

Invited Seminar

2024. 8. 23. 16:00 (성호관 201호)

Professor Yasuyuki Takata

International Institute for Carbon Neutral Energy Research
(WPI-I2CNER),
Kyushu University, Japan



A Challenge of Lowering Wall Superheating at Onset of Nucleate Boiling

Abstract: Onset of nucleate boiling (ONB) always needs wall superheating, ΔT_{sat} , to activate bubble nucleation sites. In general, $\Delta T_{sat, ONB}$ ranges from a few degrees to several decades depending on type of fluids, wettability, surface structures and concentration of non-condensable gasses. From a viewpoint of electronic cooling, the smaller $\Delta T_{sat, ONB}$ is desirable to avoid thermal damages to electronic chips and to ensure stable boiling heat transfer. We have been studying the effects of wettability and solubility of air on the ONB and obtained some important findings for water. Regarding the wettability effect, hydrophobic area of the surface attracts dissolved air and works as an excellent nucleation site. Therefore, by making use of biphilic surface the nucleate boiling is significantly enhanced. The boiling performance of biphilic surface is of about 7 times larger than that of mirror copper surface. This enhancement technique is very effective in subatmospheric condition. Presence of both hydrophobicity and dissolved air drastically reduces $\Delta T_{sat, ONB}$. In case of subcooled boiling, the $\Delta T_{sat, ONB}$ sometimes becomes negative value. We have made clear the mechanism of early onset by making use of a special experimental apparatus that can remove air from boiling water. Another challenge of lowering $\Delta T_{sat, ONB}$ has been made for other fluids. We succeeded to lower $\Delta T_{sat, ONB}$ for ethanol by halloysite nanotube (HNT) coating the contact angle of which is higher than 90° for ethanol. Nucleate boiling for ethanol is also enhanced by about 3 to 4 times compared with bare copper surface. Our recent challenge is to lower the $\Delta T_{sat, ONB}$ and enhance nucleate boiling for HFE7100 by making use of anodized aluminum surface which has nanopores of 20-200nm in pore size. The present talk will also report some experimental findings of this recent study.

Bio: Professor Yasuyuki TAKATA is a Research Professor at International Institute for Carbon-Neutral Energy Research (I2CNER), Kyushu University. He is also Professor Emeritus at Kyushu University and Honorary Professor at the University of Edinburgh. He was a Professor in the Department of Mechanical Engineering, Kyushu University until March 2022. His research interests include two-phase flow and heat transfer, thermophysical properties of hydrogen at ultra-high pressure, micro refrigerator and micro heat transfer device and numerical simulation of thermal and fluid flow. He was the Presidents of Heat Transfer Society of Japan (HTSJ) from 2019 to 2020 and Japan Society of Thermophysical Properties in 2016. He served as the President of the Asian Union of Thermal Science and Engineering (AUTSE) from October 2020 to September 2022. He received numerous awards including the JSME Thermal Engineering Achievement Award in 2010, and ASME ICNMM2018 Outstanding Leadership Award in 2018 and Heat Transfer Society Award for Scientific Contribution in 2022. He is a Council Member of Science Council of Japan since October 2020.