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Special Issue Reprint

Heat Transfer and Fluid Flow in Microstructures

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Microstructured surfaces overcome the performance limitations of conventional smooth surfaces, transforming passive interfaces into active functional units and thereby offering a revolutionary approach for precise control over fluid dynamics, phase change behavior, and energy transport. Translating their significant potentials into stable, reliable, and scalable engineering applications involves complex multi-scale and multi-physics coupling challenges. Research on microstructured surfaces has become a comprehensive interdisciplinary frontier integrating surface engineering, micro-/nano-fabrication, fluid mechanics, heat transfer, and materials science. This calls for full-chain innovation that spans fundamental mechanisms, material systems, manufacturing processes, and system integration, achieving a deep synergy between structures and functions, materials and processes, and designs and applications. The 15 original research articles in this Reprint focus on this interdisciplinary field, bringing together a range of research achievements covering fundamental studies, numerical simulations, experimental characterizations, and application explorations. Based on their research direction and characteristics, the contributions can be grouped into the following three themes: fundamental studies on the mechanisms of single-phase flow, fundamental studies on the mechanisms of multiphase flow, and extended research on the applications for multiphase flow. This classification framework systematically presents a complete research spectrum, from fundamental flow principles to engineering solutions.

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