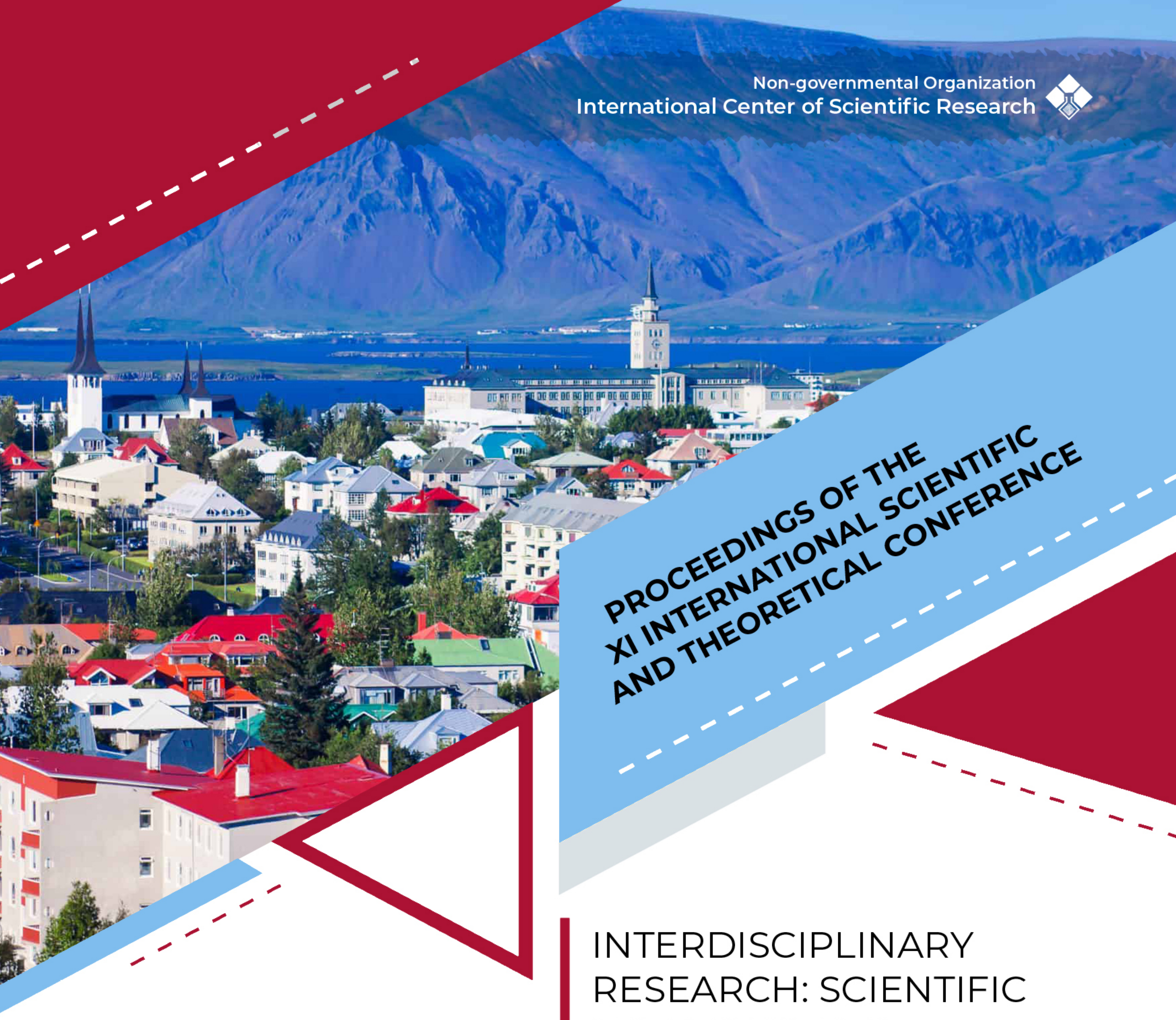

Non-governmental Organization
International Center of Scientific Research

PROCEEDINGS OF THE XI INTERNATIONAL SCIENTIFIC AND THEORETICAL CONFERENCE

INTERDISCIPLINARY RESEARCH: SCIENTIFIC HORIZONS AND PERSPECTIVES

30.01.2026

REYKJAVÍK
ICELAND

SCIENTIA
COLLECTION OF SCIENTIFIC PAPERS

Non-governmental Organization
International Center of Scientific Research

SCIENTIA

COLLECTION OF SCIENTIFIC PAPERS

with the proceedings of the
XI International Scientific and Theoretical Conference

