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Short Communication

Water Splitting Cells for Hydrogen Production by Using Electrocatalyst

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DESCRIPTION

Electrolysis of water splitting is a pathway that is efficient for hydrogen production in terms of energy conversion and storage at which catalysis or electro-catalysis plays a critical role. The development of water splitting cells for hydrogen production from renewable sources and fuel cells for effective conversion of hydrogen to electricity has become a global drive towards sustainable power package [1].

The reaction of water electrolysis can be divided into two half-cell reactions i.e., Hydrogen Evolution Reaction (HER) and Oxygen Evolution Reaction (OER). Hydrogen Evolution Reaction (HER) is the reaction where water is reduced at the cathode to produce H_2, and Oxygen Evolution Reaction (OER) is the reaction where water is oxidized at the anode to produce O_2.One of the critical barriers that keeps water splitting from being of practical use is the sluggish reaction kinetics of Oxygen Evolution Reaction (OER) and Hydrogen Evolution Reaction (HER) due to high over potentials, a measure of the kinetic energy barriers. Therefore, catalysis plays a major role in both Oxygen Evolution Reaction (OER) and Hydrogen Evolution Reaction (HER) [2,3]. Highly effective catalysts are required to minimize the over potentials for Oxygen Evolution Reaction (OER) and Hydrogen Evolution Reaction (HER) towards efficient H_2 and O_2 production.

Electrocatalyst in water splitting

Catalyst or electro-catalyst depends upon the operating conditions of the water electrolysis cell. The three main electrolysis technologies are:

(1) Proton Exchange Membrane (PEM) electrolysis

(2) Alkaline electrolysis

(3) High-Temperature solid oxide water electrolysis.

The solid oxide electrolysis requires high amount of energy consumption because of its high temperature [4]. For the Proton Exchange Membrane (PEM) based electrolysis cell, the water splitting is performed under acidic condition and using Proton Exchange Membrane (PEM). It has some advantages on the conditions such as lower gas permeability and high proton conductivity which results in high energy efficiency and fast hydrogen production rate.

The electrolytic water splitting is not only an uphill reaction, it is also reflected by the positive value of ΔG (Gibbs free energy), but has to overcome a significant kinetic barrier at which catalyst plays a crucial role. The evaluation of electro-catalytic water splitting is based upon several key parameters like activity, stability, and efficiency [5].

Noble-metal based electro-catalysts

Noble metals, such as Pt Group Metals (PGMs, including Pt, Pd, Ru, Ir, and Rh) show outstanding catalytic performance for Hydrogen Evolution Reaction (HER). However, the commercial application of these noble-metal based catalysts is hindered by their storage and high cost. The noble metals other than Ir and Ru, such as Rh, Au, Pt, and Pd, has been emerging a viable Oxygen Evolution Reaction (OER) electro-catalysts [6]. The design of Pt, Pd, Ru, and Au catalysts involves the construction of bi- or tri-functional electro-catalysts for Oxygen Evolution Reaction (OER), Oxygen Reduction Reaction (ORR), and Hydrogen Evolution Reaction (HER). As Rh, Pt, Au, and Pd have have smaller dissolution resistances and Ir and Ru which is an acidic electrolyte with a large over potential.The evalution of their their Oxygen Evolution Reaction (OER) behaviors has been conducted in alkaline solution [7].

Non-noble metal based electro-catalysts

Transition Metal Carbides (TMCs) have received extensive interest in the development of non-noble metal based electro-catalysts. For example, Mo_2C and WC are shown to exhibit high catalytic activity towards Hydrogen Evolution Reaction (HER). In addition to the high electrical conductivity, the properties of hydrogen adsorption and d-band has electronic density state that

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exhibit an optimal combination which is considered to be a main factor for the observed high Hydrogen Evolution Reaction (HER) activity [8].

Transition Metal Phosphide (TMP) is one of the developing electro-catalysts with high catalytic activity and stability in both acidic and basic (pH universal). It has been proposed that P- atom plays a significant role in Transition Metal Phosphide (TMP) due to the excellent conductivity and unique electronic structure.

CONCLUSION

The hydrogen is a promising substitute for fossil fuel and it has highest gravimetric energy density and zero pollution emission, which provides a clean and renewable energy as an alternative to fossil fuels. The development of water splitting cells as efficient energy conversion and storage system plays an important role in hydrogen production. However, the energy efficiencies of water electrolysis are hindered by the reaction kinetics of Oxygen Evolution Reaction (OER) and Hydrogen Evolution Reaction (HER) due to high over potentials only 4% of the word's hydrogen generation from water splitting is their at present.

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