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Advanced Metallic Frameworks for Development of Robust and Efficient Water Splitting Electrodes

Authors : Tam D. Nguyen, Joe Varga, Douglas MacFarlane, Alexandr Simonov

Abstract : Development of advanced technologies for green hydrogen generation from renewables is of key strategic importance to global future energy security and economic growth. Renewable-powered water electrolysis (WE) is considered as the most effective of the sustainable methods for hydrogen generation at scale. Currently, the greatest challenge of hydrogen production via water electrolysis is the insufficiently high efficiency. In which, the energy loss associated with the conversion of water to hydrogen is approximately 40-60%, with 30-35% associated with the electrolysis itself and 10-12% with gas compression and transportation. Hence, development of an energy-efficient water electrolyser that can generate hydrogen at high pressure will address both of these major challenges. This requires the development of advanced electrode configuration of the water electrolysis cell. Herein, we developed a highly-ordered interconnected structure of the metallic inverse-opal (IO) frameworks based on low cost materials, e.g. Cu, Ni, Fe, Co. The water electrolysis electrodes based on these frameworks can provide excellent mechanical strength required for the application under conditions of extreme pressure, as well as outstanding catalytic performance through the exceptional high surface area and high electrical conductivity. For example, NiFe layered double hydroxide (LDH) catalyst deposited on Cu IO is able to reach the oxygen evolution reaction (OER) catalytic performance up to the rates of > 100 mA cm−2 (>727A gcatalyst-1) at an overpotential of ~0.3 V. This high performance is achieved with only few micron-thick catalyst layers, in contrast to similarly performance of 103-fold thicker electrodes based on foams and other substrates.

Keywords : oxygen evolution reaction, support materials, mass transport, NiFe LDH
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