Interdisciplinary Research: Scientific Horizons and Perspectives

📅 January 30, 2026
📍 Reykjavík; Iceland

Hosted by an authorized Crossref member with the support of the
Institute of Scientific and Technical Integration and Cooperation

Published online by Primedia E-launch LLC (USA)
Published in print by LLC UKRLOGOS Group (Ukraine)

✔ ISO 2108:2005 ✔ ISO 1086:1991 ✔ ISO 7275:1985

Reykjavík, 2026

UDC 082:001
I-69

The conference is included in the Academic Research Index ReserchBib International catalog of scientific conferences and registered for holding on the territory of Ukraine in UKRISTEI (Certificate № 508 dated June 10th, 2025).

Chairman of the Organizing Committee:
Miriam Goldenblat
International Center of Scientific Research, Ukraine

Book layout designer:
Gabriela Torres
Primedia E-launch LLC, USA

Responsible editor:
Yuliia Babych
UKRLOGOS Group ltd., Ukraine

I-69 **Interdisciplinary Research: Scientific Horizons and Perspectives**: Collection of Scientific Papers «SCIENTIA» with Proceedings of the XI International Scientific and Theoretical Conference, January 30, 2026. Reykjavík, Iceland: International Center of Scientific Research.

ISBN 979-8-89660-289-7 (series)
DOI 10.36074/scientia-30.01.2026

This collection presents the proceedings of the scientific conference, bringing together research papers on a wide range of contemporary academic topics. The volume highlights diverse perspectives, innovative approaches, and practical findings that reflect the current trends and challenges in global science and education. This collection is intended for students, postgraduate and doctoral candidates, educators, researchers, and professionals from diverse disciplines.

Conference proceedings are presented in Google Books and Bookwire™ by Bowker, ensuring international availability.

UDC 082:001

www.previous.scientia.report

CONTENT

SECTION 1.
ECONOMIC THEORY, MACRO- AND REGIONAL ECONOMY

SECTION 2.
ENTREPRENEURSHIP, TRADE AND SERVICE SECTOR

SECTION 3.
FINANCE AND BANKING; TAXATION, ACCOUNTING AND AUDITING

SECTION 4.
MANAGEMENT, PUBLIC MANAGEMENT AND ADMINISTRATION

SECTION 5.
SOCIAL WORK AND SOCIAL WELFARE

SECTION 6.
INTERNATIONAL RELATIONS

SECTION 7.
LAW AND INTERNATIONAL LAW

SECTION 8.
INSTITUTE OF LAW ENFORCEMENT, JUDICIAL SYSTEM AND NOTARY

SECTION 9.
MILITARY SCIENCES, NATIONAL SECURITY AND SECURITY OF THE STATE BORDER

SECTION 10.
BIOLOGY AND BIOTECHNOLOGY

SECTION 11.
AGRICULTURAL SCIENCES AND FOODSTUFFS

SECTION 12.
CHEMISTRY, CHEMICAL ENGINEERING AND BIOENGINEERING

SECTION 13.
FOOD PRODUCTION AND TECHNOLOGY

SECTION 14.
ELECTRONICS AND TELECOMMUNICATIONS

SECTION 15.
COMPUTER AND SOFTWARE ENGINEERING

SECTION 16.
SYSTEM ANALYSIS, MODELING AND OPTIMIZATION

SECTION 17.
INFORMATION TECHNOLOGIES AND SYSTEMS

SECTION 18.
TRANSPORT AND TRANSPORT TECHNOLOGIES

SECTION 19.
PHYSICS AND MATHEMATICS

SECTION 20.
PHILOLOGY AND JOURNALISM

SECTION 18.

