Disturbance of the temperature field caused by a fracture in polymer materials

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The article presents a solution to the problem of temperature distribution in a sample containing a fracture. We analysed the temperature field in depth. We show that when a steady-state heat flow affects a cracked sample, the temperature gradient locally increases in the vicinity of the fracture, which makes the temperature stresses increase. We computed the temperature profile along two crack surfaces, the equidistant curves of the temperature field adjacent to the fracture, relative distortion of the temperature field caused by the crack, and the distribution of the tangential and normal components of the heat flux vector along the width of the sample in the vicinity of the fracture. We plotted the vector lines of the temperature field in a sample featuring an internal fracture. We present a detailed analysis of the temperature field at the crack tip where the heat flow concentrates, and computed temperature values in that region. We determined how the maximum distortion of the temperature field depends on the distance to the fracture. We demonstrate the following: that the fracture dimensions define the size of the temperature field distortion zone adjacent to the crack; that in addition to the displacement discontinuity in the crack surfaces there exists a temperature discontinuity proportional to the power of the external heat flow and the size of the crack; that the fracture is a stress raiser (amplifying the stresses locally) in the mechanical field, and in the temperature field it additionally acts as a heat flow concentrator.

Keywords: *fracture, temperature field*

REFERENCES

[1] Dimitrienko Yu.I., Sokolov A.P. *Inzhenernyy zhurnal: nauka i innovatsii — Engineering Journal: Science and Innovation*, 2013, iss. 11. DOI: 10.18698/2308-6033-2012-11-427

[2] Dimitrienko Yu.I., Sborshchikov S.V., Sokolov A.P. *Composites: Mechanics, Computations, Applications. An International Journal*, 2013, vol. 4, no. 4, pp. 345–364. DOI: 10.1615/CompMechComputApplIntJ.v4.i4.50

[3] Dimitrienko Yu.I., Dimitrienko I.D., Sborschikov S.V. *Applied Mathematical Sciences*, 2015, vol. 9, no. 145, pp. 7211–7220.

[4] Dimitrienko Yu.I., Sborshchikov S.V., Sokolov A.P., Gafarov B.R., Sadovnichiy D.N. *Kompozity i nanostruktury — Composites and Nanostructures*, 2013, no. 3, pp. 35–51.

[5] Dimitrienko Yu.I., Drogolyub A.N., Sokolov A.P., Shpakova Yu.V. *Nauka i obrazovanie —- Science and Education*, 2013, no. 11. DOI: 10.7463/1113.0621065

[6] Lebedev M.P., Makarov V.V., Ivanov A.M., Golikov N.M. *Izvestiya Samarskogo nauchnogo tsentra Rossiyskoy akademii nauk — Proceedings of the Samara Scientific Centre of the Russian Academy of Sciences*, 2015, vol. 17, no. 2, pp. 7–10.

[7] Cherepanov G.P. *Mekhanika razrusheniya* [Failure mechanics]. Moscow, Izhevsk, Computer Research Institute Publ., 2012, 872 p.

[8] Slutsker A.I. *Fizika tverdogo tela — Physics of the Solid State*, 2005, vol. 47, no. 5, p. 777.

[9] Kartashov E.M., Kudinov V.A. *Analiticheskaya teoriya teploprovodnosti i prikladnoy termouprugosti* [Analytical theory of thermal conductivity and applied thermoelasticity]. Moscow, Editorial URSS Publ., 2010, 656 p.
[10] Landau L.D., Livshits E.M. *Teoreticheskaya fizika. Teoriya uprugosti* [Theoretical physics. Theory of elasticity]. Moscow, FIZMATLIT Publ., 2003, 257 p.
[11] Godovikov A.A. *Kristallokhimiya prostykh veshchestv* [Crystal chemistry of simple substances]. Novosibirsk, Nauka Publ., 1979, 147 p.

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