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Development of a Biochar-Based Catalytic ink for Enhancing the Hydrogen Evolution Reaction.

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Introduction

Energy demand continues to rise steadily, and concerns about global warming are intensifying efforts to move away from fossil fuels in order to reduce global temperatures and limit the temperature increase to 1.5ºC above pre-industrial levels [1].

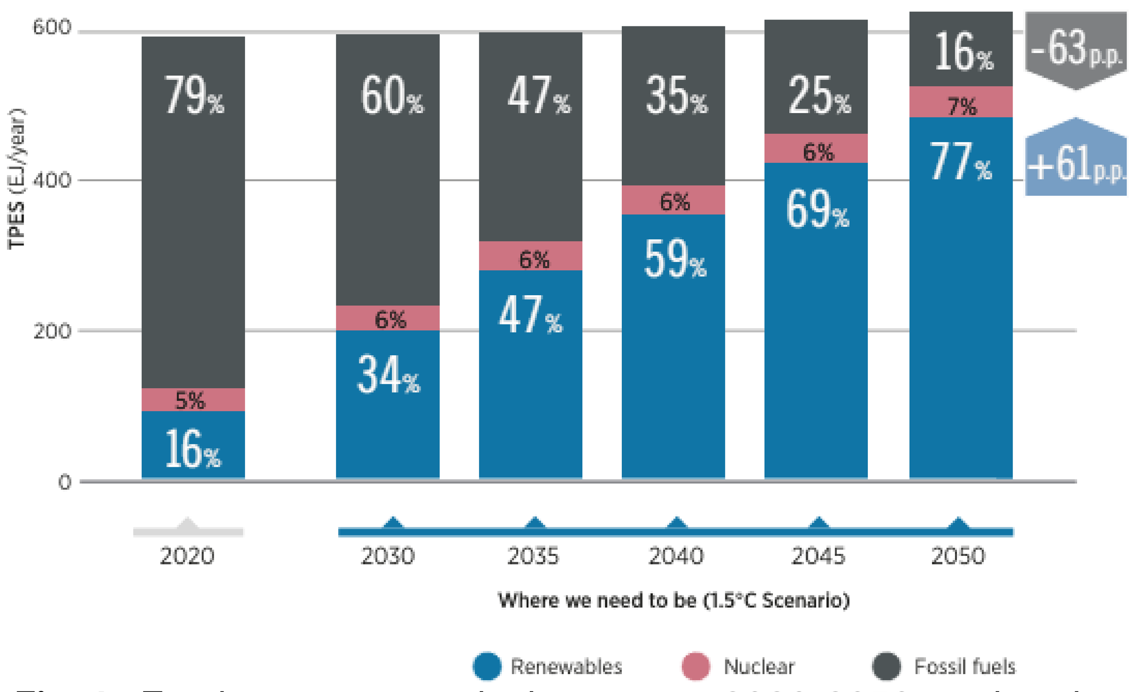


Fig 1. Total energy supply by group, 2020-2050 under the 1.5°C Scenario [2].

The extraction of fossil fuels contributes to

- **80%** World energy consumption
- **50%** Carbon dioxide emissions worldwide
- **90%** Responsible for the loss of biodiversity.

The implementation of renewable energy sources is essential to address issues related to energy security and affordability. However, renewables currently do not represent a high percentage of global electricity generation, making it difficult to achieve net-zero emissions targets by 2050

Hydrogen is a strong candidate for the energy transition process, functioning as both an energy carrier and vector. Additionally, it is a precursor or component in various industrial processes [3].