TRANSPORT AND TRANSPORT TECHNOLOGIES

Sandler Albert
Candidate of Technical Sciences, Associate Professor
National University «Odessa Maritime Academy», Ukraine

Romanovska Olha
Senior Lecturer
Danube Institute of National University «Odessa Maritime Academy», Ukraine

Karpilov Oleksandr
Senior Lecturer
National University «Odessa Maritime Academy», Ukraine

IMPROVING THE ENERGY EFFICIENCY OF VESSELS WITH WIND-ASSISTED PROPULSION

Wind and solar radiation are increasingly being considered as alternative and supplementary energy sources in modern shipping. A landmark example of this trend is the 1,800-TEU container vessel Canopée, approved by the French classification society Bureau Veritas (BV) (Fig. 1).

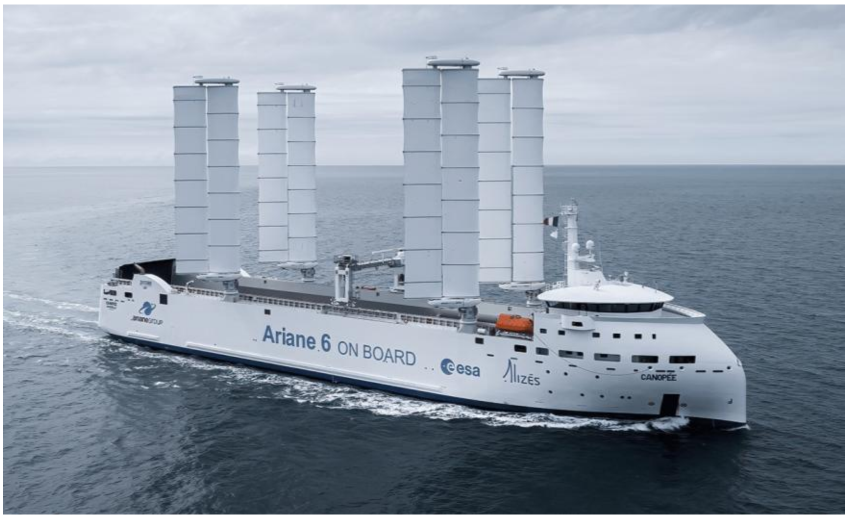

Fig. 1. **Wind-assisted container vessel Canopée**

The Canopée project has demonstrated the reliability of the hybrid wind-assisted propulsion system OceanWings in commercial operation. Two years after entering service, Canopée, the world's first cargo vessel equipped with four automated rigid OceanWings sails, has been evaluated as a successful implementation by the joint venture Jifmar and Zéphyr & Borée, with significant fuel savings being reported. The vessel operates within the Ariane 6 program, transporting cargo between Europe and French Guiana.

With an overall length of 122 m, Canopée became the first large-scale hybrid wind-assisted cargo platform, establishing a benchmark for a new generation of wind-assisted propulsion systems. Over two years of operation, the system demonstrated an outstanding availability level of 99.6%, confirming its reliability under commercial service conditions.

According to operator estimates, a single sail provides average fuel savings of approximately 1.3 t per day, equivalent to an engine power of about 300 kW. When all four sails are deployed, fuel savings reach up to 5.2 t per day, corresponding to avoided CO_2 emissions of approximately 20.8 t per day. During a recent transatlantic voyage, fuel savings per sail reached up to 2.2 t per day, corresponding to approximately 510 kW of propulsion power, while the vessel achieved a sailing speed of up to 13.7 knots.

Encouraged by the operational performance, the vessel operator Alizés plans further development of the OceanWings platform through the integration of advanced software solutions and artificial intelligence aimed at improving operational efficiency. Discussions are ongoing regarding the implementation of this technology on new and larger commercial vessels operating on various routes [1 – 3].

Another notable example of successful wind-assisted propulsion is the vessel Neoliner Origin (Fig. 2).

