*Proceedings of the 8th World Congress on Momentum, Heat and Mass Transfer (MHMT'23)*
*Lisbon, Portugal – March 26 – 28, 2023*
*Paper No. ICMFHT23 142*
*DOI: 10.11159/icmfht23.142*

# Flow Boiling Heat Transfer Enhancement with Biphilic Surfaces at Sub-Atmospheric Pressures

**Vahid Ebrahimpour Ahmadi[1,2], Tayfun Guler[1,2], Ali Kosar[1,2,3,*]**
[1]Faculty of Engineering and Natural Science, Sabanci University, Istanbul, Turkey
[2]Sabanci University Nanotechnology and Applications Center (SUNUM), Sabanci University, Tuzla, Istanbul 34956, Turkey
[3]Center of Excellence for Functional Surfaces and Interfaces for Nano-Diagnostics (EFSUN), Sabanci University, 34956 Istanbul, Turkey
vahid@sabanciuniv.edu; tayfun.guler@sabanciuniv.edu
*Correspondence: kosara@sabanciuniv.edu

## Extended Abstract

Flow boiling heat transfer at reduced pressures is an effective method for electronics cooling, as it allows for lower saturation temperatures. The wettability properties of the heater surface are a significant parameter in boiling enhancement. In addition, the system pressure is a crucial parameter that alters bubble behavior and heat transfer. A decrease in pressure can dramatically change the vapor density and surface tension. The increased surface tension results in an increase in the value of minimum radius of curvature of nucleation and superheat values. This study investigates the effect of the superhydrophilic/superhydrophobic ratio on the flow boiling under sub-atmospheric and atmospheric pressure conditions. For this, four different surfaces, superhydrophilic (S1), superhydrophobic (S2), one-third superhydrophobic (S3) (from inlet to exit), and two-third superhydrophobic (S4) ) (from inlet to exit) surfaces, were prepared and tested at various heat fluxes, three system pressures of 48 kPa, 68 kPa, and 101 kPa and mass flux of 103 $kg.m^{-2}.s^{-1}$. Based on the obtained results, biphilic surfaces provide up to 28% enhancement compared to superhydrophilic surface at high heat fluxes in sub-atmospheric heat transfer. Flow visualization demonstrates that mixed-wettability surfaces prevent annular flow by vapor breaking up and extending the efficient slug regime to high heat fluxes. Biphilic surfaces manipulating the vapor phase distribution enhance the heat transfer coefficient. It is noteworthy that the superhydrophobic surface, fabricated through a wet chemical etching process, was less affected by pressure reduction, and benefits from high density nucleation sites at low and medium heat fluxes, thereby resulting in a noticeable performance improvement. The obtained experimental data in this study will be helpful for development of thermal-fluid systems operating under the sub-atmospheric conditions.