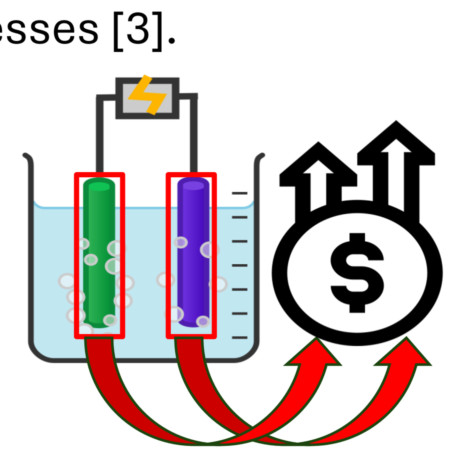
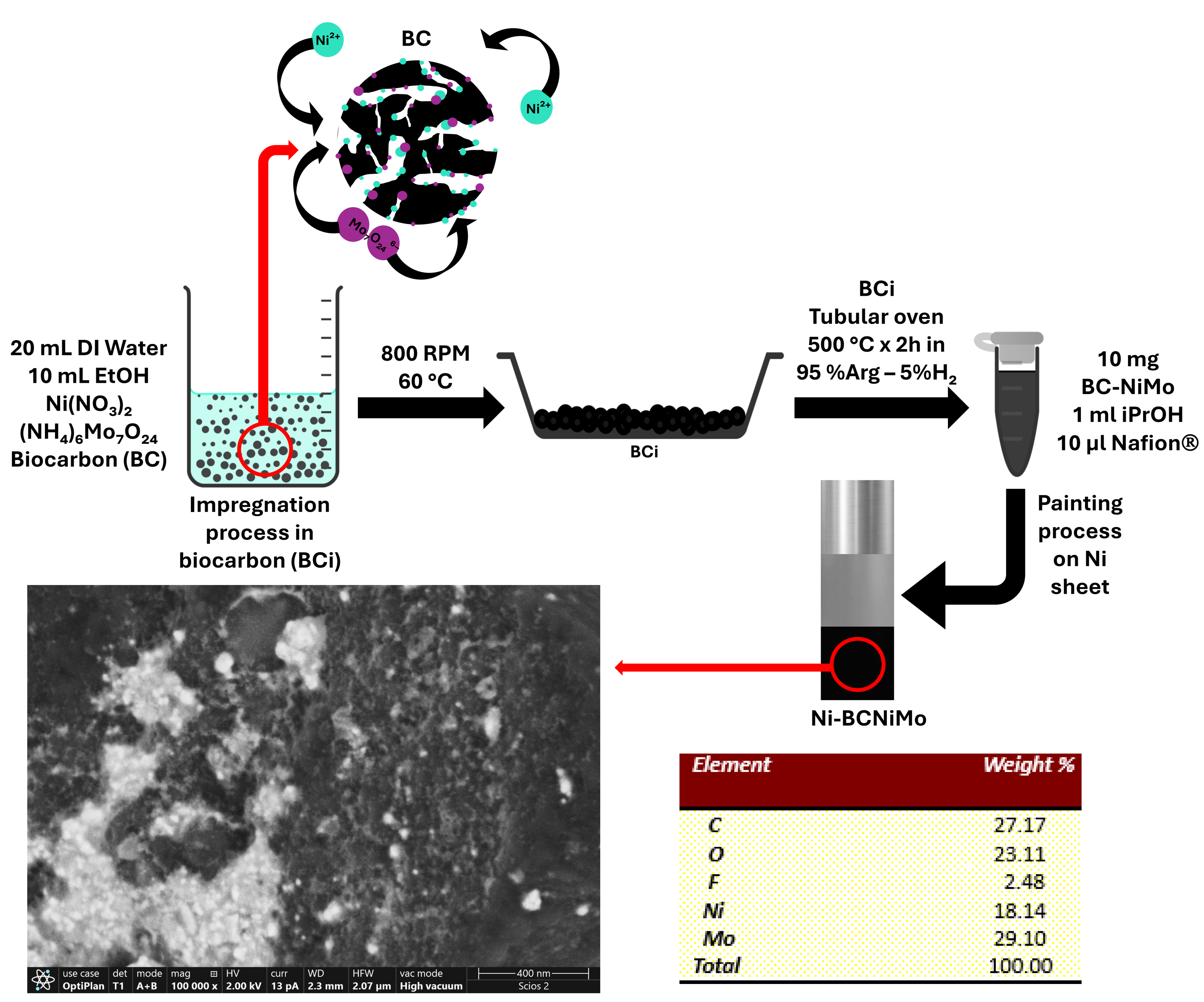


Fig 2. Applications of hydrogen [3]. **Fig 3.** Price increases due to electrode materials

The production costs of hydrogen through electrolysis can rise due to the expensive materials used in the electrodes. Therefore, a catalytic ink made of biochar impregnated with Ni and Mo was investigated to address this issue.

