Università degli Studi di Padova – Dipartimento di Ingegneria Industriale

Corso di Laurea in Ingegneria Chimica e dei Materiali

Relazione per la prova finale

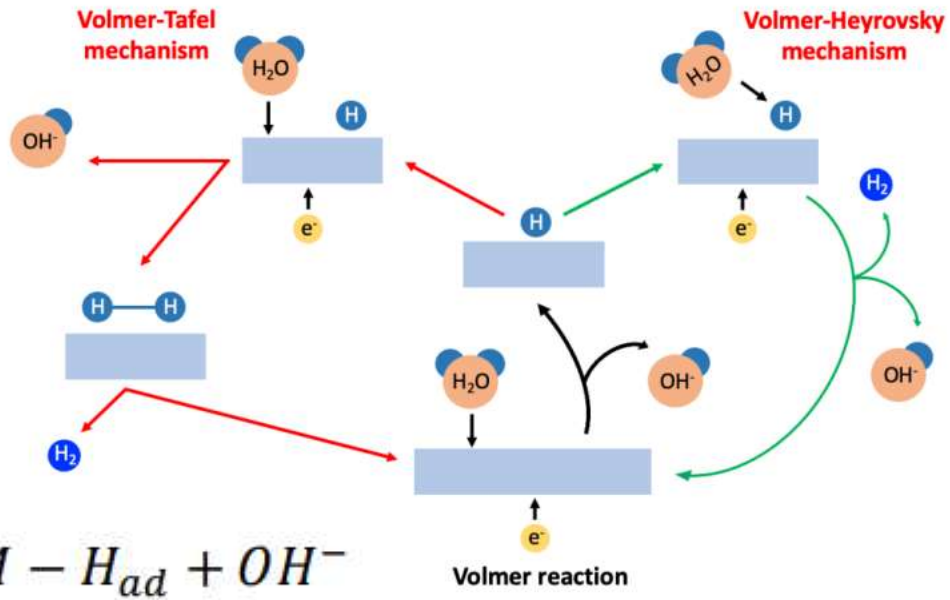
Studio del solfuro di molibdeno supportato su carboni mesoporosi come catalizzatore per evoluzione di idrogeno in ambiente alcalino

