

Preface

The thermomechanical properties of composites on a polymer matrix at high temperatures are essentially different from those at normal temperatures. The main distinctions briefly consist in the following:

- at high temperatures there occurs an irreversible variation (degradation) of all mechanical and thermal properties of a material that usually has a complex nonlinear character depending on time exposure under high temperature;
- there are complicated internal physicochemical processes in a matrix and fibers under high temperatures called by the general notion of ablation; the internal physicochemical and mechanical processes run differently in the matrix and fibers, and this leads to the appearance of considerable internal thermal stresses. Generally speaking, a composite under high temperatures can be considered as a multiphase system consisting of solid, gaseous, and fluid phases interacting mechanically and chemically with each other.

There are three levels of temperature: normal, elevated, and high. Normal or room temperatures are 10–30 °C; elevated temperatures are 30–200 °C; high temperatures are those above 200 °C. However, the dividing line between elevated and high temperatures depends on the material involved; a temperature is called high for a particular composite material if, at this temperature, irreversible internal physicochemical transformations occur in the matrix and/ or fibers of the material.

New models are presented for the thermomechanical behavior of composite materials and structures, taking into account internal physicochemical transformations such as thermodecomposition, sublimation, and melting at high temperatures (up to 3000 K). This is of great importance for the design of new thermostable materials, for the investigation of reliability and fire safety of composite structures, the investigation of interaction of composites with laser irradiation, and for the design of heat-shield systems, etc.

Structural methods are presented for calculating the effective mechanical and thermal properties of matrices, fibers, unidirectional, disperse-particles reinforced and textile composites, in terms of properties of their constituent phases.

Calculation methods are presented for characteristics such as the rate of thermo-mechanical erosion of composites under high-speed flow and heat deformation of composites with account of chemical shrinkage. Great attention is paid to the comparison of modeling results with experimental data. Further, the book collects unique experimental results on mechanical and thermal properties of composites under temperatures up to 3000 K.

The behavior of composite shells under high temperatures is simulated by the finite element method. So cylindrical and axisymmetric composite shells, and composite plates are investigated under local high-temperature heating.

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Temperatures

Dimitrienko, Y.I.

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