

Fabrication of Ni-alloy nanostructured electrodes for alkaline electrolyzers.

Salvatore Geraci^{1,2}, Sonia Carbone¹, Roberto Luigi Oliveri¹, Bernardo Patella¹, Rosario Miceli^{1,2}, Filippo Pellitteri^{1,2}, Massimo Caruso^{1,2},
Giuseppe Aiello¹, Rosalinda Inguanta^{1,2}

¹ Department of Engineering, Università degli Studi di Palermo, Palermo, Italy.

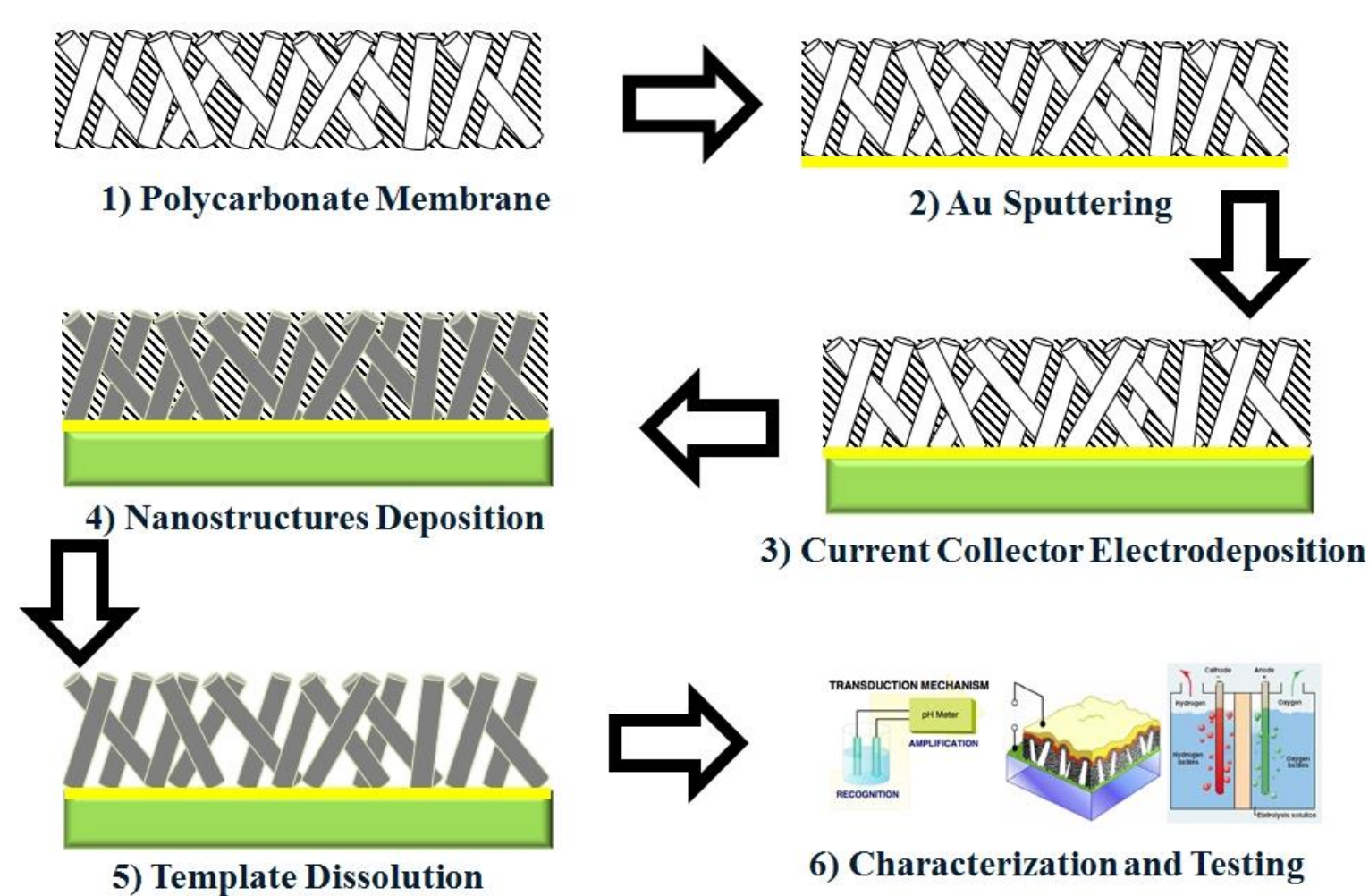
² Sustainable Mobility Center (Centro Nazionale per la Mobilità Sostenibile—CNMS).

