

In the recent years there has been the significant considerable development of micro- and nanotechnology. An example would be the nanosecond laser micromachining used for the production fabrication of MEMS (*Micro Electro-Mechanical Systems*). Such a development would not have been possible without the knowledge of mechanisms of energy transport in 'a small size' and /or 'the short time interval'. In this case, the classical descriptions of thermal processes based on the Fourier law and used in the macro scale disappoint. The analysis and modeling of ultrafast laser interaction with materials, thermal processes in micro/nano-devices, micromachining thermal sensors, actuators etc. require the use of other mathematical models. They include, among others, the Cattaneo-Vernotte equation, the dual phase lag equation and two temperature models which are called the non-Fourier heat conduction equations.

It should be noted that the non-Fourier heat conduction equation can also be successfully used to model the thermal phenomena occurring in the living organisms exposed to high and low temperatures, that can be used for the numerical simulations of medical procedures such as artificial hyperthermia (heating) and tissue freezing (cooling).

The application of non-Fourier heat conduction equations as a base of the computer simulation of thermal processes occurring in the microscale requires the development of numerical methods of solving them and that is the main purpose of the project. The base for the development of those methods could be, among others, the finite difference method, the control volume method or the boundary element method successfully used in the analysis of thermal phenomena on the macroscale. Applicants intend to develop the procedures for numerical modeling of phase transitions as the melting (defrosting), evaporation and solidification (freezing). The ablation phenomenon will also be considered. The project will focus on the effectiveness of the proposed algorithms to be developed for massively parallel and heterogeneous computing platforms.

Developed algorithms, procedures and computer programs will be made available to interested persons and institutions. They allow the modeling of selected physical and technological processes, eg. the laser interactions with materials, the design of micro and nano-electronics circuitries or the thermal processes proceeding in the biological tissue domain.