CINTECX´S ANNUAL CHALLENGE 2023

Bioingenería y Procesos Sostenibles BIOSUV Universida de Vigo

DESIGN AND SYNTHESIS OF NEW MATERIALS FOR H_2 GENERATION AS A RENEWABLE ENERGY SOURCE

Grupo Novos Materiais Universida de Vigo

1. ACTUAL SCENARIO

Popullation growth

High Energy demand — Causes — Decrease: Traditional energy resources (COST)

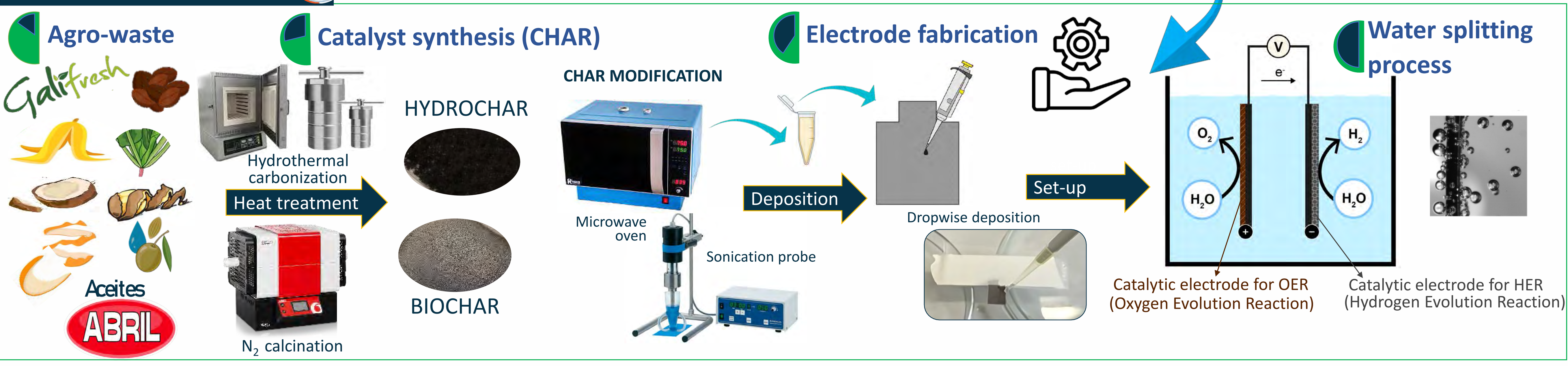
Agrowastes generation — Decrease: · Profitable land areas · Soil quality

2. NOVEL ALTERNATIVE

Ecofriendly H_2 production by water splitting process

- Request catalyst is synthetised from agrowastes
- Favouring the "green" use of water splitting processes
- Avoiding metal catalysts
  - Environmental friendless
  - Enhanced stability
  - Cost reduction

3. PROCEDURE



4. RESULTS

4.1 CHARS' SCREENING

Banana, potato and chestnut peels, as well as rice bran, spinach stem and spent coffee were thermally-treated. Only some chars exhibited catalytic water splitting behaviour, specifically hydrochars, due to their acid pH and their higher content on oxygenated groups.

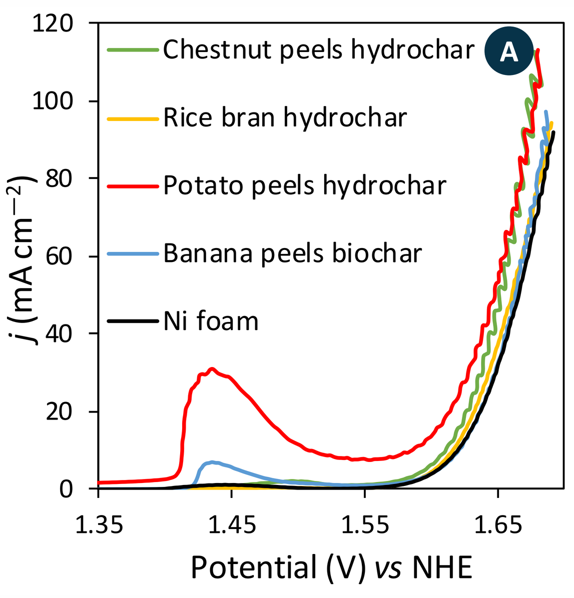
Hydrochar synthesized from potato peels and biochar attained from N_2 calcination of banana peels provided higher intensities at a given potential (A) with the smaller activation energy (B). Concerning electrochemical impedance spectroscopy (C) spinach stem and rice bran hydrochars were also good electric conductors.