Methodology



Element	Weight %
C	27.17
O	23.11
F	2.48
Ni	18.14
Mo	29.10
Total	100.00

Fig 4. Diagram of the synthesis process

Results

Characterization and electrochemical tests

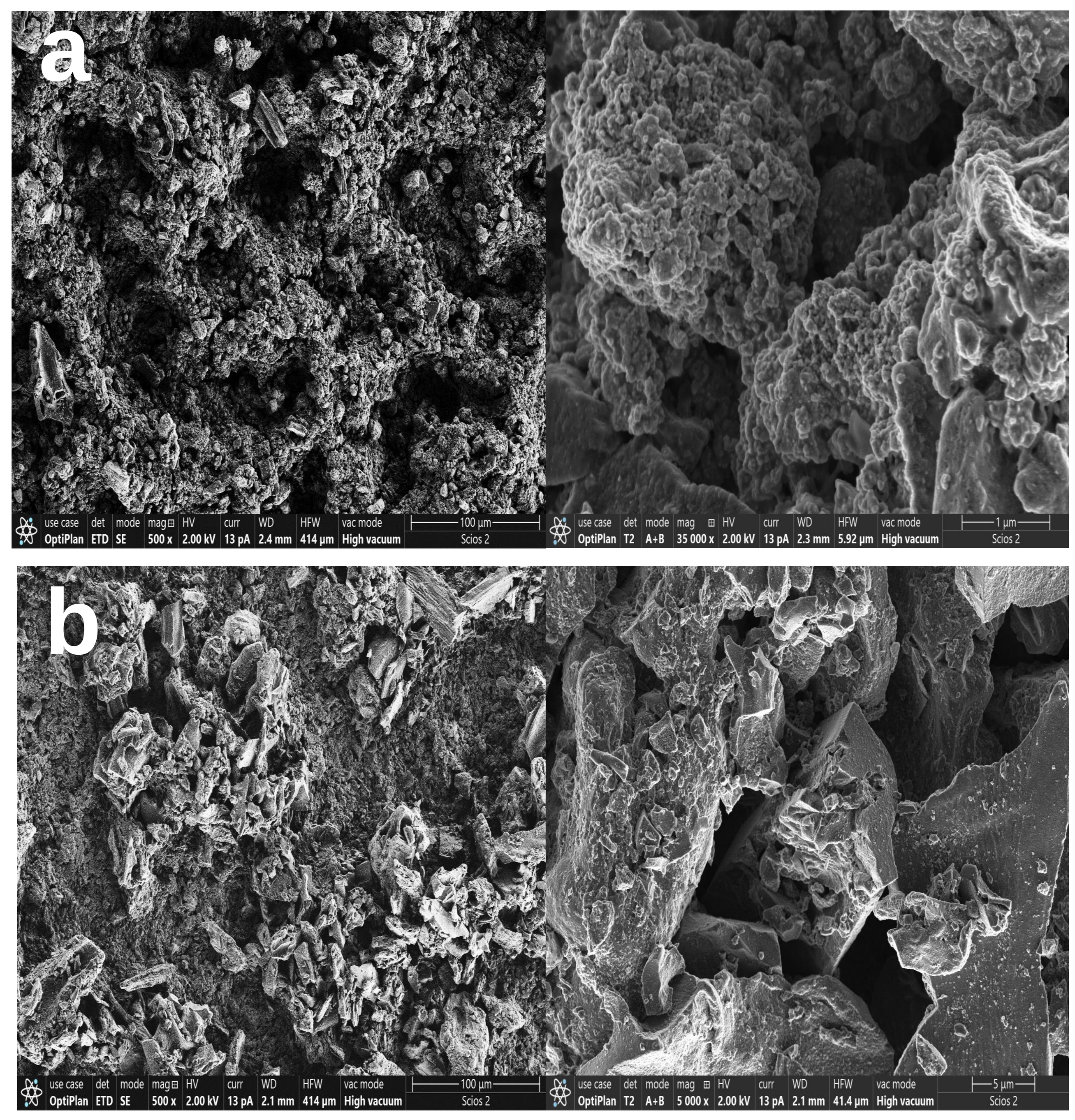


Fig 5. SEM Images of developed electrodes. a) SEM Ni-BCNiMo, b) SEM Ni-BC

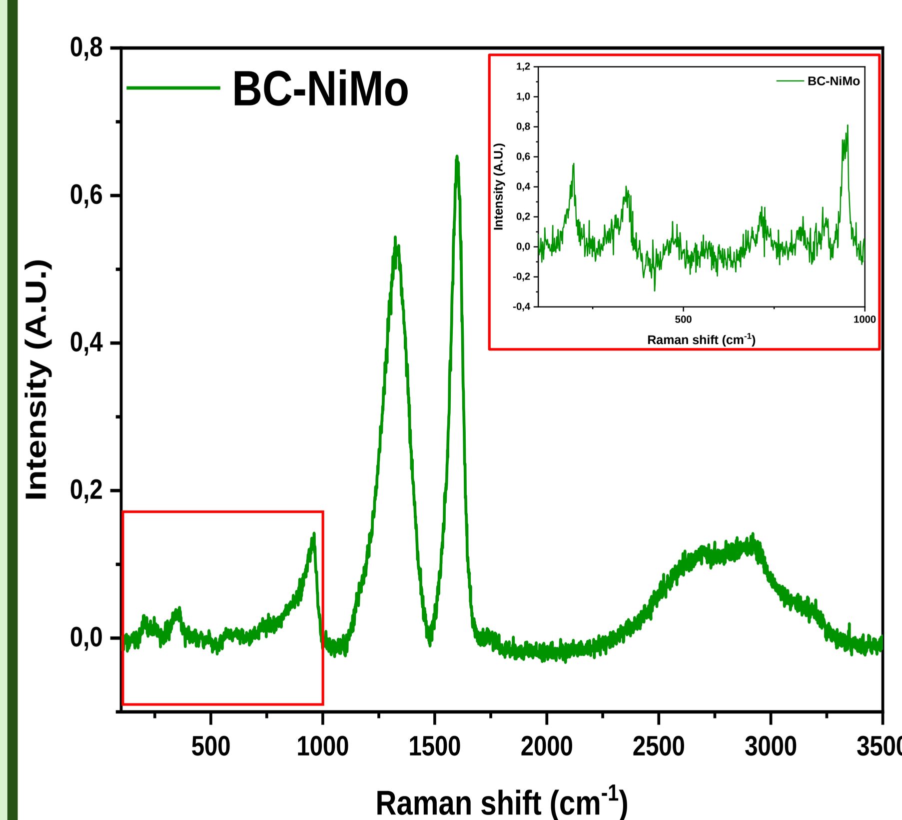


Fig 6. Raman spectra

