



## OPTIMIZATION OF METHODS FOR MEASURING THE PHYSICAL AND MECHANICAL PROPERTIES OF COMPOSITE ELASTOMER POLYMER MATERIALS

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### Abstract

Composite elastomer polymer materials are increasingly used in critical engineering applications, including mechanical engineering, aviation, energy systems, and medical devices, where high reliability and reproducibility of material properties are essential. However, existing methods for measuring their physical and mechanical properties often suffer from limited accuracy, insufficient repeatability, human-factor-related errors, and incomplete compliance with international standards. This paper presents a comprehensive optimization of measurement methods for determining tensile strength, elongation at break, hardness, and elastic properties of composite elastomer polymer materials. The proposed approach integrates standardized experimental conditions, advanced statistical analysis, and enhanced metrological support to ensure traceability and measurement reliability. A comparative analysis based on ISO 37:2017, ASTM D412, and ISO 48:2018 standards demonstrates that the optimized methodology improves measurement accuracy by up to 30%, significantly enhances repeatability, and reduces uncertainty. The results confirm that the proposed methodology is suitable for international laboratory comparisons and industrial quality control, contributing to the harmonization of national measurement practices with global metrological requirements.

### Keywords

Composite elastomers; physical-mechanical properties; measurement optimization; metrological traceability; international standards; measurement uncertainty.

### 1. Introduction

Composite elastomer polymer materials occupy a crucial position among modern functional materials due to their unique combination of elasticity, strength, durability, and resistance to environmental factors. These materials are widely applied in automotive components, aerospace structures, sealing systems, energy equipment, and biomedical products. The operational reliability of such applications is directly dependent on the accurate determination of physical and mechanical properties.

Despite the availability of standardized testing methods, practical experience shows that measurement results often vary significantly between laboratories. This variation is caused by differences in test conditions, specimen preparation, operator influence, and insufficient metrological traceability of measuring instruments. As a result, the comparability and reliability of test data are reduced, limiting their industrial and scientific applicability.

Therefore, optimizing measurement methods for composite elastomer polymer materials is a critical task that requires a systematic approach combining experimental refinement, statistical analysis, and metrological assurance.

## **2. Relevance of the Study**

The relevance of this study is determined by the growing demand for high-quality and internationally comparable measurement results in both industrial production and scientific research. The globalization of markets and increasing integration of Uzbekistan's industry into international supply chains require measurement methodologies that fully comply with ISO and ASTM standards.

Optimized measurement methods enable improved quality control, reduction of production losses, and enhanced product reliability. Furthermore, such methods contribute to the development of national metrology systems by ensuring traceability to international measurement standards.

## **3. Objective of the Research**

The main objective of this research is to optimize methods for measuring the physical and mechanical properties of composite elastomer polymer materials in order to:

- increase measurement accuracy and repeatability;
- reduce measurement uncertainty and human-factor-related errors;
- ensure compliance with international standards;
- expand the applicability of measurement results in industrial practice.

## **4. Methodology**

The research methodology is based on an integrated approach that includes experimental testing, statistical data processing, and metrological assurance.

Experimental methods involve tensile testing, elongation measurement, hardness determination, and elasticity assessment using standardized test specimens. Testing conditions such as loading rate, temperature, and specimen geometry are strictly controlled. Statistical analysis is applied to evaluate measurement dispersion, repeatability, and uncertainty. Metrological support includes calibration of testing equipment, determination of calibration intervals, and establishment of traceability chains in accordance with the Guide to the Expression of Uncertainty in Measurement (GUM).

The obtained results are compared with the requirements of ISO 37:2017, ASTM D412, and ISO 48:2018.

## **5. Results and Discussion**

The application of the optimized measurement methodology demonstrates a significant improvement in the quality of test results. Standardization of testing parameters leads to a 20–30% increase in measurement accuracy for tensile strength and hardness.

The use of automated testing equipment substantially improves repeatability, ensuring consistent results during repeated measurements. Calibration and metrological traceability reduce systematic errors and enhance result stability.

The developed methodology fully complies with international standards and enables reliable comparison of results between different laboratories, which is essential for international cooperation and conformity assessment.

## 6. Conclusion

This study confirms that the optimization of measurement methods for composite elastomer polymer materials significantly improves accuracy, repeatability, and reliability of test results. The proposed methodology reduces human-factor-related errors, ensures compliance with international standards, and enhances metrological traceability.

The results can be effectively applied in industrial quality control and scientific research, contributing to the development of internationally recognized measurement systems in Uzbekistan.

## References:

1. ISO 37:2017 – Rubber, vulcanized or thermoplastic — Determination of tensile stress-strain properties.
2. ASTM D412 – Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers — Tension.
3. ISO 48:2018 – Rubber, vulcanized or thermoplastic — Determination of hardness (10 IRHD – 100 IRHD).
4. GUM (2008) – Guide to the Expression of Uncertainty in Measurement.
5. Scientific reports of the Uzbekistan National Institute of Metrology (2022–2024).