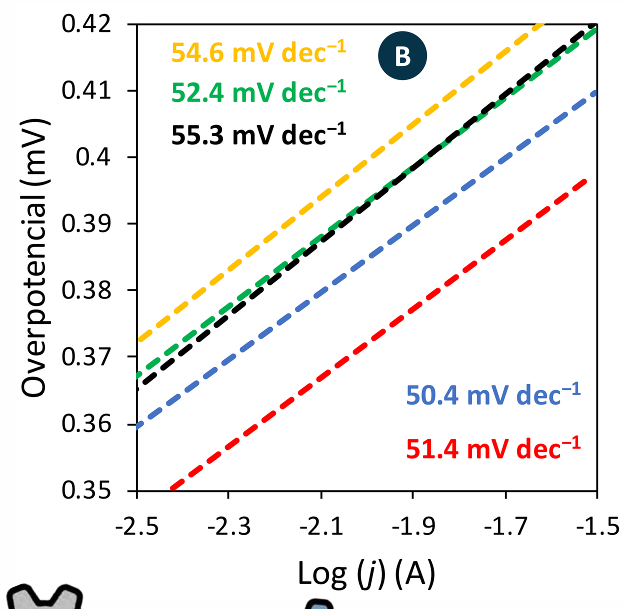
CHAR CHARACTERISTICS

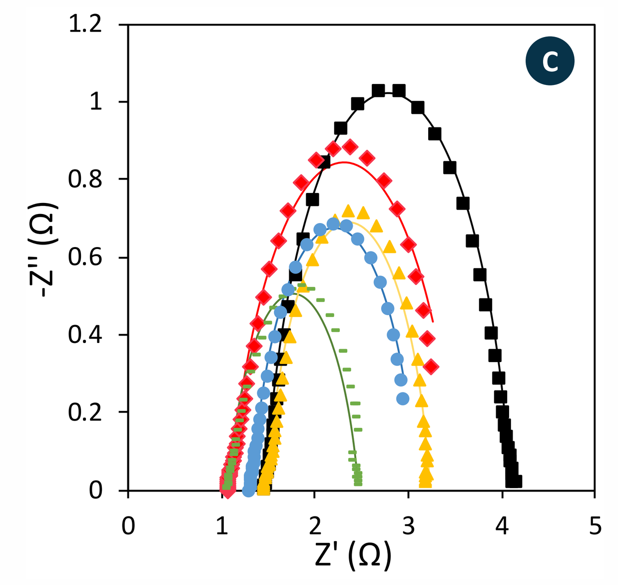
Metal free (C/N/O/H)

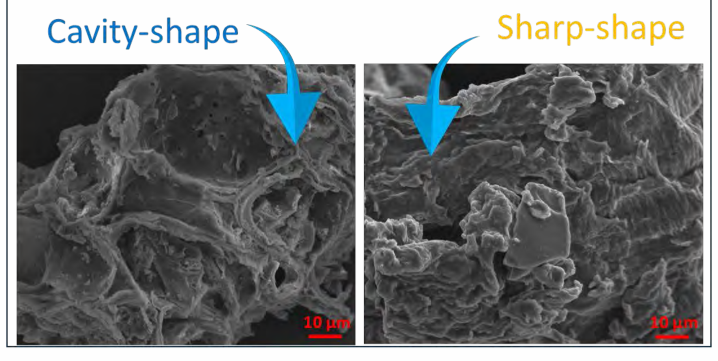
Functional groups

HYDROCHAR	BIOCHAR
Oxygenated groups	Nitrogenated groups
Amorphous	High surface areas
Acid pH	Basic pH
Cavity-shape	Sharp-shape





