Outstanding performance as proactive support in catalytic green hydrogen production of sustainable graphene synthesised from a macroalgae waste

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Introduction

Graphene materials find nowadays application in multiple research areas, due to their outstanding properties. An important application is its use as support of catalysts in green energy production. Conventional graphene preparation routes use graphite or fossil fuel derivatives as **starting material**, which represents an environmental concern. The replacement of these fossil fuel derivatives by a **biomass source** constitutes a sustainable approach to that end. Our first goal in this work is the development of a new procedure to prepare and fully characterized a **graphene-like material from an Agar–Agar industry macroalgae *Gelidium Sesquipedale*** waste. The characteristic of this graphene like material are compared to the graphene obtained similarly but from a standard graphite. Finally, the potential of these materials to serve as proactive support for the electrocatalytic production of green hydrogen via water splitting is assessed.

Agar-Agar Industry

***Gelidium sesquipedale* Macroalgae**

Agar-Agar

Macroalgae waste (AM)

Objectives

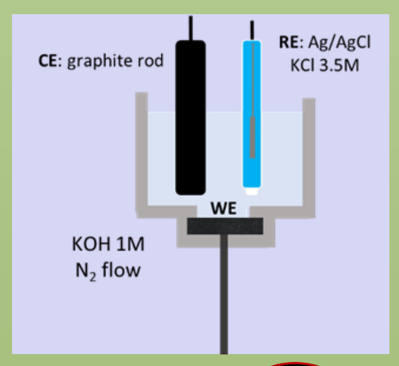
- **Prepare and characterize grahene materials from Gelidium sesquipedale Macroalgae biochar**
- **Prepare hybrid graphene/Ni-Fe nanoparticle 3D electrodes and study their electrocatalytic performance for green hydrogen production by water splitting**

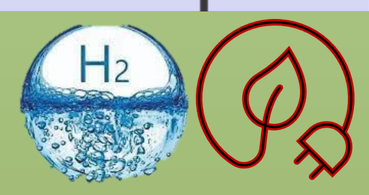
Experimental Method

(AM)

Application: Catalysts support

Green Energy production

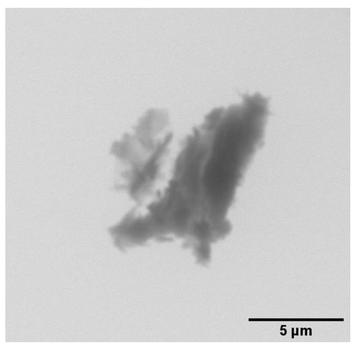




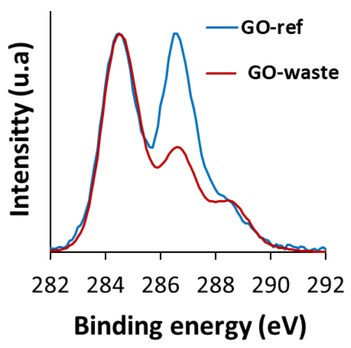
Results & Discussion

Graphene material obtained from Macroalgae waste by Hummers' method

STEM image of GO-waste



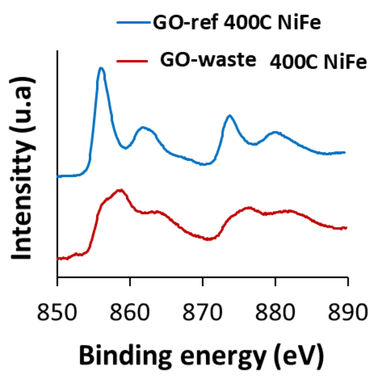
C1s XPS spectra



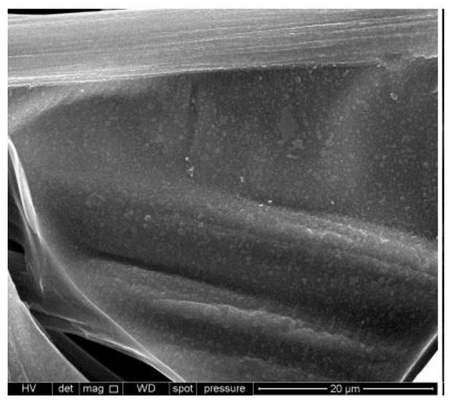
C1s spectra show that the graphene oxide-like material prepared from biochar waste is less oxidized compared to the GO produced using a commercially available reference graphite

