Modelling of polymer materials under action of intensive flows of energy

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The simulation results of the polymeric materials destruction can be used for study of their behavior during energy impact, for verification of volume fracture models for brittle materials, and for validation of wide-range equations of state.

We consider the impact of a powerful laser and electron beam on plexiglas and polystyrene samples. The calculated data are compared with theoretical predictions and experimental data by NRC "Kurchatov Institute".

Hydrodynamic modeling of heating and destruction of the material was carried out with the use of wide-range equation of state on the basis of semi-empirical model QEOS for the description of the liquid and solid phases of matter at low temperatures with the Maxwell construction. Program package MARPLE3D has been employed to estimated the velocity of plasma expansion from the irradiated surface, the mass of evaporated material, and the mechanical pressure impulse in the sample. The characteristic destruction of the region on the front surface of the sample due to high-temperature exposure was observed.

Modeling of the brittle fracture in the sample was carried out using the greatest principal stress criterion and taken once cracks Maynchen-Sack model. The impact was simulated by the equivalent pulse, calculated at the first stage, applied via the initial and boundary conditions. The problem was solved numerically using grid-characteristic method. As the results, two characteristic regions of destruction were obtained by numerical simulation: the destruction area in the form of "flower" in the volume, and the area of ​​the rear spall. The typical dimensions of the destroyed areas are in good agreement with experiment. It should be noted that the mechanism of fracture in the volume caused by the interaction of converging spherical waves is essentially three-dimensional.

The variation of the strength characteristics of the material leads to a noticeable change in the size of the destroyed area. Thus, after verification of the model on the experimental data, it can be used to analyze the strength of various structural units.

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