INTERNATIONAL CONFERENCE
St Petersburg, RUSSIA
04 March 20120

SUAI State University of Aerospace Instrumentation

Science & Technology City Hall

«Metrological Support of Innovative Technologies» ICMSIT-2020

«The tensile strength diagnostics of transparent monolithic polycarbonate by piezoelectric effect»

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ICMSIT-2020
Metrological Support of Innovative Technologies

Problem statement

- The diagnostics of strength characteristics of organic glasses should be used in same practices application, as an aircraft cockpit glazing, building stained-glass windows, glass roofs. That because of hardness organic glass decrease under such external influences as irradiation with solar radiation, wind and snow loads, temperature changes, and aging of the material.

Problem statement

- The lack of changes in the construction of organic glass and saving the view through glass is the main criteria of its strength diagnostic methods choosing. The promising method for such diagnostics is based on the piezoelectric effect in polymers.

Problem statement

- The piezoelectric effect in organic glasses is determined by the structure and its changes. Therefore, the relationship between piezoelectric voltage and structure changings in the organic glass under the external force can allowed to diagnostic the tensile strength decrease.

Problem statement

- The piezoelectric effect in polymers is rather well studied, but there are no data in the literature on the influence of the measurement circuit (the location, area and geometry of the electrodes) on the relationship between mechanical stresses and piezoelectric voltage in monolithic polycarbonate. The purpose of this work is to determine the influence of the location of the electrodes for measuring piezoelectric stress on the possibility of diagnosing the tensile strength of monolithic polycarbonate.

Solution methods

- The influence of the electrodes location on the results of piezoelectric stress measurements (U)

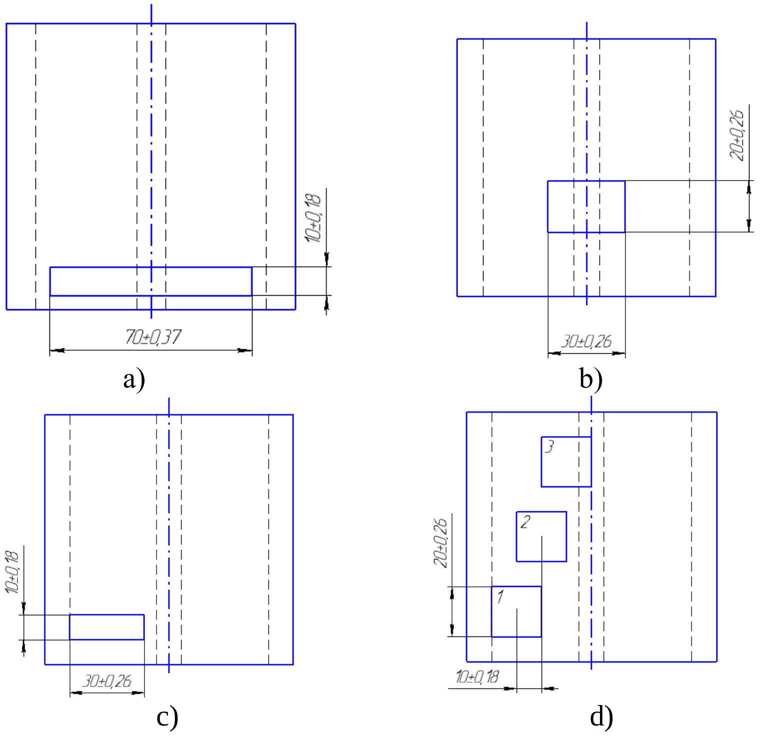

Figure 1. Electrode layouts.

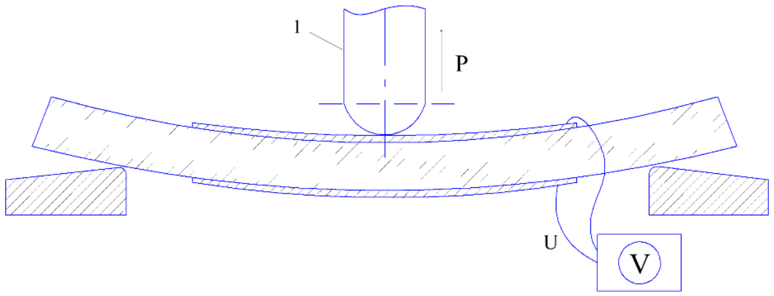

Figure 2. Experimental setup.