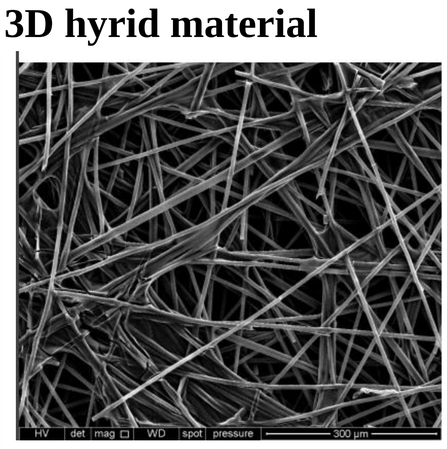
3D hybrid graphene/NiFe electrode

Ni2p XPS spectra



SEM images of 3D hyrid material

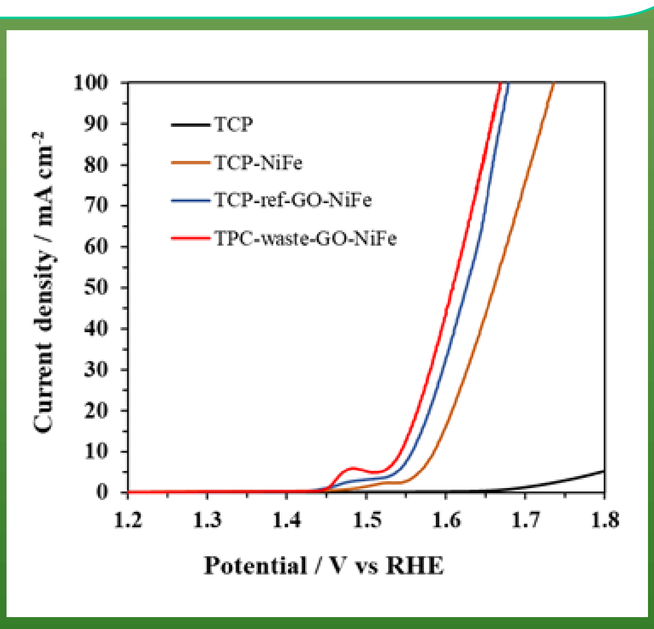




Ni 2p show a typical nickel hydroxide spectra for GO-ref, while in the case of biochar, a less well-defined spectra was acquired. This represents a more heterogeneous mixture of nickel species.

Electrocatalytic performance in OER

The as prepared electrodes were used in OER, by determining the cyclic and linear sweep voltammetry curves. Additional studies with bare TCP and without the presence of graphene (TPD-NiFe) were also conducted as comparative purposes. The sample without graphene (TCP-NiFe) presents a higher overpotential value. In this regard, TCP without nickel and iron result shown no catalytic activity, demonstrating its bare activity towards OER. On the other hand, the presence of graphene on the electrode (TCP-ref-GO-NiFe and w TCP-waste-GO-NiFe) caused a decrease in the potential needed to initiate the reaction (TCP-NiFe), confirming the proactive performance of these nanomaterials in the reaction. Moreover, an improvement in the catalytic performance is observed when using graphene from algae-waste (TCP-waste-GO-NiFe) in comparison to the electrode with graphene from graphite (TCP-ref-GO-NiFe). The overpotential at 10 mA/cm^2 is about 310 mV for TCP-waste-GO-NiFe and 330 mV for TCP-ref-GO-NiFe, a value comparable to other NiFe composites (Li *et al* (2019)). These promising results evidence the possibility of using algae-derived waste and transform it into a value-added carbon material with application in green hydrogen production.



Acknowledgement

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