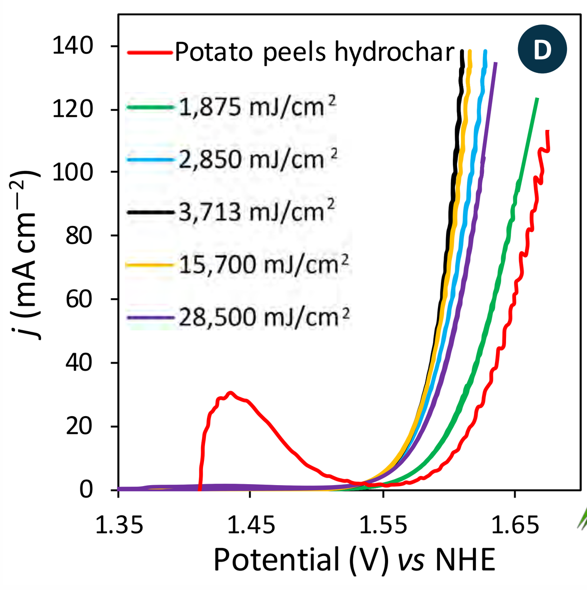




4.2 FURTHER OPTIMIZATION

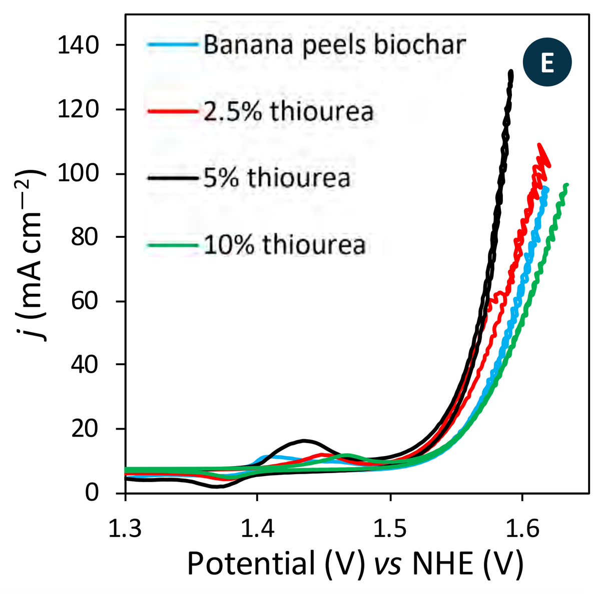
Laser modification

The application of a laser beam to the catalytic electrode with potato peels hydrochar (D) promoted: 1) the hydrochar melting into supported nickel foam electrode, favouring electronic transference and stability 2) the generation of oxygenated groups, favouring OER. The laser beam intensity resulted to influence the OER performance.