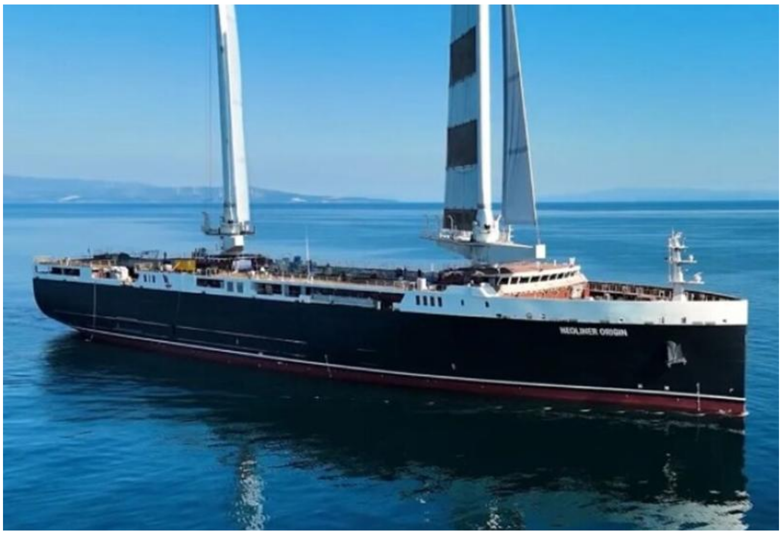

Fig. 2. **Vessel equipped with auxiliary wind-assisted propulsion, Neoliner Origin**

The vessel is equipped with two rigid composite sails. Neoliner Origin became one of the first test platforms for the Solid Sail system, which was officially introduced only in the summer of 2022. For Neoliner Origin, the Solid Sail system is intended not only to provide propulsion assistance but also to significantly improve fuel efficiency. According to the shipowner, the vessel consumes approximately five times less fuel compared to conventional cargo vessels of similar size. The total sail area is about 3,000 m^2, comparable to approximately half of a football field. The sails are mounted on articulated masts with a height of 76 m, which can be reduced when required [4 –5].

Despite the optimistic outlook, several significant drawbacks of wind-assisted propulsion systems on large vessels must be acknowledged, as they directly affect technical and economic performance, including:

relative unreliability and safety concerns associated with sails and masts under storm conditions, leading to increased insurance risks;

the requirement for large sail areas ($3 \dots 4 \times 10^3$ m^2) and multiple masts for high-deadweight vessels, resulting in increased manufacturing and operational costs;

challenges related to initial strength and fatigue resistance of highly loaded tall masts under long-term degradation of mechanical properties, necessitating additional maintenance costs;

reduction in vessel stability due to elevated centers of aerodynamic force and wind-induced rolling, posing potential safety hazards;

the need to supply onboard electrical power without additional carbon emissions [5, 6].

It is considered appropriate to address these limitations by dividing them into several groups, namely: solutions for rigid sails, solutions for flexible sails, and the development of an efficient information-measurement system for controlling both types of wind-assisted propulsion systems (WAPS).

Rigid sails are attractive due to their structural stability, and their surfaces can be utilized for the placement of devices designed to harvest low-grade solar thermal energy [7, 8]. Particularly promising in this context are silicon-based optical fibers capable of functioning as photovoltaic elements.

Such fibers can be scaled to considerable lengths, reaching several meters. They enable the fabrication of flexible, curved, or twisted solar textiles through the weaving of silicon conductors commonly used in photovoltaic cells. This approach departs from the conventional concept of connecting flat semiconductor chips to cylindrical optical fibers. The developed innovative optical fiber incorporates an embedded electronic component, eliminating the need for integration with discrete chips. This technology is realized using high-pressure chemical processes that allow layer-by-layer deposition of semiconductor materials within microscopic cavities of the optical fiber.

A further stage of development involved fibers fabricated from crystalline silicon-based semiconductor materials. These fibers operate as photovoltaic devices converting solar radiation directly into electrical current. Moreover, long fiber-based photovoltaic elements enable the creation of textiles composed of interwoven silicon fibers. Such textiles can be applied in various fields, including onboard power generation.

Textile structures based on solar fibers are lightweight, flexible, and convenient for transportation, as they can be folded and deployed as required. These textiles can be easily integrated into the vessel’s electrical power systems.

A major advantage of flexible solar materials is their ability to capture solar energy at varying angles of incidence. Flexible and curved textiles minimize dependence on solar elevation, azimuth, and time of day. Another important property of silicon fibers is their compactness and high response speed to visible laser radiation. These devices function as photodetectors with bandwidths exceeding 1.8 GHz, making them highly efficient in this application domain [8].

