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# 沸腾现象中近壁面过热边界层的实验测量方法


## 摘要

沸腾现象广泛存在于核能系统的多元场景。目前关于沸腾过程中径向温度分布和过热层厚度特性的研究相对不足，现有研究多沿用单相流热边界层定义，对沸腾特有的过热边界层厚度界定标准不一导致壁面法向温度梯度及边界层演化规律尚缺乏统一共识，影响了汽泡边界层内能量传递与相变传热机制的定量描述。为解决上述问题，本文开发近壁面流体精细化测温的微型热电偶（Micro Thermocouple，简称 MTC）实验方法，以及微米级空间分辨率与毫秒级时间分辨率的高精度同步测量手段，提出基于物理机制的汽/液相分离算法，获得纯液相温度分布和局部空泡份额。



## 关键词

过热边界层；微型热电偶；沸腾传热



## Abstract

Boiling phenomena are widely encountered in various scenarios of nuclear energy systems. However, studies on radial temperature distributions and superheated layer thickness characteristics during boiling remain relatively insufficient. Existing research mostly follows the definition of single-phase thermal boundary layers, and inconsistent criteria for defining the superheated boundary layer thickness unique to boiling have led to a lack of unified consensus on wall-normal temperature gradients and boundary layer evolution dynamics. This inconsistency hinders the quantitative description of energy transfer and phase-change heat transfer mechanisms within the bubble boundary layer. To address these issues, this study develops a micro-thermocouple (MTC) experimental method for fine-scale temperature measurement of near-wall fluids, along with high-precision synchronized measurement techniques featuring micron-scale spatial resolution and millisecond-level temporal resolution. Furthermore, a vapor/liquid phase separation algorithm based on physical mechanisms is proposed to obtain the pure liquid-phase temperature distribution and local void fraction.



## Keywords

superheated boundary layer; micro-thermocouple; boiling heat transfer



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