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Nanostructured phase-changeable fluids and their applications in heat transfer

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Cooling is one of the most important technique challenges faced by a range of diverse industries and military needs. There is an urgent need for the innovative heat transfer fluids with improved thermal properties over those currently available. Recently, phase change materials (PCMs) have received considerable attention for the application of thermal energy storage and transfer, which offer the potential to reduce energy consumption and in turn lower the related environmental impact. PCMs are capable of absorbing and releasing large amounts of thermal energy when they undergo phase transition. Latent heat storage materials provide much higher energy storage density with a smaller temperature difference between storing and releasing processes, than the sensible thermal storage materials. PCMs latent heat storage can be normally achieved through solid-solid, solid-liquid, and liquid-gas phase change. Here, the concept of using phase-changeable nanoparticles to increase the effective heat capacity and the heat transfer rate of the fluid is investigated. A large amount of heat can be absorbed or released when these nanoparticles undergo phase transition from solid to liquid or liquid to gas or vice versa and, thus, enhancing the heat transfer rate. Two types of phase change fluids are introduced: One contains liquid nanodroplets that will evaporate at elevated temperatures orliquefies at reduced temperatures, called "nanoemulsion fluids"; the other is suspensions of solid-liquid metallic-change nanoparticles. The explosive vaporization of the dispersed nanodroplets would significantly improve the heat transfer in the nanoemulsion fluids. The solid-liquid metallic phase-change nanoparticles will increase the effective heat capacity and thermal conductivity of the base fluids simultaneously.

Biography

Jiajun Xu has completed his PhD in Mechanical Engineering from University of Maryland-College Park. In 2013, he joined University of the District of Columbia as an Assistant Professor. His research interests are micro/nanoscale thermal transport and energy conversion, thermal science and its applications in electrical engineering, optical engineering, and material science. He has published more than 20 papers in peer-reviewed journals and conference proceedings.

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