CP 11

CONCEPT PAPER

for KIER International Cooperation project

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Title	**Porous Inorganic-Organic Hybrid Electrodes for Oxygen Evolution Reactions in Weak Alkaline Electrolysis**			
Description	● Barrier(s) to tackle The great merits on water electrolysis technologies regarding maturity, large capacity, and cost-effective features have drawn much attention as one of the applications for energy storage systems connected to the renewable energy sources such as the wind and solar. These may provide economic advantages for the management of peaks and valleys in electrical loads as storing to hydrogen as second energy carrier sources, especially in long-term and large-scale(>MW) storage systems. However, the variable loads arise from the renewable power sources can affect the performance on electrolysis and influence the apparent durability. Especially, improvements of poor oxygen evolution reaction(OER) kinetic efficiency, mitigation of electrode degradation, and differential pressure operation would increase the system lifetime, and thus improve the economics of water electrolysis. Furthermore, the strong alkaline electrolytes(e.g., 25~30 wt% KOH and NaOH) leads to limit of selection of materials due to corrosion issue on building an electrolysis system. ● Strategy to solve To resolve above issues(i.e., corrosion, differential operation, and poor kinetic efficiency), the new design of the alkaline water electrolysis components is required, which can be operated in weak electrolytes with lower ohmic loss and high kinetic efficiency. In weak alkaline electrolyte, a well-developed sulfonate polymer membrane can be easily adaptable and thus has a benefit on differential pressure operation in the response of the intermittent renewable operations. Also, the utilization factor of the OER electrode can be improved by designing efficient ionic and electronic channel path to the active sites of the catalyst in the electrode. By applying highly efficient and stable heteroatom doped-graphene encapsulated bimetallic nanocomposites as OER electrode using metal-organic frameworks (MOFs) as a self-sacrificial template, the kinetic efficiency of OER will be improved even in weak alkaline solution due to structural benefits of easy hydroxyl ion penetration and electronic conductive layer of graphene shell as well as physical barrier for enhanced OER. Even though MOFs have been used for synthesizing transition metal-based electrocatalysts, few studies on heteroatom-doped graphene encapsulated bimetallic nanocomposite for OER. The nanostructured porous bimetallic MOFs are containing Ni and Fe, or Co elements, with via various synthesis methods(e.g., hydrothermal and solvothermal). Synthesized MOFs will be converted to porous via heat treatment or hydrothermal synthesis, which will give graphene encapsulated bimetallic nanohybrids. The physical, chemical and electronic properties of graphene encapsulated bimetallic nanocomposites can be controlled by designing synthesis and process conditions to obtain optimized OER efficiency and durability.			
Outcomes*	● A new cell design for differential pressure operation in weak alkaline water electrolysis ● Cell voltage efficiency 85%@ 0.2A/cm^2 in weak alkaline solution ● On/off cell voltage durability degradation ≤5% ● 1 SCI article with IF upper 20% and 1 patent application			