



## STUDY OF CHANGES IN MECHANICAL PROPERTIES OF 3D ELEMENTS OF PRINTED PRODUCTS UNDER THE INFLUENCE OF ULTRAVIOLET RADIATION

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**Abstract.** *The paper investigates changes in the mechanical properties of 3D elements of printed products printed from PLA and ABS plastics using FDM technology under the influence of ultraviolet radiation. The obtained results allow us to assess the behaviour of filaments under the influence of ultraviolet radiation and determine their suitability for further operating conditions.*

The interrelation of technological parameters of additive printing [1] and the effect of ultraviolet radiation determines the resistance of 3D elements of printed printed matter to changes that affect their mechanical properties. A number of modern studies have shown a significant impact of ultraviolet radiation on the mechanical properties of 3D elements of printed printed matter, and their results show that thermal aging caused by the action of ultraviolet radiation, depending on the printing conditions and type of material, can both improve and deteriorate the mechanical characteristics of 3D elements.

The influence of environmental factors on 3D elements of printed printed products during their operation, in particular, prolonged exposure to high temperatures, ultraviolet radiation and humidity, remains insufficiently studied. In turn, the available research shows that taking into account the natural effects on 3D printed printed matter elements manufactured by additive technologies can help to increase their service life, optimise the choice of consumables, design solutions, and increase environmentally friendly approaches in the field of printing production.

The study used PLA and ABS plastics manufactured by MonoFilament [2]. 3D elements of printed products were printed on a 3D printer 'XYZprinting da Vinci Jr. 1.0 Pro' with the following parameters for 3D elements made of PLA plastic: printing temperature – 200 °C, platform temperature – 60 °C, printing speed – 70 mm/s, filling density – 100%, layer height – 0.15 mm. Similarly, the printing parameters for ABS plastic 3D elements were selected, namely: print temperature – 280 °C, platform temperature – 110 °C, print speed – 50 mm/s, filling density – 100%, layer height – 0.15 mm.

The test specimens (10 each of PLA and ABS plastic) were tested for UV resistance in a Formlabs irradiation chamber (Form Cure L) [3], in accordance with ISO 4892-3 [4], using the artificial accelerated weathering method, with continuous 24-hour exposure to UV radiation at a temperature of 50 °C throughout the test period.



To analyse the mechanical properties, the specimens were subjected to bending testing on a Testometric DBBMTCL-250 kg testing machine [5].

According to the results of flexural tests and analysis of stress-strain diagrams of 3D elements made of PLA and ABS plastics, it was determined that the average difference in flexural strength for 3D elements made of ABS plastic is 2.092 MPa, and for 3D elements made of PLA plastic - 9.088 MPa.

Exposure to UV radiation resulted in an overall decrease in the flexural strength of the treated materials, namely, the PLA plastic samples by 22%, while the ABS samples lost only 10% of their initial strength. This indicates a greater resistance of ABS samples to UV radiation compared to PLA samples, which provides their advantages in the production of 3D elements of printed products that are operated under conditions of constant exposure to sunlight.

Thus, exposure to ultraviolet radiation causes destabilisation processes in PLA and ABS polymeric materials produced by MonoFilament. In particular, under the influence of ultraviolet rays, the chemical structure of the materials is disturbed: in PLA, the destruction of polymer chains, in ABS, the degradation of the butadiene component. These processes are accompanied by increased brittleness, yellowing, microcrack formation, and accelerated aging of polymers, which ultimately leads to a decrease in the flexural strength of 3D elements of printed matter. The research results indicate the expediency of a reasonable choice of polymeric materials for the manufacture of 3D elements of printed products by polymer extrusion, taking into account the specifics of the conditions of their further operation. In particular, it has been found that PLA plastic is advisable to use for 3D elements that are not exposed to prolonged ultraviolet radiation. In contrast, ABS plastic shows higher resistance to external factors. The results obtained are significant for understanding the performance characteristics of 3D elements in the field of printing production.

#### References

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