Ternary alloys of Ni-Fe-P for alkaline electrolyzer

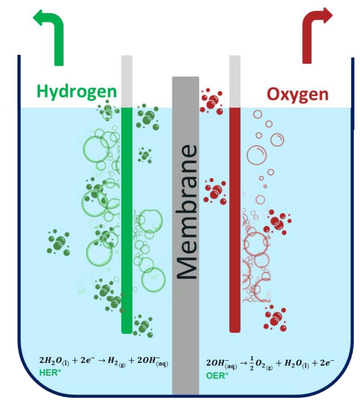
S. Carbone[a], R. L. Oliveri[a], B. Patella[a] R. Miceli[a], F. Pellitteri[a], A. O. Di Tommaso[a], G. Aiello[a], R. Inguanta[a]

[a]Department of Engineering, Università degli Studi di Palermo, Viale delle

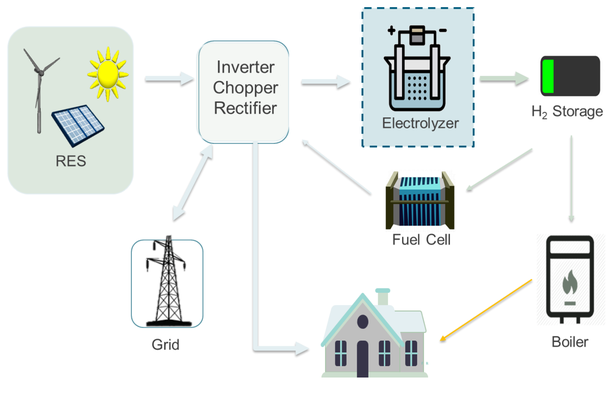
sonia.carbone@unipa.it

INTRODUCTION

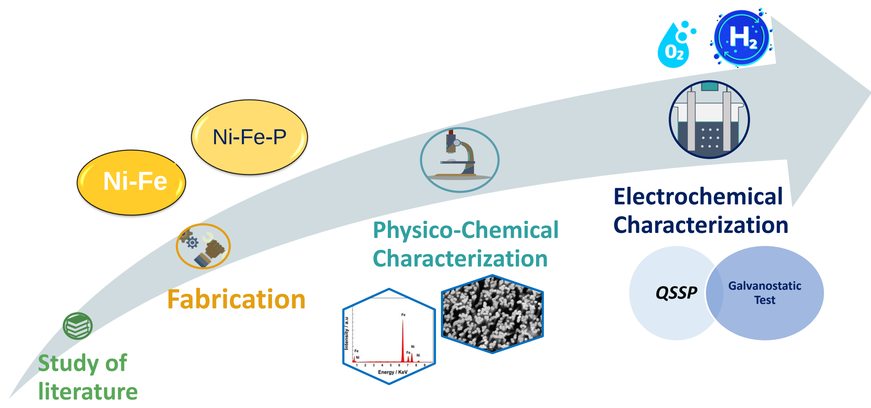
Electrolysis of water represents a clean way to generate hydrogen and oxygen. The hurdle to be overcome is the realization of highly efficient but inexpensive electrode materials as an alternative to traditional noble metal-based electrocatalysts. Transition metal phosphides (TMPs) have attracted attention due to their catalytic action for HER and OER in alkaline electrolytes. In this work, a ternary alloy of Ni-Fe-P with nanowires morphology was investigated.



