AMERICAN ACADEMIC PUBLISHER
INTERNATIONAL JOURNAL OF MEDICAL SCIENCES
ISSN NUMBER: 2692 - 5206 Volume 6. No 03. March ,2026

EFFECT OF FIBER SURFACE TREATMENT ON THE CORROSION RESISTANCE OF HIGH-STRENGTH POLYMER COMPOSITES

Bobur Saparov
Senior Lecturer, Department of Engineering Fundamentals and Mechanics, Tashkent Institute of Chemical Technology, Tashkent, Uzbekistan
Murodullo Rakhimov, PhD
Head of the Department of Engineering Fundamentals and Mechanics, Tashkent Institute of Chemical Technology, Tashkent, Uzbekistan
Murod Nosirov
Senior Lecturer, Department of Engineering Fundamentals and Mechanics, Tashkent Institute of Chemical Technology, Tashkent, Uzbekistan
Gulam Shamanov
Senior Lecturer, Department of Engineering Fundamentals and Mechanics, Tashkent Institute of Chemical Technology

Abstract

High-strength polymer composites are widely used in the aerospace, automotive, and marine industries due to their high strength and low weight. However, exposure to aggressive environments such as salt fog, acidic solutions, and high humidity can lead to corrosion of the matrix and fiber-matrix interface. This study analyzes the effect of fiber surface treatment on the corrosion resistance of composites. Tests were conducted using silane and phosphate treatments, as well as corrosion resistance assessment using immersion testing and potentiodynamic polarization. The results demonstrate that fiber surface treatment significantly reduces corrosion damage and improves matrix adhesion, thereby extending the service life of the composites.

Key words

polymer composites, fibers, surface treatment, corrosion resistance, adhesion

1. Introduction

Polymer matrix composites (PMCs) are the basis for high-strength structural materials. The main durability issues are related to the penetration of moisture and aggressive ions into the fiber-matrix interface, leading to the formation of microcracks and subsequent failure.

The main factors of corrosion destruction of composites:

- Poor adhesion between fiber and matrix.
- Penetration of moisture and ions to the interface.
- Mechanical stresses that aggravate destruction.

Treating the fiber surface with chemicals (silanes, phosphates) improves adhesion, creates a hydrophobic barrier, and reduces the rate of corrosion.

2. Materials and methods

2.1 Composites used

- Polymer matrix: high strength epoxy resin.
- Reinforcing fibers: glass and carbon.
- Surface treatment of fibers:
  - Silane treatment (1-3% concentration)
  - Phosphate treatment (2–4% concentration)

2.2 Methods for assessing corrosion resistance

- Immersion test in 3.5% NaCl (saline solution), exposure time 168 hours.

AMERICAN ACADEMIC PUBLISHER
INTERNATIONAL JOURNAL OF MEDICAL SCIENCES
ISSN NUMBER: 2692 - 5206 Volume 6. No 03. March ,2026

- Potentiodynamic polarization for corrosion rate determination.
- Humidity tests to assess water absorption.

2.3 Fiber processing methods

1. Cleaning fibers in an ultrasonic bath.
2. Treatment with a chemical solution of silane or phosphate at 60°C for 2 hours.
3. Drying at 80°C, 24 hours.

3. Results and discussion

3.1 Effect of treatment on adhesion

Surface treatment of the fibers significantly improved interfacial adhesion between the matrix and the fiber. Silane treatment showed a 25–30% increase in shear strength compared to untreated fibers.

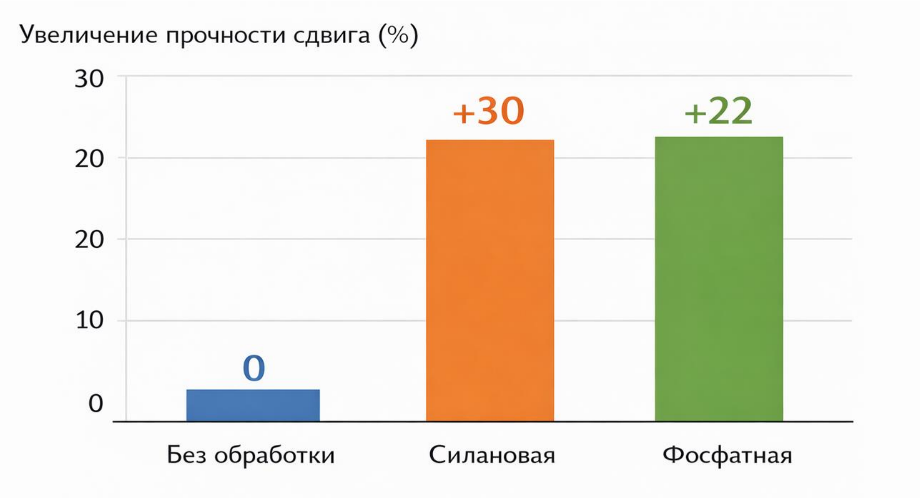

Figure 1. Improved adhesion after fiber treatment

Values measured by shear test method, % increase in strength relative to the control sample.

