Water Electrolysis in Saturated Phosphate Buffer at Neutral pH

([1]*Graduate School of Engineering, The University of Tokyo*) ○Takahiro Naito,[1] Tatsuya Shinagawa,[1] Kazuhiro Takanabe[1]

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Adopting the renewable energy is a prerequisite to achieve the sustainability in our society, which is majorly impeded by its spatiotemporal fluctuations. Electrocatalytic processes in this context has regained worldwide interests, whereby we can convert the renewably generated electric power into chemical energy for the use of an energy carrier. Among a variety of energy carriers, hydrogen stands out owing to its high weight energy density.[1] However, conventional polymer exchange membrane (PEM) and alkaline water electrolyzers produce the hydrogen only at a cost economically inferior to those based on fossil fuels.[1] We consider the near-neutral pH electrolyte as the next generation electrolyte medium for the electrolysis,[2] whose milder condition than the conventional electrolyzer offers broader options for materials, which would decrease the capital cost of the electrolyzer. Particularly, densely buffered near-neutral pH medium would enable large mass-transport fluxes and in turn higher efficiency during the electrolysis. Nevertheless, the fundamental understanding as to the physicochemical properties of such electrolyte has been lacking, requiring research activity in this direction.

This presentation reports and analyzes physicochemical properties of densely buffered solutions at neutral pH, and demonstrates water electrolysis in such solutions.[3] Our quantitative analysis validated the applicability of the existing model dealing with the diluted solutions[2] to dense solutions, which allowed for determination of mass-transport fluxes and associated losses during water electrolysis. In the thus identified electrolyte that minimizes the mass-transport losses at pH 7, i.e., saturated K-phosphate solution, water electrolysis was examined using model electrodes at elevated temperatures as in **Figure 1**. The figure revealed that the performance at neutral pH is not only comparable to but also more stable than the extreme pH conditions, demonstrating the potential of the densely buffered electrolyte for the water electrolysis.

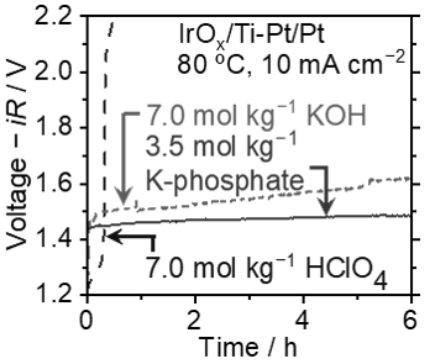

Figure 1. Water electrolysis performance. Chronopotentiometry (CP) profile performed at 10 mA cm^{-2} and 80 °C in electrolyte solutions of 7.0 mol kg^{-1} KOH, 7.0 mol kg^{-1} $HClO_4$, and 3.5 mol kg^{-1} K-phosphate (pH 7.0 at 25 °C) under Ar bubbling.

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