Bioelectrochemical device for H₂ or O₂ production by water splitting

The CSIC has designed a bioelectrochemical device for water splitting using a laccase enzyme developed by the Institution, through protein engineering, which makes the electrolysis more efficient and economical for hydrogen production. The laccase catalyses the water oxidation at lower overpotential, allowing significant energetic saving, and with high oxygen evolution. Companies interested in developing and using this device for hydrogen production, are sought.

An offer for Patent Licensing

Water electrolysis catalysed by laccase enzyme

Decomposition of pure water into hydrogen and oxygen at standard temperature and pressure is not favourable in thermodynamic terms. Currently, the electrolytic process is rarely used in industrial applications since hydrogen can currently be produced more affordably from fossil fuels. In this context finding efficient and economical water splitting process would be a key technology component of a hydrogen economy.

In this invention an electrocatalysts has been used for increasing the efficiency of the electrolysis of water, specifically, a laccase enzyme has been immobilised onto the anode of an electrochemical cell, allowing water oxidation and producing oxygen with lower overpotential. These enzymes have been broadly used as bioelectrocatalyst in fuel cells, as electron donor for oxygen reduction. However in this case, reverse activity of the enzyme has been used, allowing high oxygen evolution ratio against H₂O₂ production during water electrolysis.

A high potential laccase, resistant to anions and developed by our Institution through directed evolution techniques, was immobilised onto a graphene anode with excellent results. The overpotencial for oxygen production was lowered and it resulted in a long life electrode, keeping its activity after 3 days of use.

Main applications and advantages

- The electro-catalytic cell with the immobilised laccase allows simultaneous production of H₂ and O₂ at potentials around 1.2 V.
- The amount of O₂ obtained, compared with the H₂O₂, is five times higher than the amount obtained in the no-catalysed electrolysis.
- this method may be carried out without need of solar light, unlike PSII, the only enzyme known to date to catalyse the electrolytic generation of oxygen from water
- The evolved enzyme can be produced at industrial scale and it is easily immobilised onto low-density graphite electrodes.
- The energetic saving and the low cost of the electrochemical device make this electrochemical production of H₂ a cost efficient process.

Patent status
Spanish patent filed with possible international extension

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