salvatore.geraci01@unipa.it

INTRODUCTION

In last years, renewable energy sources are becoming more and more important owing to the progressive decarbonization of energy processes to reduce CO₂ emissions [1,2]. In this view, authorities all around the world are encouraging the use of renewable energies by promoting laws and initiatives for the most sustainable energy transition [3,4]. One way to produce green hydrogen is by water electrolysis using only electricity from renewable sources. The most relevant part of the cost of electrochemical hydrogen comes from the electricity cost and catalysts. For this reason, research is focused on improving the performance of the electrolyzer, using more efficient and less expensive materials, such as Nickel-based alloy [5], with nanostructured morphology. Starting from the best-performing nickel-iron alloy previously studied [6], this work focuses on the fabrication of nickel-iron-sulfur electrodes.

ELECTRODE FABRICATION



Nanowires of Ni-Fe-S alloy were fabricated by template electro-synthesis by means of polycarbonate nanoporous membranes.

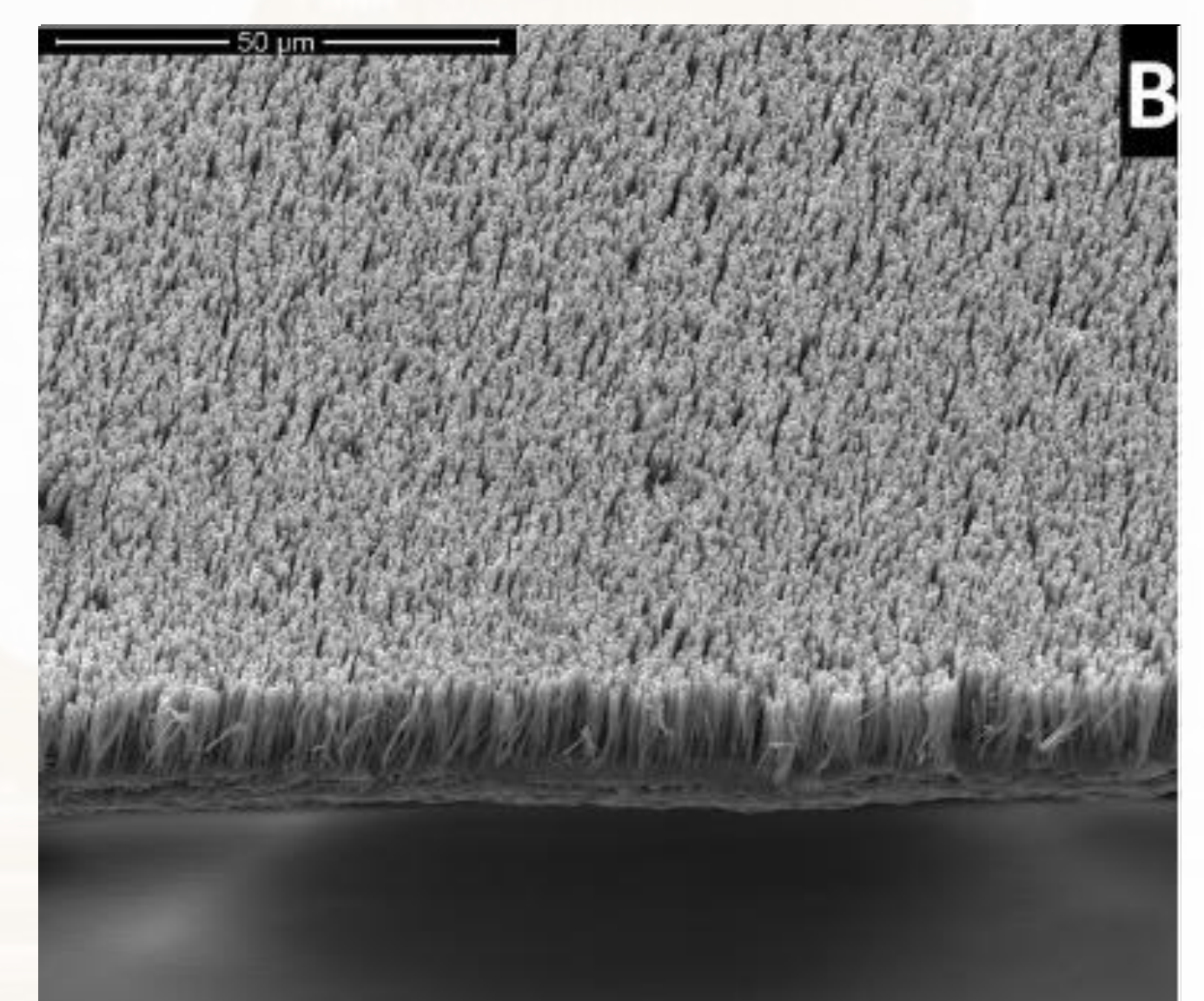
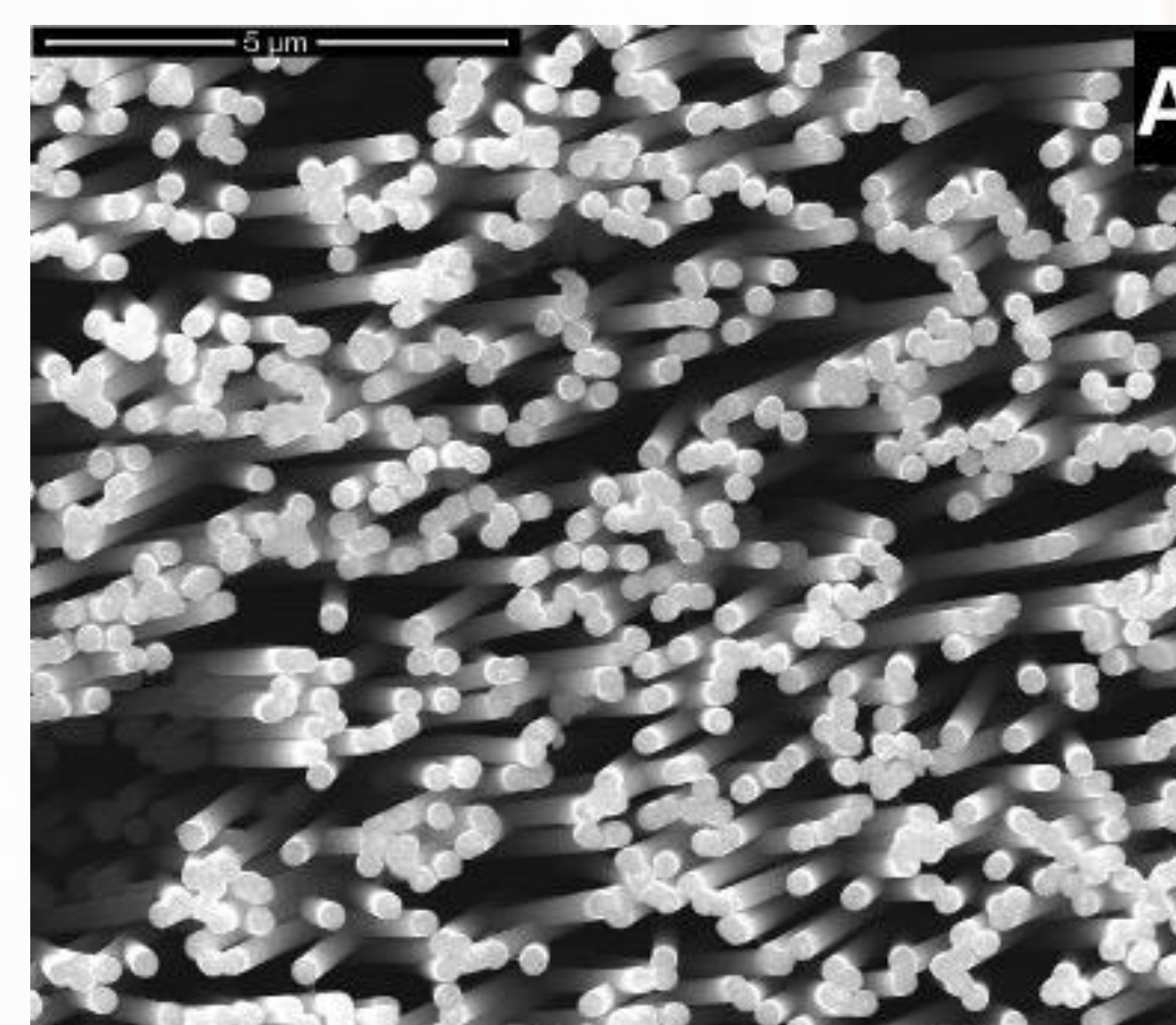
NWs electrodeposition was carried out by pulsed potential using the Watt's bath also containing:

