THERMAL PERFORMANCE OF MICROCHANNELS WITH PATTERNED SUPER-HYDROPHOBIC SURFACES UNDER LAMINAR FLOW

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This article presents the simulation results and the effects of slip length and fractal ratio on patterned super-hydrophobic surfaces in microchannels under laminar flow conditions. The effects of using different slip length ratios and fractal ratios on patterned surfaces were simulated numerically at two Reynolds number values. Dimensionless parameters such as Nusselt number, friction factor, and performance efficiency indicator were used to study the effects of boundary conditions (i.e., surface features) on microchannel thermal performance. The results show that the flow structure within a patterned microchannel experiences flow fluctuations near the wall boundary caused by the super-hydrophobic surface. The results also indicate that patterned surfaces with high slip length enhance heat transfer performance and reduce pressure drop.

1. INTRODUCTION AND BACKGROUND

With the rapid development of microtechnologies and nanotechnologies, microdevices and nanodevices are finding a wide use in industry [1–4]. The interfacial phenomena of flowing fluids in microdevices have been receiving increased attention since they have proven to be effective in improving the heat transfer performance in devices such as microchannels. Recently, Chen et al. [5–7] focused their study on the development of the boundary layer of laminar flow in microchannels with rough surfaces. They found that the self-affine fractal dimension of a rough surface is able to affect the heat transfer behavior and pressure drop characteristics in a microchannel. Turbulence flow cases in microdevices have received more attention lately since the boundary layer tends to separate and reattach in the turbulent region with increasing speed, resulting in enhanced heat transfer performance. Hattori and Nagano [8] presented detailed flow structures and suggested heat transfer mechanisms in the turbulent boundary layer characterized by separation and reattachment using the...