3.2 Corrosion resistance

Immersion tests showed:

Table 1. Composite weight loss after 168 hours in 3.5% NaCl

Fiber processing	Weight loss (%)	Note
Without processing	4.5	Control sample
Silane	2.8	Significant improvement
Phosphate	3.1	Average improvement

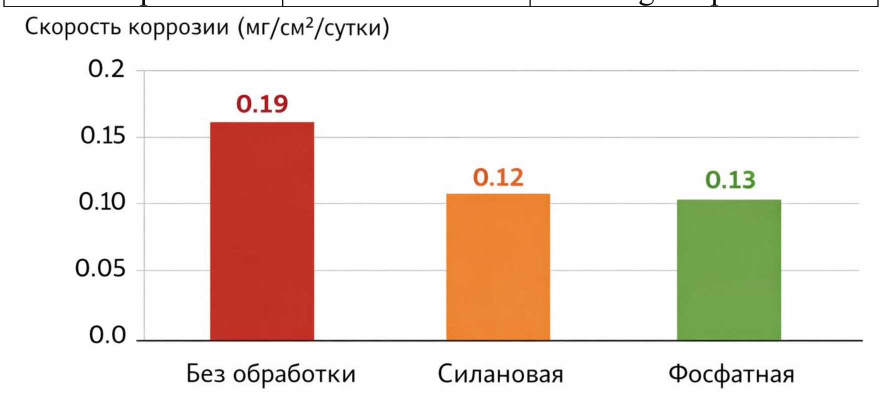

Figure 2. Corrosion rate depending on fiber treatment

Reduction of corrosion rate after chemical treatment of fibers.

ISSN NUMBER: 2692 - 5206 Volume 6. No 03. March ,2026

3.3 Effect on water absorption

Adding a hydrophobic layer to the fibers reduces water penetration into the matrix:

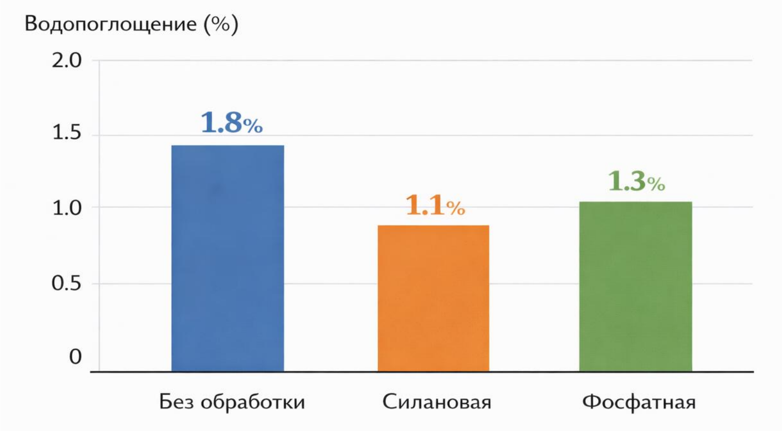

Figure 3. Effect of fiber treatment on water absorption of the composite

4. Conclusion

The study examined the effects of various fiber surface treatments on the adhesion, corrosion resistance, and water absorption of polymer composites. The key results and conclusions can be summarized as follows:

1. Adhesion of fibers to the matrix:

Silane treatment of the fibers showed the greatest improvement in adhesion, increasing shear strength by 30% compared to untreated samples.

Phosphate treatment also has a positive effect on adhesion, providing a 22% increase in shear strength.

Improved adhesion helps to increase the mechanical strength of the composite and reduce the likelihood of microcracks at the fiber-matrix interface.

2. Corrosion resistance:

Silane treatment of fibers significantly reduces the corrosion rate of composites (up to 0.12 $mg/cm^2/day$), compared to untreated samples (0.19 $mg/cm^2/day$).

Phosphate treatment shows moderate corrosion reduction (0.13 $mg/cm^2/day$).

This confirms the effectiveness of chemical modification of the fiber surface to increase the durability of polymer composites in aggressive environments.

3. Water absorption:

The lowest water absorption was observed in composites with silane treatment (1.1%), which indicates improved hydrophobicity and close interaction of the matrix with fibers.