- FeSO₄·7H₂O
- Na₂S₂O₃·5H₂O

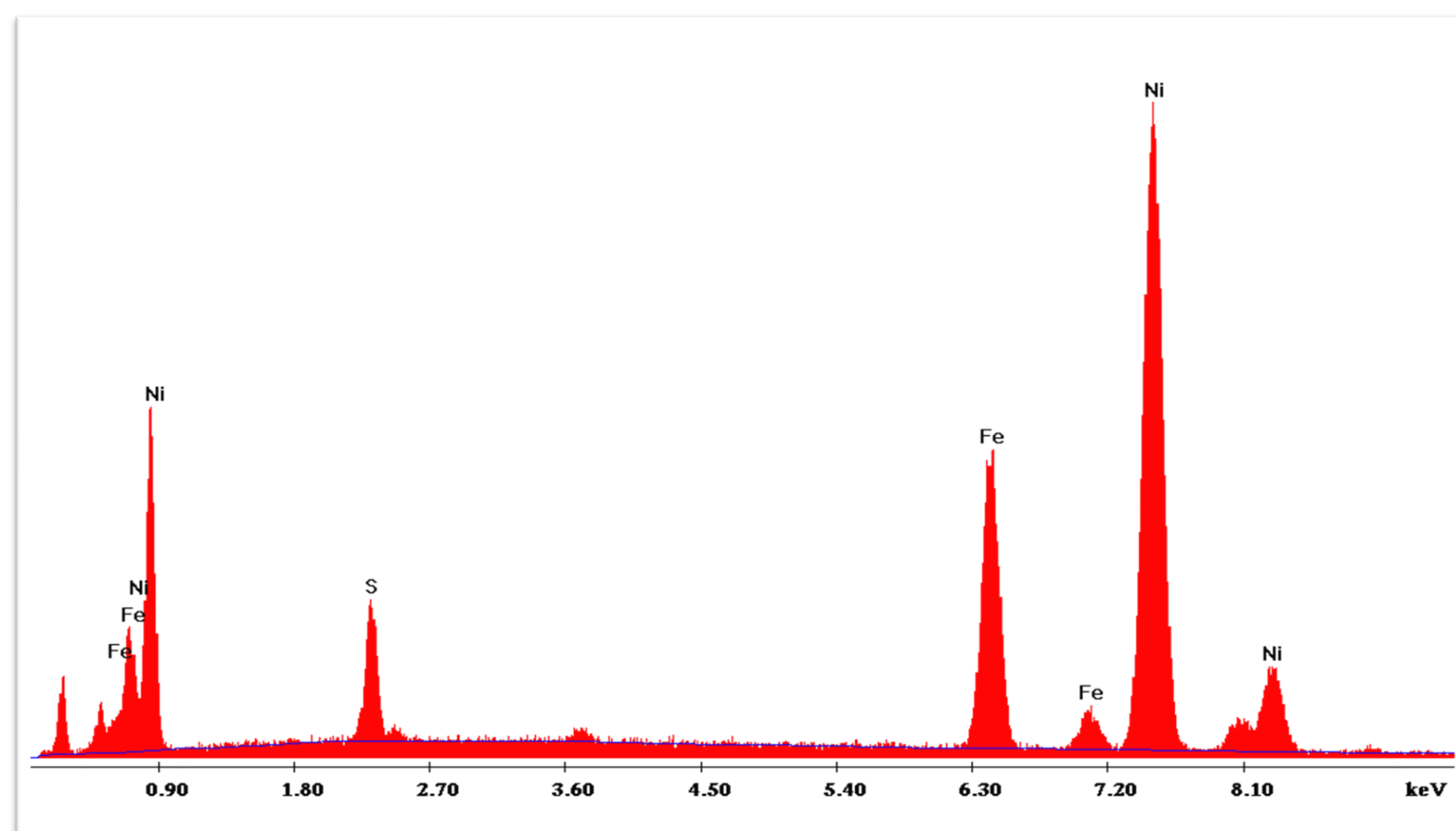
Nickel-iron-sulfur alloy electrode with an overall thickness of about 30 microns was obtained. The current collector has a thickness of about 12-15 μm, while the NWs length was about 12-16 μm.

