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Nanometer scale thermal response of polymers to fast thermal perturbations

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Abstract

© 2018 Author(s). Nanometer scale thermal response of polymers to fast thermal perturbations is described by linear integro-differential equations with dynamic heat capacity. The exact analytical solution for the non-equilibrium thermal response of polymers in plane and spherical geometry is obtained in the absence of numerical (finite element) calculations. The solution is different from the iterative method presented in a previous publication. The solution provides analytical relationships for fast thermal response of polymers even at the limit $t \to 0$, when the application of the iterative process is very problematic. However, both methods give the same result. It was found that even fast (ca. 1 ns) components of dynamic heat capacity greatly enhance the thermal response to local thermal perturbations. Non-equilibrium and non-linear thermal response of typical polymers under pulse heating with relaxation parameters corresponding to polystyrene and poly(methyl methacrylate) is determined. The obtained results can be used to analyze the heat transfer process at the early stages of crystallization with fast formation of nanometer scale crystals.

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