STUDY OF THE INFLUENCE OF TEMPERATURE AND LOAD ON THE MECHANICAL PROPERTIES OF UNIRRADIATED AND IRRADIATED PLEXIGLASS OF DIFFERENT TYPES IN THE FLAT STRAIGHT BENDING TEST

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I. INTRODUCTION

Polymer materials have several of advantages over traditional products [1]. The mechanical properties of composites can change at high strain rates and after irradiation with high – energy particles [2 - 4]. Such materials will also vary with increase of the load. This makes it possible to take into account changes in the design and operation of structures operating in harsh conditions [5, 6]. This work is devoted to a comprehensive study of various types of unirradiated and irradiated Plexiglas, which are tested for plane straight bending under the influence of temperature.

II. RESEARCH METHODS

Two types of smooth and corrugated plexiglass (pyramids and stripes) were taken as the materials under study. Specimens of smooth plexiglass had thickness (h) of 1 mm and a width (b) of 5 and 10 mm and with different working lengths (L) – 20, 30, 40, 50, 60 and 70 mm. The experiment was carried out at temperature of 20, 25 and 50 °C. Electron irradiation of corrugated plexiglass samples was carried out on an ELA-6 linear accelerator with an energy of 2 MeV in air. The radiation dose was 100 kGy. For bending tests under various load conditions, a BI (bursting installation)-50 tensile testing machine was used. It is a setup consisting of a loading device, a control panel and rods connecting the loading device with a control panel. On the bottom of the device were a force sensor, a temperature chamber, and various supports.

III. RESULTS AND DISCUSSION

As a result of the experiments carried out on testing samples of smooth plexiglass of various sizes for a flat straight bend, the dependences of deformation on stress were obtained. From the data obtained, the dependence of deformation on stress for unirradiated samples of smooth Plexiglas 5 mm wide and of various lengths at 20 ° C (room) temperature is satisfactorily described by a linear model for all sizes. Moreover, the maximum deformation of the samples, depending on the length of the samples and the stress, varies in the range of 35 – 60%.

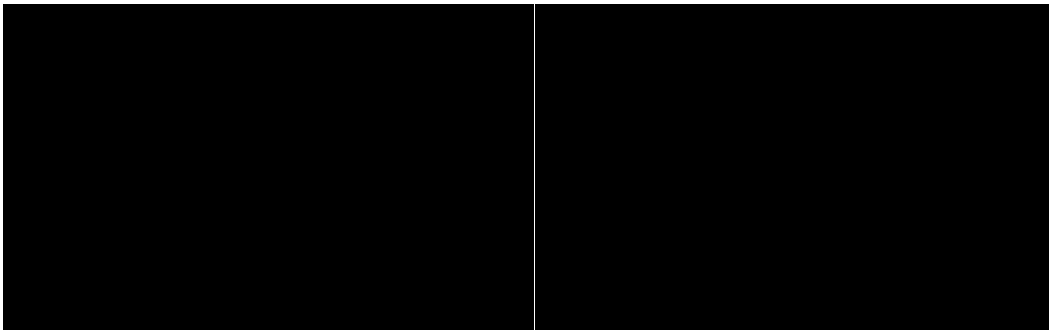
1 – 20; 2 – 40; 3 – 70 mm

Figure 1. Dependence of deformation on stress when testing specimens of smooth PMMA 5 mm wide (left) and 10 mm (right) for bending at a temperature of 25 °C

From Figure 1 it follows that with an increase in the width of the samples, the deformation decreases. Strength characteristics are also undergoing significant changes. The article shows the dependence of deformation on stress for unirradiated and irradiated samples of corrugated plexiglass, in which plane bending occurs with and without taking into account the horizontal component. From the result of the experiment, it follows that smooth and corrugated plexiglas (both unirradiated and irradiated) are described with good accuracy by a linear model:

$$\varepsilon=\alpha\sigma,$$

where α is the slope tangent. For unirradiated striped-corrugated glass, α = 0.14, and for pyramid-corrugated glass, 0.2%/MPa. For irradiated materials, α = 0.1 and 0.13%/MPa, respectively.



1 – 20; 2 – 40; 3 – 70 mm

Figure 2. Dependence of deformation on stress when testing samples of smooth polymethylmethacrylate 5 mm wide (left) and 10 mm (right) for bending at a temperature of 50 °C

With a further increase in temperature, the samples begin to bend without load, which made it difficult to analyze the behavior of the material. It can be seen from the figures that a long sample has a greater deflection (regardless of temperature) than a short one and breaks at a lower value of mechanical stress. With an increase in the temperature of the test specimen in the range of 20 – 50 °C, an increase in deformation characteristics by 20 % is observed for all sizes of the material, and the strength characteristics deteriorate by 10-30%.

IV. CONCLUSIONS

Experiments on the dependence of deformation on stress during flat straight bending testing of unirradiated and irradiated Plexiglas samples of various types in a temperature chamber have been carried out. It was found that the maximum deformation of samples of various sizes varies in the range of 50 – 60%, depending on the stress, length and width of the material. It was found that electron irradiation leads to a noticeable change in the deformation-strength characteristics of the material, which manifests itself in an improvement in plasticity. With an increase in the temperature of the test specimen in the range of 20 – 50 degrees, an increase in deformation characteristics is observed by another 20 % of the maximum for all sizes of the material, and the strength characteristics deteriorate by 10 – 30 %.

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