SEM

The surface of the current collector appears to be uniformly covered with NWs.



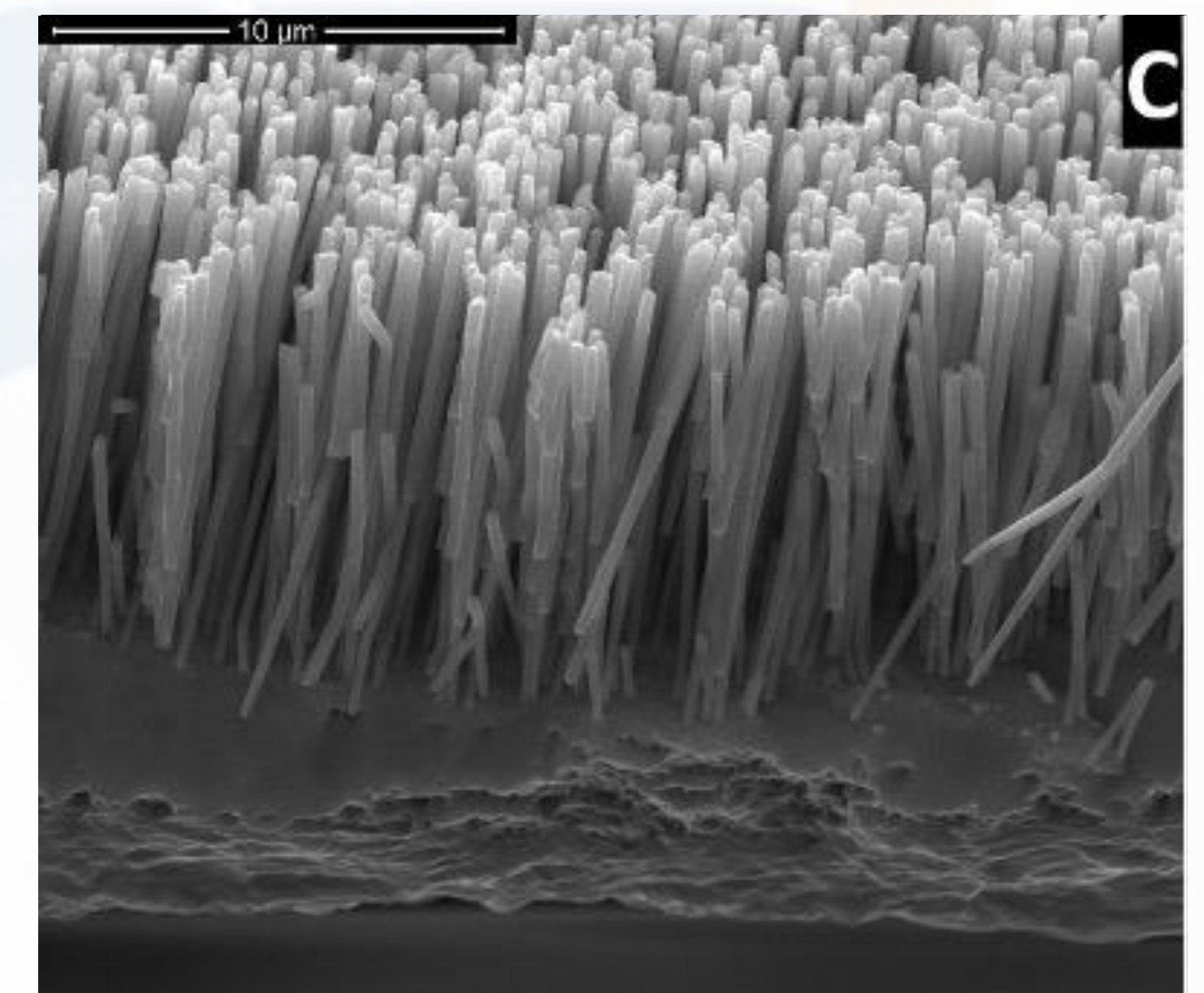
EDS ANALYSIS



The alloy composition was evaluated by EDS analysis. The content of the metals in NWs is different from the content in the electrodeposition bath.

