Validation of the numerical solution for problem of thermal shock in graphite

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Parts made of carbon materials in rocket and space technology are subjected to intense thermal effects that precede their combustion, which leads to the initiation of stress waves (thermal shock) with their subsequent destruction. High heating rate and strong nonlinear dependence of thermal conductivity on temperature due to porosity of carbon material determine the possibility of the effect of metastable heat localization in the blow-up regime. The evolution of the thermomechanical system is described by a system of differential equations of solid mechanics taking into account thermal expansion. Analytical solutions can be obtained for simplified formulations, so in practice numerical solutions are required, including those taking into account nonlinear thermophysical properties of materials. The most popular numerical methods in solid mechanics are the finite difference method and the finite element method. In this work, the formulation was implemented in the finite element analysis application package Comsol Multiphysics. The validation of the thermal problem was carried out on the basis of the analytical solution for the so-called fast diffusion equation $u_t = \Delta u^m/m$. A comparison with an analytical solution for the temperature dependence of thermal conductivity in the form of an inverse power dependence is presented.

The work was carried out as part of a major scientific project funded by the Ministry of Science and Higher Education of the Russian Federation (Agreement No. 075-15-2024-535 dated 23 April 2024).