For flexible sails, the integration of thermoelectric fibers into the sail fabric appears more appropriate.

Thermoelectric materials have attracted significant attention as promising energy-harvesting devices. While conventional generators exhibit reduced efficiency at low power levels and dissipate thermal energy under low-temperature conditions (~150 °C), thermoelectric devices offer the potential to outperform traditional technologies in such environments due to higher energy conversion efficiency. Despite these advantages, thermoelectric energy harvesters face three major challenges inherent to modern power sources.

The first challenge is the requirement for thermoelectric modules to be sufficiently flexible to enable cost-effective mass production. Prior to converting thermal energy into electrical energy, the modules must adapt to various heat source geometries while effectively accumulating thermal energy. Traditional approaches rely on individually fabricated solid-state modules; however, increasing attention is being paid to organic and hybrid materials that enable more flexible solutions.

The second challenge involves optimizing electrical interconnections between electrodes without the use of electrically conductive adhesives (ECAs), thereby reducing costs. Due to the low thermal stability of organic and hybrid materials, plasma metallization techniques are unsuitable, while ECAs remain imperfect due to relatively low electrical conductivity and mechanical instability.

The third challenge is associated with maintaining a sufficient temperature gradient (ΔT) required for efficient power generation under natural air-cooling conditions. Owing to the high thermal conductivity of commercially available modules, primarily designed for Peltier cooling systems, the achievable ΔT is limited to approximately 2°C or 10°C at hot surface temperatures of 40°C and 120°C, respectively, significantly restricting their performance in energy-harvesting applications.

Conventional solid-state thermoelectric modules require water-cooling systems to ensure adequate ΔT within thermoelectric materials. However, their application is severely constrained by high costs and installation complexity. To increase ΔT, two main approaches are considered: increasing module thickness and reducing the thermal conductivity of thermoelectric materials. Experimental studies have shown that using mixtures of thermoelectric powders with low-volatility organic solvents as a basis for adhesive thermoelectric materials enables low thermal conductivity. The viscosity of such dispersions is described by a modified Roscoe equation accounting for the volumetric fraction of components. Optimal electrode adhesion was achieved at powder volume fractions of 55 … 60%. Furthermore, application of the Kanari model for filled composites confirmed that thermal conductivity can be significantly reduced to values close to those of organic compounds, thereby facilitating larger ΔT. At the same time, increased viscosity indicates strong interparticle interactions, ensuring effective electrical conductivity and thermoelectric voltage generation even in thick modules.

Thus, adhesive-based thermoelectric materials demonstrate significant potential for overcoming existing technical limitations. To identify key factors affecting their properties, the dependence of output thermoelectric electromotive force (thermo-EMF) and electrical resistance on the thickness of the intermediate layer in single-cell structures was investigated. Experiments were conducted using adhesive Sb- and Bi-based materials with different particle sizes and three types of low-volatility organic solvents. The analysis revealed a linear relationship between output voltage and layer thickness, with the slope dependent on thermoelectric powder characteristics, confirming that energy generation is governed by the Seebeck effect inherent in the powders.

Using externally measured ΔT values for single-cell structures, Seebeck coefficients of 12 μV/K and 40 μV/K were obtained for adhesive Sb and Bi, respectively. Accounting for temperature losses during external measurements, these values are close to bulk values (Sb: 35 μV/K; Bi: 70 μV/K), which are independent of particle size. However, particle size significantly influenced electrical resistance, particularly for thicker layers, thereby affecting ΔT. Since ΔT increases with intermediate layer thickness, the use of larger thermoelectric particles (38 … 150 μm) is advantageous for efficient thermal energy harvesting and power transfer. Experimental results also confirmed that S-shaped deformation provides optimal electrode contact with adhesive-based thermoelectric materials, minimizing contact resistance. An experimental 6×6 module exhibited a resistance of 212 Ω and generated 42 mV at a hot-plate temperature of 120°C. Due to the thermal insulation environment, modules with 2.4 mm thick layers maintained ΔT values of approximately 10°C and 40°C under natural air cooling with fins at hot-plate temperatures of 40°C and 120°C, respectively. The observed thermoelectric voltages closely matched predicted values based on single-cell structures. Although measured resistances of 2×3 and 6×6 modules were approximately two and six times higher than predicted, respectively, a significant reduction in resistance was achieved. These results indicate that structural design parameters of thermoelectric modules can compensate for intrinsic material limitations. The thermal insulation environment effectively regulates thermal conductivity under external conditions.