Composition of Nickel-iron-sulfur alloy

	Wt %	Bath concentration
S	8.11	5 gL ⁻¹
Fe	19.79	123 gL ⁻¹
Ni	72.1	Watt's Bath



ELECTROCHEMICAL CHARACTERIZATIONS

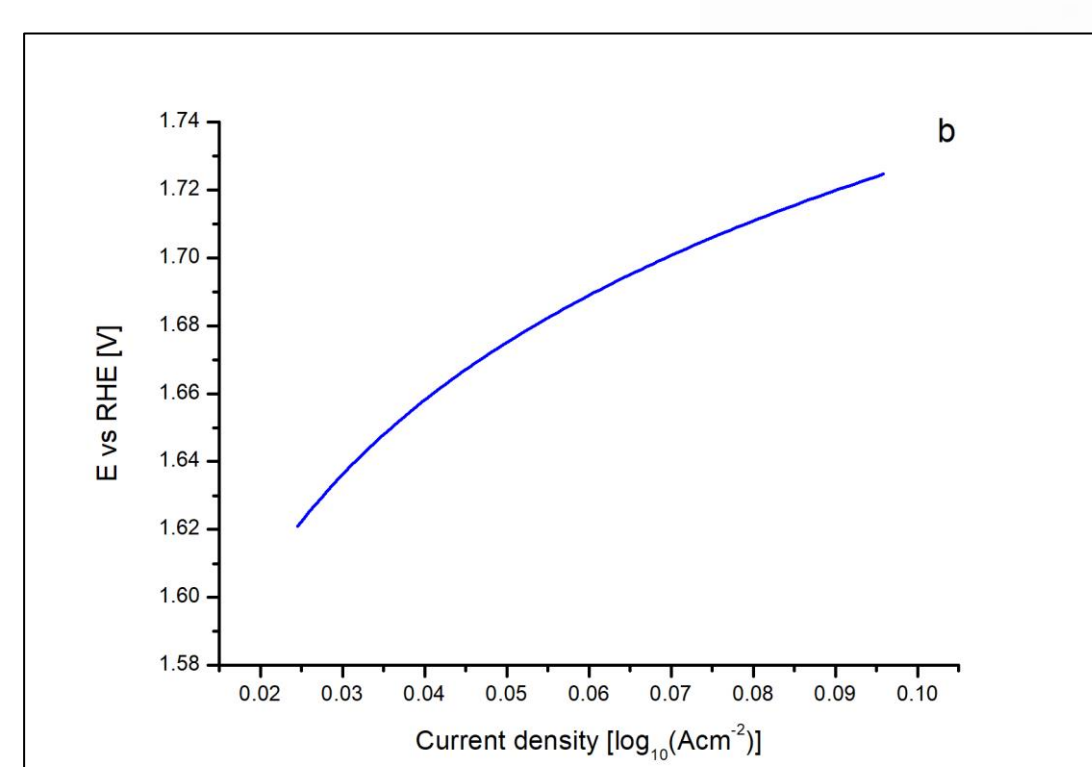
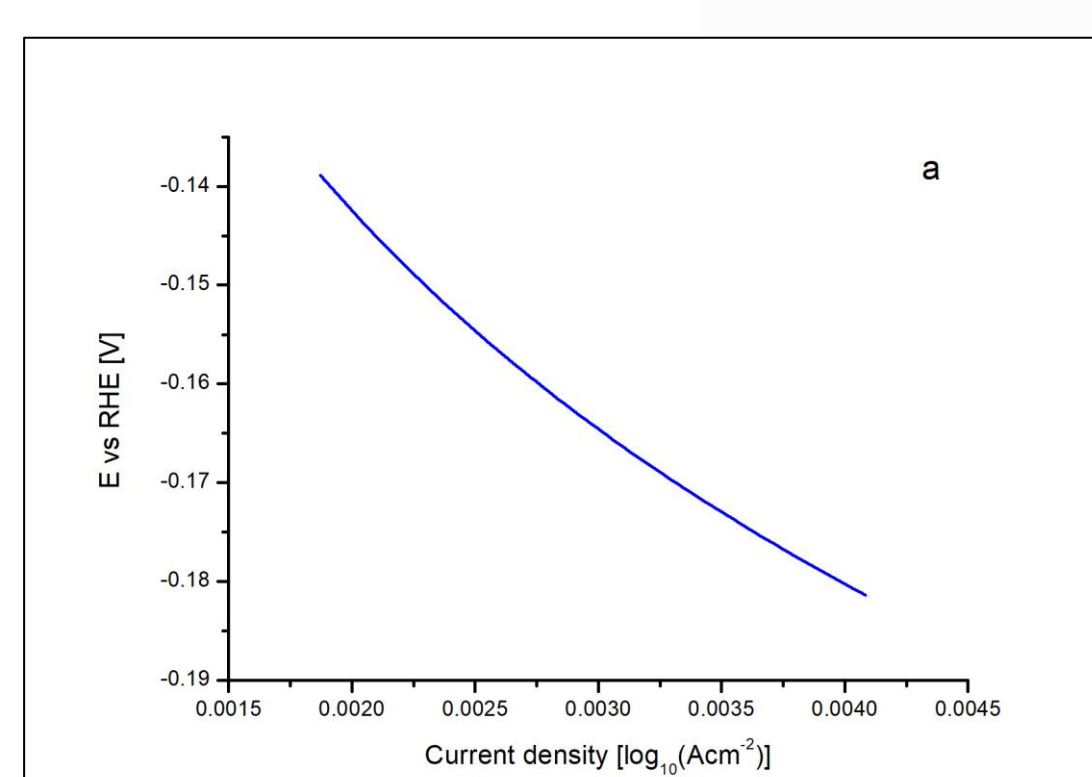
The linear part of QSSP curves were fitted with Tafel's equation. The table below shows the value of the slope.

