The development of technology and the optimisation of components lead to the miniaturisation of devices, including those that generate undesirable large amounts of heat. Examples include increasingly efficient (and smaller) processors or other electronic equipment that require the dissipation of large heat fluxes to maintain the proper operating temperature and prevent damage from overheating. The phase change, which accompanies pool boiling, can achieve a heat flux density that is thousands of times higher than that in single-phase heat transfer. Additionally, enhanced surfaces increase the heat transfer capabilities from areas where heat is undesired. Even small changes such as increased roughness, mini- and micro-channels, additional foam or mesh can significantly enhance the heat transfer coefficient compared to a flat surface. Nucleation sites formed during boiling generate vapour bubbles, and their size and high density significantly influence the enhancement of heat transfer, leading to more efficient cooling of the heated surface.

In this project, the focus is on developed surfaces consisting of mini-channels partially filled with foam or a copper mesh. Preliminary studies have observed that mini-channels with porous structures placed within them, in the appropriate configuration, allow for nearly a twofold increase in the heat transfer coefficient and up to 70% higher heat flux density for distilled water compared to mini-channels without porous elements and almost a threefold increase compared to a flat surface. It has also been noticed that porous fillings in mini-channels provide the best heat transfer when filling space in range of 40% - 60%.

The subject matter presented in the project was motivated by the need to find a surface that would enable the dissipation of larger amounts of heat across various temperature ranges. Additionally, a gap in the available literature has been identified as it does not fully explain the mechanisms determining the growth of bubbles in mini- or micro-channels, which are usually limited to the presence of nucleation sites and bubble detachment. This project aims to expand the knowledge concerning pool boiling on surfaces with mini-channels and porous elements placed within them through experimental research using samples with different geometric dimensions of mini-channels (depth, width, spacing) and parameters of porous structures (pore size, mesh size, element thickness, distances between them, and their length). Despite various solutions employed by scientists from many countries to develop surfaces, the authors have not found similar solutions involving a combination of mini-channels and additional fillings such as foam or copper mesh. The proposed project will allow for the analysis of samples subjected to experimental research, which will result in the creation of a mathematical model enabling the determination of bubble diameter and their changes during growth and detachment from the expanded surface. During experiments, the samples will undergo visualisation, enabling a comparison between numerical calculations and the experiment. Boiling curves will also be determined, allowing for the determination of heat transfer coefficients, heat flux densities, and overheating of individual samples, facilitating comparisons between them and studies conducted by other researchers.