Thus, in addition to their economic feasibility for maritime applications, adhesive-based thermoelectric materials offer low thermal conductivity, making them particularly suitable for flexible thermoelectric modules. They enable efficient utilization of low-temperature solar heat under natural air-cooling conditions with fins for energy harvesting [9].

It is evident that when large-area heat-harvesting surfaces are employed, the efficiency of WAPS is directly dependent on the quality of control under varying wind loads. The control system must provide continuous environmental monitoring and real-time adaptive control of propulsor geometry with high dynamic response.

One of the most promising approaches to addressing this challenge is the development of sensors with distributed integral sensitivity, which can be integrated into distributed measurement networks. Fiber-optic technology is considered the most suitable technological basis for such devices, as fiber-optic sensors combine both data transmission and sensing functions. This enables the development of fundamentally new high-speed measurement devices capable of integration into complex information-measurement systems for monitoring multidimensional physical field distributions. In general, a distributed fiber-optic measurement network consists of a set of individual sensing lines arranged in a specific spatial configuration. An integral fiber-optic sensing line functions as a transducer capable of detecting external influences along its entire length. To minimize the number of information channels, tomographic methods are proposed, whereby each sensing line forms an integral image of the physical field distribution. Even with a limited number of such integral images, the overall field distribution can be reconstructed with sufficient accuracy [10 – 15].

Integration of fiber-optic sensors into distributed measurement networks significantly reduces the weight and cost of diagnostic equipment while expanding the dynamic measurement range. Particular emphasis is placed on fiber-optic Fabry–Pérot interferometers and fiber Bragg gratings, which form the basis for distributed sensors with spectral multiplexing.

A key feature of such fiber-optic measurement systems is the requirement for reliable operation under harsh environmental conditions, necessitating the use of specialized optical fibers and materials. Based on the results reported in [15 – 21], artificial sapphire is recommended for the fabrication of sensors within distributed fiber-optic measurement networks. This material provides the required mechanical properties for force and pressure sensors integrated into wind-assisted propulsor elements within acceptable geometric dimensions.

Thus, the integration of a multiparametric distributed fiber-optic measurement network into WAPS enables not only continuous monitoring of any sail section but also provides an additional source of alternative energy. Moreover, the application of onboard auxiliary energy-harvesting systems positively impacts both specialist training and the economic performance of shipping companies [22 – 24].

References:

1. Первый мире парусный контейнеровоз – детали проекта. URL: https://www.korabel.ru.news/comments/pervyy_mire_parusnyy_konteynerovoz_-_detali_proekta.html.
2. Canopée подтвердила эффективность парусного движителя OceanWings спустя два года эксплуатации. URL: https://ariacrew.com/ru/blog/news/canopee-podtverdila-effektivnost-parusnogo-dvizhitelya-oceanwings-spustya-dva-goda-ekspluatacii-346
3. Опришко, М. О., Карпілов, О. Ю., Сандлер, А. К., & Філін, В. М. (2022). Застосування новітніх матеріалів для створення елементів комбінованих електроенергетичних установок з вітрорушієм. СУДНОВА ЕЛЕКТРОІНЖЕНЕРІЯ, ЕЛЕКТРОНІКА І АВТОМАТИКА, 169.
4. Проект Neoliner Origin и долгая история постройки. URL: https://interparus.com/neoliner-origin-a-21st-century-sailing-merchant-ship/
5. Карпілов, О., Удолатій, В., & Сандлер, А. Автоматизований вітрильно-рушійний комплекс − новітні вітрила на "старих" щоглах. Grail of Science, (39), 369-374.
6. Настасенко, В. А. (2018). Современные судовые парусные системы и технико-экономический анализ их эксплуатации. Розвиток методів управління та господарювання на транспорті, (4), 73-96.
7. Сандлер, А. К., & Цюпко, Ю. М. (2015). Модуль для утилізації низькопотенційного тепла суднових енергетичних установок. Судовые энергетические установки, (35), 163-168.
8. Flexible silicon solar-cell fabrics may soon become possible. URL: https://www.psu.edu/news/research/story/flexible-silicon-solar-cell-fabrics-may-soon-become-possible.
9. Satoh, N., Otsuka, M., Sakurai, Y., Asami, T., Goto, Y., Kawamori, T., ... & Mori, T. (2020). Sticky thermoelectric materials for flexible thermoelectric modules to capture low–temperature waste heat. MRS Advances, 5(10), 481-487.
10. Карпилов, А. Ю., & Сандлер, А. К. Волоконная оптика в системах управления ветровыми движителями. Науково-практична конференція" Актуальні питання суднової електротехніки і радіотехніки, 12-18.
11. Данчук, Д. П., & Доломанжи, Г. Д. ІНТЕГРАЦІЯ ВОЛОКОННО-ОПТИЧНИХ ПРИСТРОЇВ У ВІТРИЛЬНО-РУШІЙНИЙ КОМПЛЕКС. ІтаТМВВТ-2022, 8.
12. Сандлер, А. К., & Карпилов, А. Ю. (2014). Повышение точности управления ветродвижителем. Енергетика судна: експлуатація та ремонт: матеріали науково-технічної конференції.– Одеса: ОНМА, 120-122.