Scan Rate: 0.166 mV s⁻¹

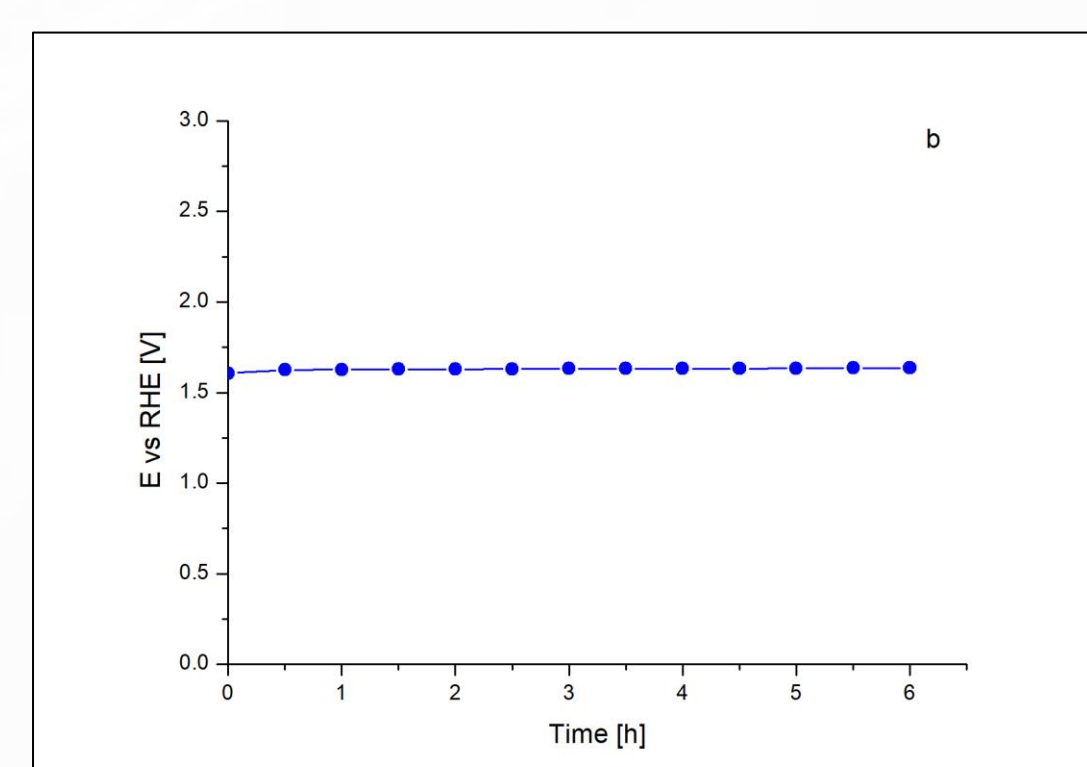
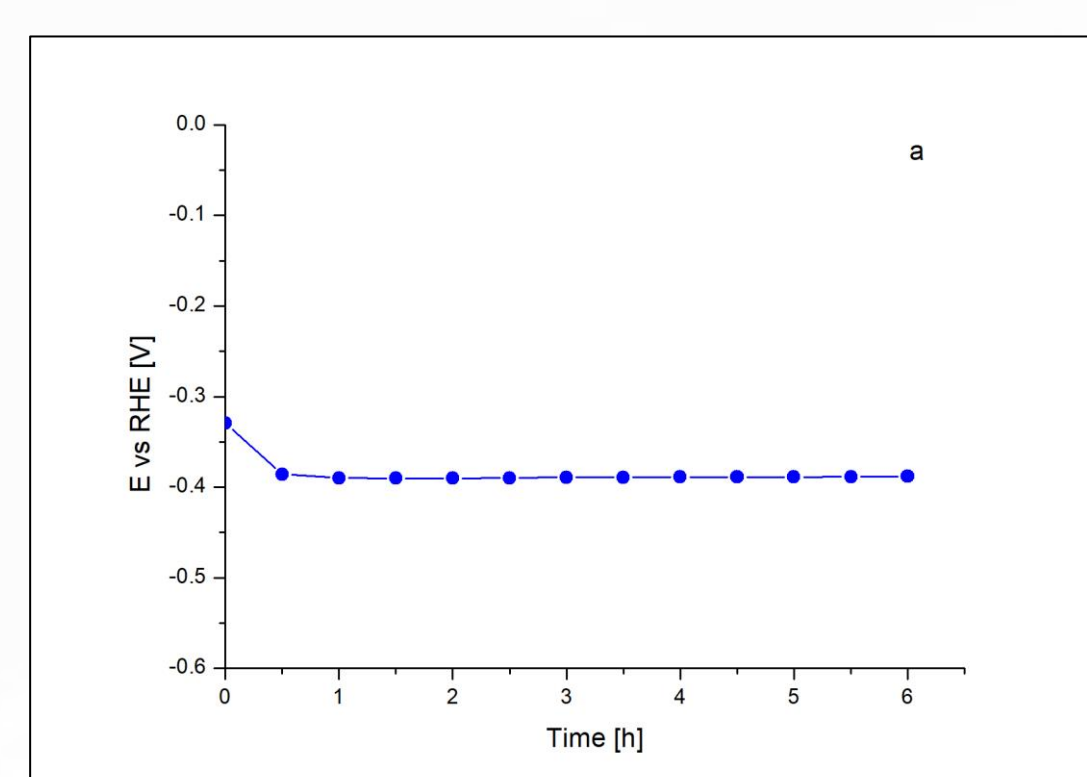
Solution: KOH 30% w/w

Temperature: Room

NiFeS	a [V]	b [V]	R ² [%]
HER	1,903	0,076	0,985
OER	-0,310	0,029	0,988



To study **stability over time**, constant current density mid-term tests were carried out for 6 h at -50 mA cm⁻² and +50 mA cm⁻² for HER and OER, respectively.



CONCLUSIONS

In this work, nanostructured electrodes of Ni-Fe-S were manufactured with a simple and cheap method. Ni alloy NWs have shown good performance due to the high surface area in respect to planar electrodes. Electrochemical and electrocatalytic properties of Ni Alloy NWs electrodes showed good performances. This work will go on to study how the concentration of sulfur could influence the performance of the electrode in HER and OER respectively. These results will even be the basis for the development of a laboratory-scale electrolyzer. Research activities are in progress for using a homemade cell with these electrodes, in which it is possible to set temperature, water flow, etc. Furthermore, other activities continue to deal with performance in seawater.

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