Alkaline Electrolyzer



RES-Hydrogen Energy Cycle



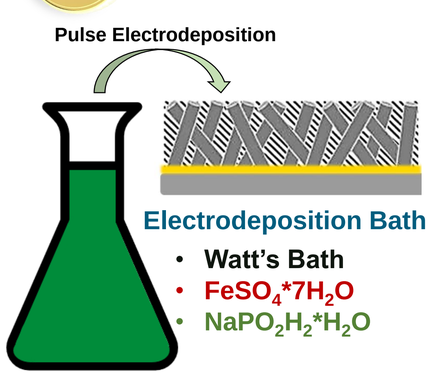
EXPERIMENTAL

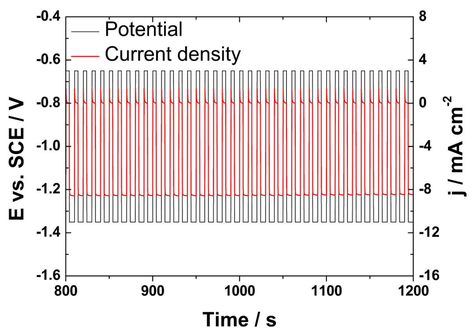
FABRICATION

1 Au Sputtering

2 Nickel Collector Deposition

3 NiFeP NWs Deposition

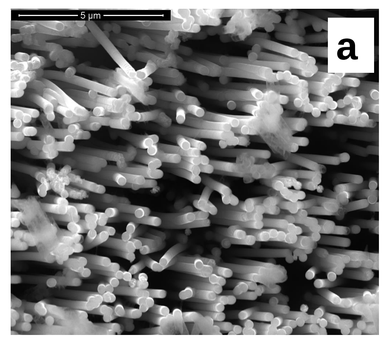




Electrodeposition Parameters

4 Membrane dissolution

SEM-EDS



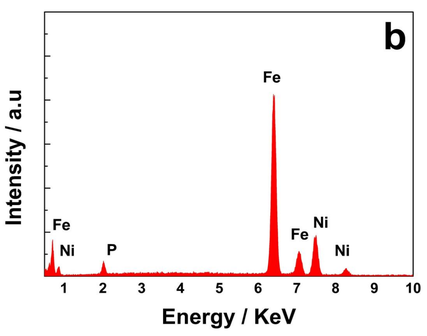
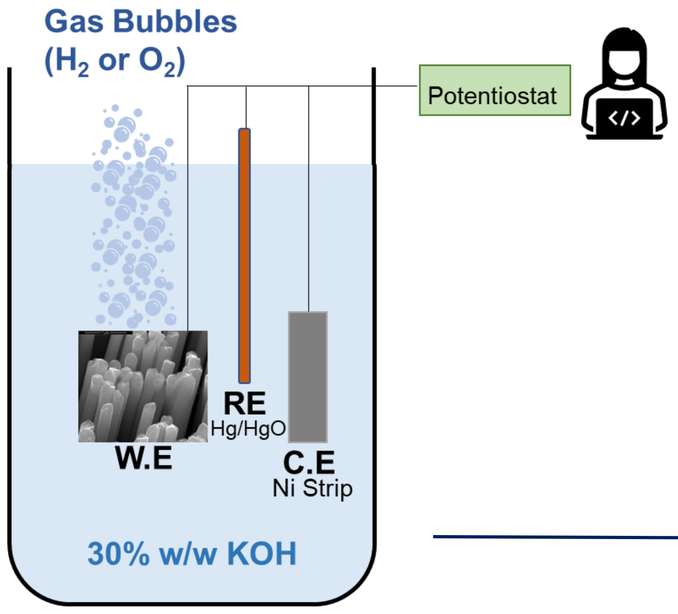


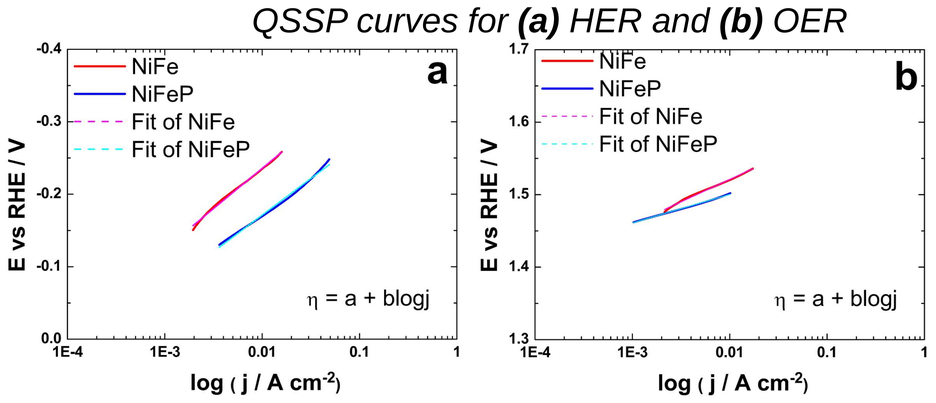
Fig. a shows the **SEM** image of nanostructured Ni-FeP electrodes. Due to the shape of the nanopores of the template, nanowires appear cylindrical with a smooth and regular surface. To composition of nanowires was estimated by EDS analysis, **Fig. b,** which has confirmed the presence of three elements.

ELECTROCHEMICAL CHARACTERIZATION



QSSP

*QSSP curves for **(a)** HER and **(b)** OER*



Tafel's parameters

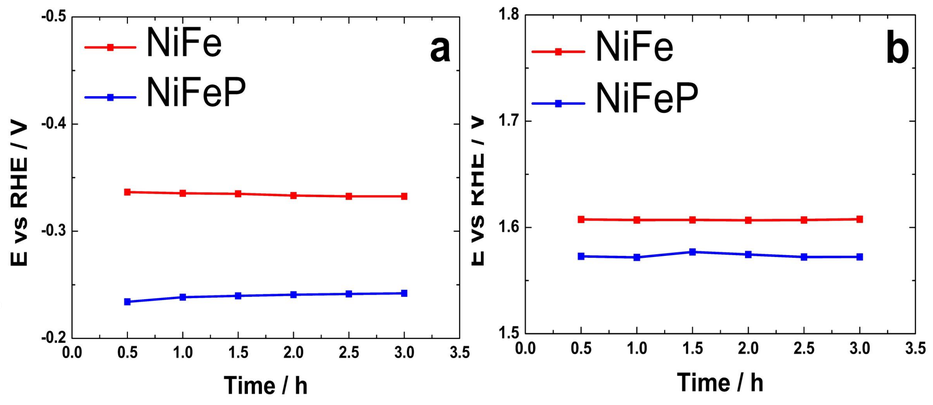
Electrode	HER			OER		
	a	b	R^2(%)	a	b	R^2(%)
NiFe NWs	-0.471	-0.116	99.57	1.612	0.045	99.46
NiFeP NWs	-0.372	-0.101	99.28	1.581	0.039	99.77

Galvanostatic Test – Mid-term behaviour

To study the stability over time, constant current density mid-term tests were carried out for 3 h at -50 mA cm^{-2} and +50 mA cm^{-2} for HER and OER, respectively.

Fig. a) *Constant current density mid.-term stability for HER*

Fig. b) *Constant current density mid.-term stability for OER*



Both electrodes showed very good stability. The potential values remained almost constant between the start and end of the test. The electrode potential of the ternary alloy is lower than the binary one.

CONCLUSION

NiFeP NWs have been successfully obtained to improve the performance of NiFe NWs. Nanostructured electrodes were obtained by template electrodeposition, a simple and inexpensive method. After assessing morphology and composition, the electrodes were tested both as anodes and as cathodes in a 30% KOH. Preliminary results have shown a significant increase in performance using the ternary alloy. Further work is in progress aimed to fabricate and test electrodes with different phosphorus content to assess the effect of composition on electrochemical and electrocatalytic performance.

ACKNOWLEDGMENTS

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