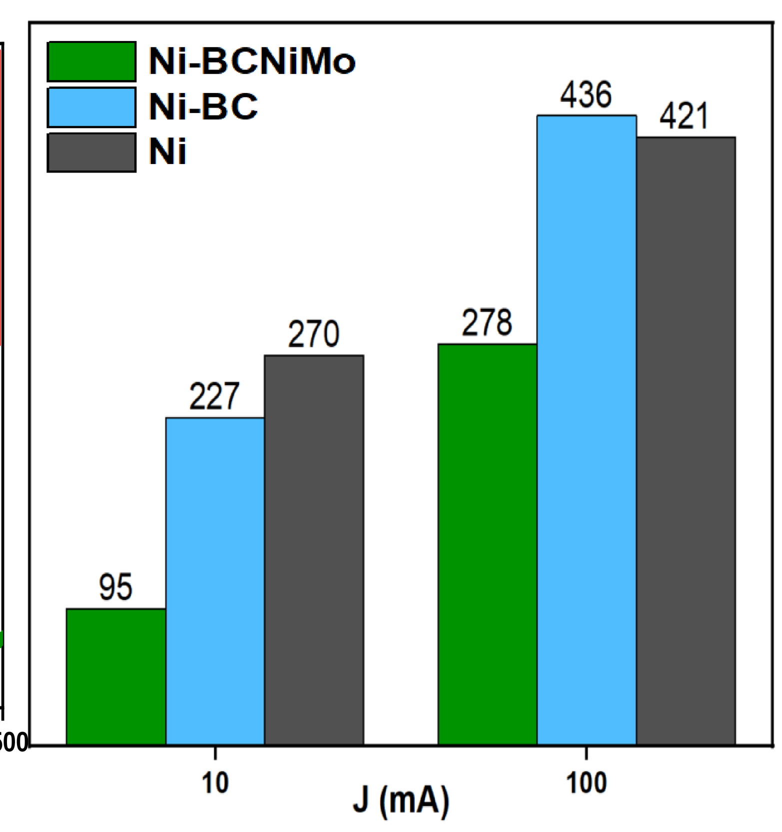


Fig 7. Overpotentials at 10 mA and 100 mA

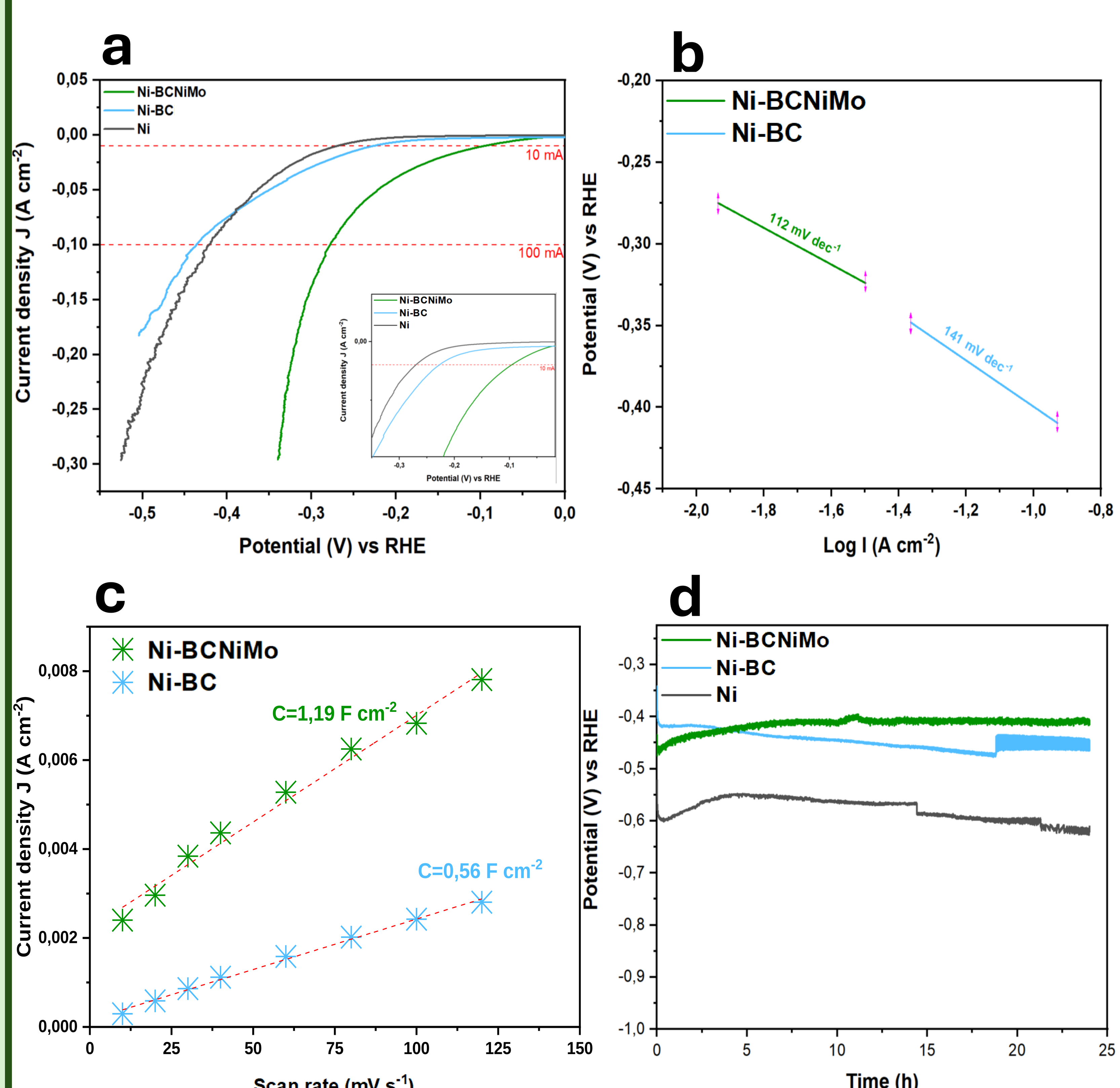


Fig 8. Electrochemical tests. a) LSV for HER, b) Tafel slopes, c) Capacitance measurements, d) Stability tests 400mA.

Conclusions

The NI-BCNiMo electrode exhibits a structure composed of cavities, generating a greater number of active sites where the HER reaction can occur.

The use of biochar as a porous structure to host the catalyst increases the efficiency of the electrode, showing an overpotential of 95 mV at 10 mA cm-2.

The addition of nickel and molybdenum significantly decreases the Tafel slope, leading to improved activities.

References

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