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Wettability effect on flow boiling characteristics within micro-passages

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Abstract - A numerical investigation on the effect of wettability characteristics on a single bubble growth during saturated flow boiling conditions within a microchannel, is conducted in the present paper. The numerical simulations are conducted with the open-source toolbox OpenFOAM, utilising a user-enhanced Volume OF Fluid (VOF) solver. The proposed solver enhancements involve a treatment for spurious velocities dampening (a well-known defect of VOF methods), an improved dynamic contact angle treatment to accurately account for wettability effects as well as the implementation of a phase-change model in the fluid domain, accounting for conjugate heat-transfer with a solid domain. The predictions of the simulations show that the local Nusselt number (Nu) is more depended on wettability characteristics for low heat fluxes, and less dependent on higher heat fluxes. In more detail, it seems that the local, instantaneous heat transfer coefficient is higher for super-hydrophilic cases in comparison to hydrophilic. However, as the applied heat flux increases, hydrophilic and super-hydrophilic cases show a similar heat transfer enhancement with respect to the single-phase heat transfer in the considered micro-channel. Finally, superhydrophobic cases, show lower heat transfer performance with respect to the single-phase case. This is due to the fact that a vapour blanket is rapidly formed immediately after the nucleation, acting as an insulator of the heated solid surface.

***Keywords*:** Flow boiling, microchannel, multiphase flow, VOF, conjugate heat transfer.