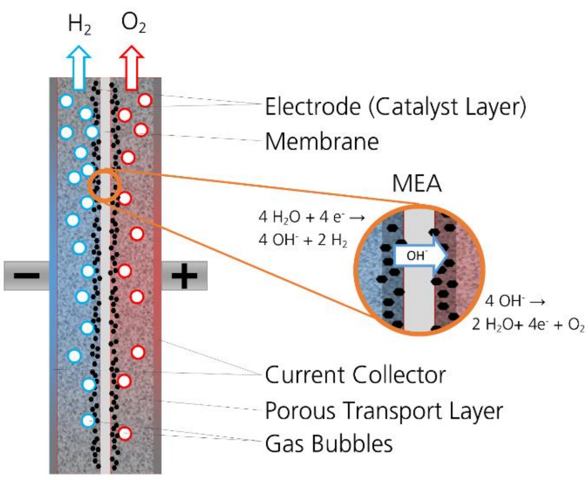
TECH FLASH

Economical and Resource-saving Green Hydrogen

Large quantities of hydrogen will be needed to ensure a successful energy transition. Fraunhofer IFAM along with consortia members are working on improving the efficiency of the emerging AEM electrolysis technology to produce green hydrogen. To make this possible, scientists from the Fraunhofer Institute for Manufacturing Technology and Advanced Materials IFAM in Dresden have turned to the readily available and resource-saving metals manganese and nickel in a bid to introduce this promising electrolysis process to large-scale industry. The new technology offers a number of other advantages in addition to reduced costs when compared to the existing processes.

Producing hydrogen with common electrolysis processes: Hydrogen can be produced through electrolysis on an industrial scale. Electric energy is used to split water molecules into hydrogen and oxygen when immersed in water mixed with a conducting salt - the so-called electrolyte. The energy is absorbed and stored in hydrogen as chemical bonds. This gas is therefore an attractive means of long-term energy storage for energy generated, for example, by wind turbines or solar panels that cannot be directly fed into the grid. Hydrogen generated by renewable energy sources is known as "green". *[Image: Diagram of an AEM electrolysis cell: The key element is the membrane electrode assembly (MEA), which con-sists of the anion-conducting membrane and the directly connected electrodes]* There are three main electrolysis processes currently in use on a larger scale. The most technically relevant and historically widespread is alkaline electrolysis (AEL), which involves adding potassium hydroxide to water, for example. A drawback of this process is the limited lower partial load range, i.e., when using a fluctuating power supply, the full range of power cannot be drawn as an electrical load. In the case of electrolysis involving a proton exchange membrane electrolyzer (PEM-EL), hydrogen ions move in a strongly acidic environment through a gas-tight membrane in direct contact with the electrodes (called a membrane electrode assembly, or MEA). This approach yields a high-power density and very dynamic load behaviour while still retaining a high degree of gas purity. However, the electrodes require the use of rare and expensive noble metals such as iridium to withstand the highly corrosive environment, as well as expensive membranes.



HighHy project: catalysts for highly efficient AEM electrolysis: Electrolysis using anion exchange membranes (AEM) is a relatively new approach. It combines the advantages of AEL, such as high long-term stability and the use of affordable and widely available metals, with those of PEM-EL, i.e. higher performance, adaptability to different loads, and gas purity. AEM electrolysis has not yet been successful in industrial applications because the oxygen evolution reaction (OER) involved in the process is too slow when using non-precious metals. Therefore, the necessary cell voltage for water electrolysis is very high for the desired current densities and as a result, the energy required for hydrogen production is very high. This is the challenge that the HighHy project is addressing to develop OER catalysts and, subsequently, high-efficiency AEM electrolyzers.

Available and affordable: nickel and manganese catalyst compound: The HighHy project researchers intend to use an innovative nickel-manganese compound as an OER catalyst to produce green hydrogen on an industrial scale via AEM electrolysis. This compound boasts crucial advantages: Both metals are inexpensive and readily available as raw materials. They also feature promising chemical activity. The Fraunhofer IFAM team is contributing its expertise in powder metallurgical strategies to this catalyst development: Not only is the electrochemical activity of the catalyst important, but the electrical contact between the electrodes and the electrolyte flow must also be optimized, allowing the gas bubbles to be guided away from the electrode in the best manner possible. Know-how regarding porous structures, like those created when nickel-manganese powder is used for coatings, is a key factor here. The researchers hope that the new catalysts will reduce the amount of electrical energy required for oxygen generation and thereby improve the efficiency of AEM electrolysis.

Price, flexibility, hydrogen purity: high potential of AEM electrolysis: The EU targets for electrolysis energy use in the new process are set at approximately 48 kilowatt-hours per kilogram of hydrogen produced by 2030. This means that AEM-EL would be capable of achieving around 80 percent efficiency, i.e., similar values to the previously established AEL and PEM-EL processes, while offering significantly greater flexibility in terms of loads driven and places of use, as well as significantly lower material costs.

Kindly get in touch with us if you are interested in this technology or require further information.
Thanks and Regards,

Ms. Anandi Iyer
Director, Fraunhofer Office India

Mr. Sanmati Naik
Sr. Manager - Energy (RE), Fraunhofer Office India
405-406, 30 MG Road, Bengaluru – 1
e-Mail: sanmati.naik@fraunhofer.in
Tel: +91 80 40965008/09
www.fraunhofer.in www.fraunhofer.de