New material and electrocatalyst for the use of H_2 as a fuel for electricity generation

VNIVERSITAT DE VALÈNCIA

R&D RESULTS

Patent

Knowledge area

- Renovable energies
- Fuel Production
- Electrocatalysis
- Photocatalysis

Collaboration

- Technology available for Licensing
- Other forms of collaboration

Ref. **201842-Abargues, R**

Film and method of obtaining layers of non-stochimetric NiO by wet deposition and its nanocomposites with metallic nanoparticles for use in electrocatalysis and photocatalysis.

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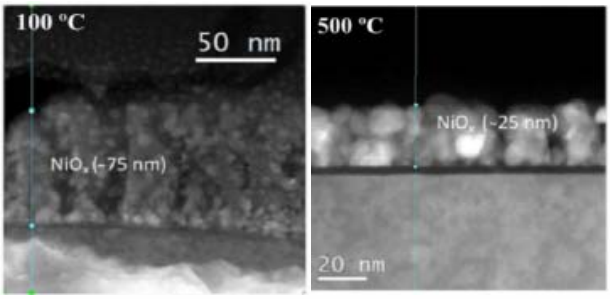
Background: Nowadays, there is a growing need in promoting the development of clean and renewable energies to combat climate change. However, one of the most important challenge is the efficient production of clean fuels like H_2 from the hydrolysis of water. The use of H_2 as a fuel is one of the most promising solutions for electricity generation as the H_2 combustion with O_2 is completely clean because H_2O is the only product of the reaction. This is carried out in a fuel cell. The hydrolysis of water is a spontaneous process only at very high temperatures, around 2200ºC. Electrolysis of water is the most promising alternative in terms of sostenibility. However, electrolysis of water at room temperature requires a large amount of extra energy, compared to the theoretically necessary to carry it out (+1.23V). This is because, as in any chemical reaction, it is necessary to overcome the activation energy of the reaction. Electrocatalysts can be used to reduce the energy required.
Although the use of photoelectrochemistry in hydrogen production processes has enormous potential, it has not yet been possible to develop an application capable of competing economically with conventional procedures. Currently, the best performing electrocatalytic systems are based on the use of precious metals (RuO_x, IrO_x, or Pt) that are highly expensive. Furthermore, methane reforming allows a cheap hydrogen production (3€/kg), but with an important carbon footprint that must be eliminated. Therefore, there is a need to develop new catalysts based on metals more abundant in the land surface.

The invention: Researchers from the Universitat de València in collaboration with researches from the Universitat Jaume I and Intenanomat S.L. have developed a novel material based on non-stoichiometric nickel oxide (NiO_x) that possesses excellent electrocatalytic properties for the electrolysis (oxidation) of water. This compound is overtaking even the efficiencies of electrocatalysts based on precious metals (RuO_x, IrO_x, or Pt). The technology allows the synthesis of the electrocatalyst through the formulation of various NiO_x precursors. These precursors are prepared in solutions for the deposition on different types of substrates in a single step by different printing techniques. The resulting material has excellent electrocatalytic properties for water oxidation with low energy requirements. The manufacturing method used is also completely scalable and compatible with roll-to-roll manufacturing techniques, where flexible substrates or thin metal sheets are required.

Applications: The invention would be applicable in electrocatalysts: for hydrolysis of water and in electrochloration and purification of water and in fuel cells for the generation of electricity from H_2 and O_2. Also can be used in the formulation of coatings and paints with photocatalytic properties and in materials for selective hole transport layers for photovoltaics and optoelectronics such as LEDs.

Advantages: The proposed system has significant advantages over established systems:

- High efficiency: low energy requirement and high stability.
- Low raw material cost. The electrocatalyst consists mainly of nickel, one of the most abundant elements in earth (approx. 17€/kg).
- Low manufacturing cost. Solution-processed Manufacture by means of continuous industrial methods such as roll-to-roll or digital printing such as ink-jet printing.
- Versatility: wide range of applications in electrochemistry, not only as an electrocatalyst for the electrolysis of water but also for reactions such as the electrochlorination of water from brine for the potabilization of water.
- Reduction of operating costs by 20-35% in electrochemical processes.



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