13. Заічко, С. І., Сандлер, А. К., & Карпілов, О. Ю. (2017). Система керування роторним багатосекційним вітрорушієм. Судовождение, (27), 85.
14. Кульчин, Ю. Н. (2001). Распределенные волоконно-оптические измерительные системы. М.: Физматлит, 272, 14.
15. Сандлер, А., Омельченко, Т., & Дулгеров, Д. (2025). ВОЛОКОННО-ОПТИЧНА РОЗПОДІЛЕНА СИСТЕМА БЕЗПЕКИ МОРСЬКИХ ПОРТІВ. Collection of scientific papers «ΛΌГОΣ», (June 6, 2025; Bologna, Italy), 332-340.
16. Сандлер, А. К. (2019). Чувствительный элемент волоконно-оптического акселерометра на основе сапфирового стекла. СУДНОВА ЕЛЕКТРОІНЖЕНЕРІЯ, ЕЛЕКТРОНІКА І АВТОМАТИКА, 28.
17. Сандлер, А. К. (2021). Метод підвищення ефективності діагностування технічного стану суднових газотурбінних установок на основі волоконно-оптичних технологій (Doctoral dissertation, –К., 2021.– 159 с).
18. Карпілов, О. Ю., Удолатій, В. Б., & Сандлер, А. К. АЛЬТЕРНАТИВНА КОНСТРУКЦІЯ ВІТРИЛЬНОГО ПРОПУЛЬСИВНОГО КОМПЛЕКСУ. SEEEA-2024, 209.
19. Міюсов, М., Сандлер, А., & Карпілов, О. (2021). Волоконно-оптичний датчик вітру.
20. Сандлер, А., & Кузнєцова, Г. (2020). Волоконно-оптичний дозиметр енергетичної освітленості ультрафіолетового випромінювання.
21. Sandler, A., Romanovska, O., Palagin, O., & Tymchynskyi, N. (2025). Fiber optic pH meter for ballast water control. Матеріали конференцій МЦНД, (10.10. 2025; Суми, Україна), 228-236.
22. Кузьменко, К., & Сандлер, А. (2024). ОСОБЛИВОСТІ ФОРМУВАННЯ ТРУДОВИХ РЕСУРСІВ В УМОВАХ АВТОМАТИЗАЦІЇ СУДЕН. Collection of scientific papers «ΛΌГОΣ», (March 29, 2024; Cambridge, UK), 79-81.
23. Мезіна, Л. В. (2025). Умови стійкого розвитку підприємств водного транспорту. Соціально-економічні виклики та можливості глобалізації, 125.
24. MEZINA, L. (2024). DEVELOPING THE EXPORT POTENTIAL OF PORT INFRASTRUCTURE IN THE FACE OF UNCERTAIN POSITIONING. Economic innovations, 26(1 (90)), 130-138.