

Heat transfer in pulsed superheated solutions with a lower critical solution temperature: experiment and model

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Local superheating and transition of the liquid coolant to a not quite stable and/or unstable state occurs during operation of microelectronic devices in confined spaces and high heat flux density. In the on and control modes, overheating occurs relative to the liquid-vapor equilibrium line or, for solutions with a lower critical solution temperature (LCST), the liquid-liquid equilibrium line. A new promising class of coolants for cooling microprocessors are solutions with LCST, for example, aqueous solutions of polypropylene glycols (PPG). The authors obtained and compared a significant array of heat transfer data for aqueous solutions of PPG-425, PPG-725 and PPG-2000. The method of controlled pulsed heating of a platinum probe (20 μm) was used to simulate local isothermal conditions in the samples. Significant asymmetry and a significant increase in heat transfer of the solution compared to pure liquid were found at low concentrations and concentrations below the critical one LCST. At significant concentrations of PPG, the effect practically disappears. A model of the kinetics of spinodal decomposition of solutions with LCST is constructed, explaining the asymmetry of heat transfer found in the experiments. It is shown that the presence of non-Newtonian properties in PPG explains the significant asymmetry of decomposition in the pulse experiment. The dependences of power on time during pulse heating of the probe at a constant temperature are obtained. These dependences qualitatively coincide with the experimental ones. The investigation has been conducted at the expense of a grant of the Russian Science Foundation (project No. 23-69-10006), <https://rscf.ru/project/23-69-10006>