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Study of Growth and Dissolution of Oxygen Bubbles on Hydrophilic and Hydrophobic Substrates by Optical Methods

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Extended Abstract

The demand for hydrogen as a clean and efficient alternative has increased significantly due to the increasing emphasis on sustainable energy sources. Further improving hydrogen electrolysis efficiency requires optimizing the PEM (Proton-exchange membrane) electrolyzers. In PEM electrolyzers for hydrogen production, electrolysis efficiency is often affected by bubbles attached to the electrodes. Moreover, the nucleation and growth of oxygen bubbles on the heat exchanger surface in the anodic water cycle impair the heat transfer, resulting in a reduction of the cooling efficiency. Thus, a better understanding of the growth dynamics of oxygen bubbles facilitates both gas separation and heat transfer improvements.

The growth dynamics of oxygen bubbles are often accompanied by mass transfer through the gas-liquid interface. The mass transfer around bubbles can be visualized using the planar laser-induced fluorescence (PLIF) method, which has high spatial and temporal resolution. Additionally, studies of the growth dynamics of oxygen bubbles frequently involve changes in bubble shape. The shadowgraph method is widely used to characterize changes in bubble shape. In this study, we combined the both methods to measure the oxygen concentration gradients around artificially introduced oxygen bubbles, which are attached to surfaces with different wettability (hydrophilic and hydrophobic substrates), as well as their shape changes in pure water with different oxygen saturation levels. The evolution of the oxygen concentration gradient and the oxygen bubble shape on different wettability surfaces are discussed.

Keywords: hydrophilic substrate, hydrophobic substrate, PLIF and shadowgraph measurement, oxygen concentration gradient, bubble shape.