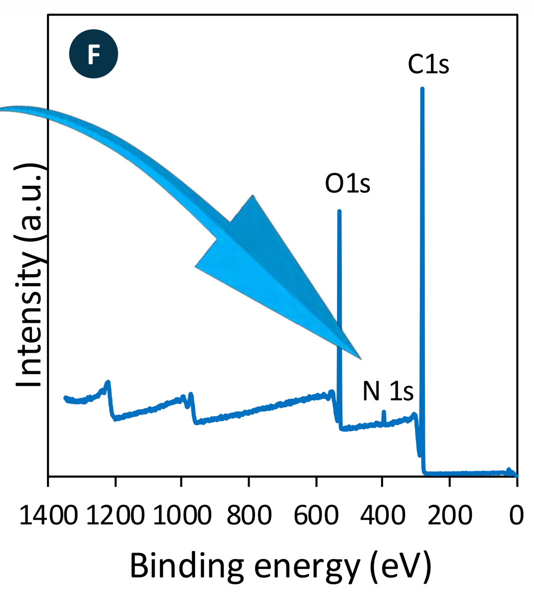


Oxygen content

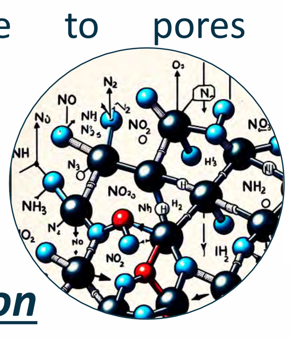
Nitrogen-based groups addition



Thiourea addition (E) allowed the introduction of nitrogen-based functional groups (F), favouring OER performance. However, too high thiourea concentrations caused a detriment on OER performance due to pores clogging.



Nitrogen content



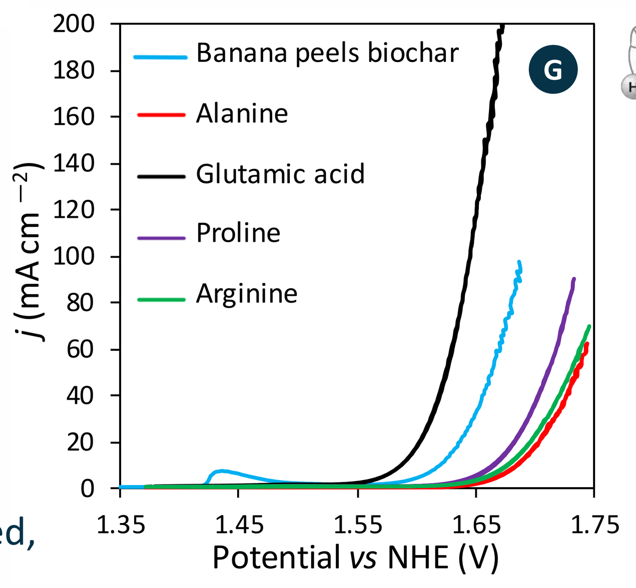
4.3 STABILITY EVALUATION

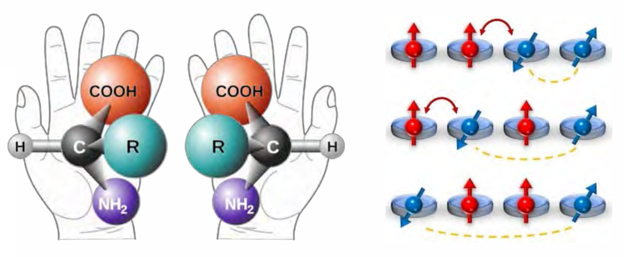
To compete with metal-based catalyst there is a need of materials with not only good electrical behaviour but also long stability, thus it was evaluated (H).

(H) Voltage increase (%) for 100 mA	Potato peels hydrochar	Potato peels hydrochar laser 3,713 mJ/cm²	Banana peels biochar	Banana peels biochar + 5% thiourea	Banana peels biochar+ 5 % glutamic acid
Accelerated Degradation Test (8,000 CVs)	7	2	6	-6	-2
Chronometry (100 h)	8	6	11	9	6

The synthesized chars were even more stable after the studied modifications. Indeed, some of them were even activated during consecutive energy input (negative values).

Spin colocation





Chiral compounds addition favour spin collocation on oxygen atoms, favouring OER (G). Thus, glutamic acid addition caused an extremely intensity increase, defeating metal-based catalysts.

Universida de Vigo

XUNTA DE GALICIA

CINTECX Centro de Investigación en Tecnologías, Energía y Procesos Industriales