Study of He II Evaporation Induced by a Thermal Pulse Impingement onto He II Free Surface

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Abstract

He II evaporation from a He II-vapor interface is experimentally investigated. The He II evaporation is caused by the impingement of a second sound thermal pulse onto a He II-vapor interface. The resulting gas- and superfluid-dynamic phenomena are visualized with the aid of a laser holographic interferometer and are directly measured with a pressure transducer and a superconductive temperature sensor. It is clearly seen in the visualization interferograms that a shock wave is formed at the front of an evaporation wave. It is confirmed that the propagation of an evaporation wave front is in good agreement with the prediction by the Rankine-Hugoniot relation. From the direct measurement data of the pressure and the temperature, we obtained the condensation coefficient of He II by the direct comparison of the data with the kinetic theory result for the weak evaporation case in the temperature range between $2.16\,K$ and $1.28\,K$. It is found that the condensation coefficient, weakly depending on the temperature, is smaller than unity. This report may be the first one describing the temperature dependence of He II condensation coefficient. It is confirmed that the condensation coefficient considerably decreases as the temperature approaches the λ point because the excellent heat transfer mechanism so called super thermal conduction deteriorates. From the comparison of the experimental result with the kinetic theory result for the strong evaporation case, it is found that the non-linear effect of slip boundary condition may arise at relatively small temperature rise of a free surface. And the reflection coefficient R_{22} of a second sound from a free surface is also measured. Furthermore, He II condensation induced by an evaporation wave impingement onto a He II free surface is studied in order to confirm the effect of super thermal conduction on the condensation coefficient of He II.