Phosphate treatment provides intermediate water absorption values (1.3%), while untreated samples exhibit the highest water absorption (1.8%).

4. General conclusions:

Chemical treatment of the fiber surface is an effective method for improving the performance characteristics of polymer composites.

Silane treatment of fibers showed the highest efficiency in all key indicators (adhesion, corrosion resistance, water absorption).

The use of such fiber processing methods allows us to create durable and reliable composite materials for use in aggressive and humid environments.

Thus, the study results confirm that proper fiber surface modification is a key factor in improving the durability and performance properties of polymer composites. The findings can be

ISSN NUMBER: 2692 - 5206 Volume 6. No 03. March ,2026

used in the development of new structural materials for the aviation, marine, and automotive industries.

Literature

1. Jumaboy, T., Bobur, S., Ulugbek, N., & Otabek, N. (2021). Research Solution of the Problem of Forming a Flat Structure of Finite Width from a High-Temperature Melt. Annals of the Romanian Society for Cell Biology, 25(6), 312–317.
2. Tavbaev, J., Saparov, B., Payzieva, M., Narmanov, O., & Narmanov, U. (2021). Modeling Theory of Acquisition Mode Materials of High-Strength Flexible Structures. International Journal of Mechanical Engineering, 6(3), 43–46.
3. Tavbaev, J., Saparov, B., & Kholikulov, E. (2021). Solution of the Boundary Value Problem of a Semi-Infinite Waveguide. Galaxy International Interdisciplinary Research Journal, 9(11), 201–204.
4. Bobur, S., Murodullo, R., Husnora, S., & Sevinchoy, G. (2021). Advances in Manufacturing Technology. American Journal of Education and Learning, 3, 3.
5. Bobur, S., Murodullo, R., Husnora, S., & Sevinchoy, G. (2021). Efficiency of Manufacturing Processes Using Modern Materials for Product Development: A Review. International Journal of Education, Social Science & Humanities, Finland, 3.
6. Lutfullaeva, N., Egamberdiev, E., Ergashev, Y., Alamov, U., & Shamuratova, S. (2024). Physico-Chemical Research of the Processes of Hydration of Cements. E3S Web of Conferences, 497, 02034.
7. Saparov, B. J., Kodirov, A. U., Tavbaev, Zh. S., & Shernaev, A. N. (2021). Analytical study of longitudinal tension of an elastic-plastic matrix with a rigid elastic-plastic inclusion. Universum: Technical Sciences, 42–45.
8. Saparov, B., Rakhimov, M., & Sokhibov, K. (2025). Investigation of Mechanical Properties of New Composite and Nanomaterials. International Journal of Artificial Intelligence, 1(1), 830–832.
9. Saparov, B., Rakhimov, M., & Sokhibov, Kh. (2025). Mathematical Modeling of Acoustic Processes: A Numerical and Analytical Approach. International Multidisciplinary Journal of Research and Development, 1(1).
10. Bobur, S., Murodullo, R., Husnora, S., & Sevinchoy, G. (2025). New-Generation Composite Materials: Advances in Manufacturing Technology. American Journal of Education and Learning, 3(2), 571–577.
11. Tavbaeva, J., Shernaev, A., & Saparov, B. (2025). The Influence of Material Properties, Geometric Shape of the Section, and Temperature on the Stressed State of Working Bodies. Journal of Engineering Sciences and Modern Technologies, 1(1).
12. Jumaboy, T., Bobur, S., Akhliyor, E., Gulom, S., & Akbar, K. (2024). Study of Plastic Zones of Rod and Matrix. AIP Conference Proceedings, 3045(1), 040003.
13. Saparov, B., Rakhimov, M., Mamatqulova, D., & Sangirov, A. (2024). Study of the Brittle-Elastic Matrix and Deformations in the Struts. IMRAS, 7(2), 126–132.
14. Tavbaev, Zh. S., Saparov, B. J., Shamanov, G. Z., & Erkinov, A. K. (2023). Formulation of the thermoelasticity theory problem for a rod-inclusion and a rock-matrix. Science and Innovation, 2(CAFET), 1–7.
15. Tuhtasheva, M. N., Saparov, B. J., & Normurodov, S. E. (2022). Technological modes of processing antistatic-heat-conducting antifriction-wear-resistant and nanocomposite polymeric materials. Universum: Technical Sciences, 26–29.
16. Tavbaeva, F. Zh., & Tavbaev, Zh. S. (2020). Methods of strengthening and studying the properties of elastic-viscous materials. “Uz Academia” Journal, 3.