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Effect of Tilt Angle of Herringbone Microstructures on Enhancement of Heat and Mass Transfer

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Abstract : The heat and mass transfer characteristics of a simple shear flow over a surface covered with staggered herringbone structures are numerically investigated using the lattice Boltzmann method. The focus is on the effect of ridge angle of the structures on the enhancement of heat and mass transfer. In the simulation, the temperature and mass concentration are modeled as a passive scalar released from the moving top wall and absorbed at the structured bottom wall. Reynolds number is fixed at 100. Two Prandtl or Schmidt numbers, 1 and 10, are considered. The results show that the advective scalar transport plays a more important role at larger Schmidt numbers. The fluid travels downward with higher scalar concentration into the grooves at the backward grove tips and travel upward with lower scalar concentration at the forward grove tips. Different tile angles result in different flow advection in wall-normal direction and thus different heat and mass transport efficiencies. The maximum enhancement is achieved at an angle between 15o and 30o. The mechanism of heat and mass transfer is analyzed in detail.

Keywords : fluid mechanics, heat and mass transfer, microfluidics, staggered herringbone mixer
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