Solution methods

- The electrodes arrangement in figure 1c showed the best correspondence of force and piezoelectric voltage. Most likely, this is due to the distribution of the sign of the piezoelectric potential over the surface of the sample. The destruction of bonds between molecules in polycarbonate leads to a decrease in piezoelectric stress. It should be noted that schemes in the region of noticeable cracks (figure 3), the first derivative of the piezoelectric voltage (dU/dt) passes through zero for all electrode deposition.

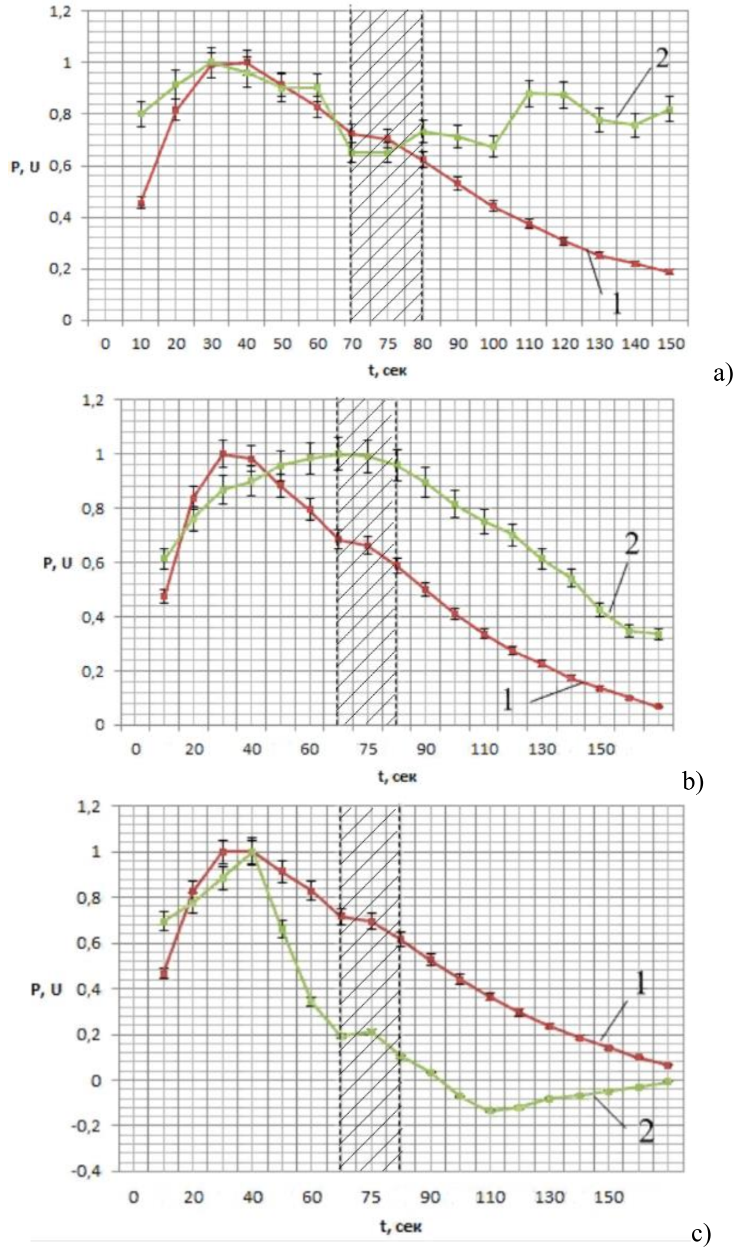

Figure 3. Typical time dependences of normalized loading forces P (1) and piezoelectric stress U (2).

Conclusions

Results, implementation

- Studies have shown that the absolute values of the measured piezoelectric stress are different from sample to sample. This difference can be explained by structural features of monolithic polycarbonate, for example, crystallinity. However, a monotonous increasing characteristic is well reproduced in all cases, during repeated measurements; the measurement error did not exceed ~ 10%.
- The monotonicity of the piezovoltage characteristic, the global peak of the piezoelectric stress before the occurrence of noticeable cracking, as well as the zeroing of the derivative of the piezoelectric stress in the cracking region, allows using the method under consideration for diagnosing the tensile strength of monolithic polycarbonate during its operation.

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