Tutor universitario: Prof. Durante Christian

Laureando: Corrocher Niccolo

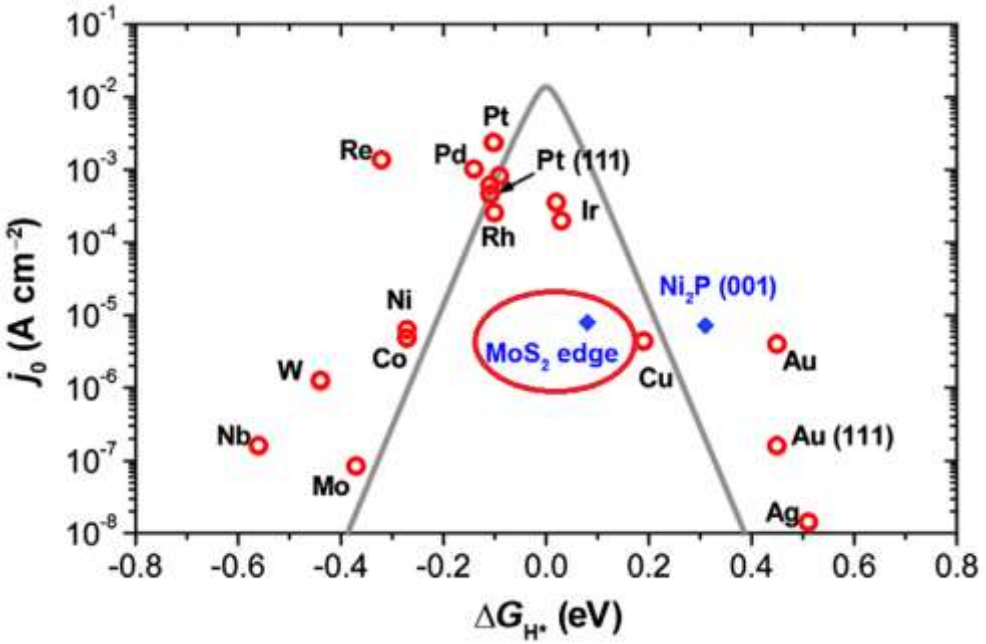
Padova, 22/09/2023

HER meccanismi di reazione

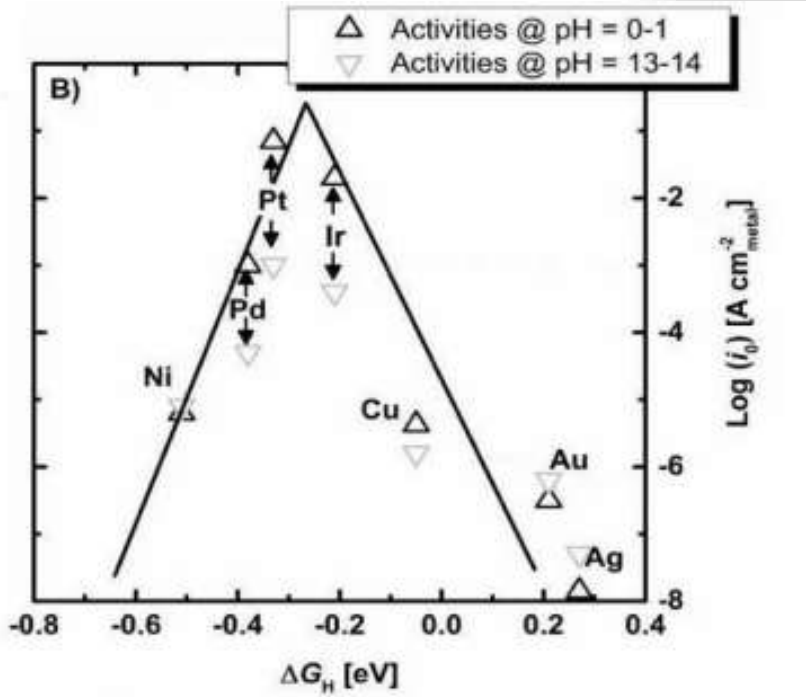


- 1° step: reazione di Volmer $H_2O + M + e^- \rightarrow M - H_{ad} + OH^-$
- 2° step:
  - Reazione di Tafel $2M - H_{ad} \rightarrow H_2 + 2M$
  - Reazione di Heyrovsky $H_2O + M - H_{ad} + e^- \rightarrow H_2 + OH^- + M$

SOLFURO DI MOLIBDENO

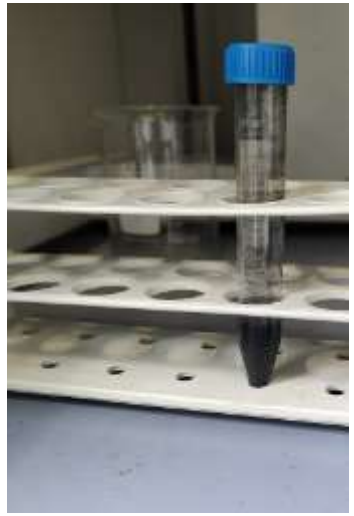


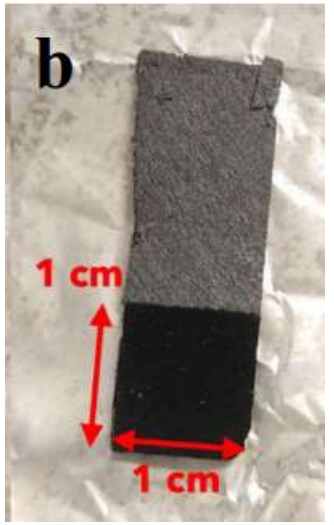
Plot a vulcano per HER in ambiente acido



Confronto attività catalitiche per HER acida e alcalina in plot a vulcano

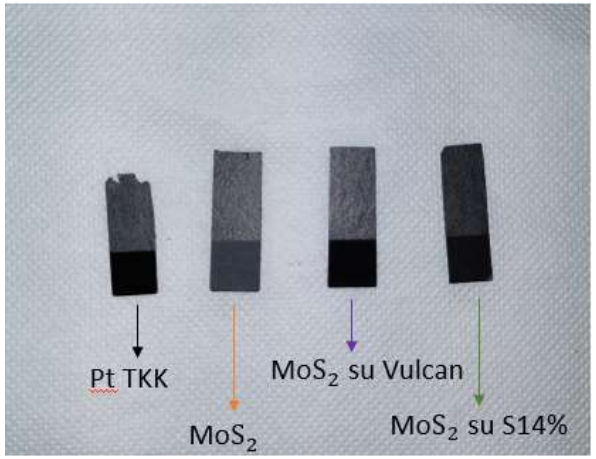
PREPARAZIONE ELETTRODI





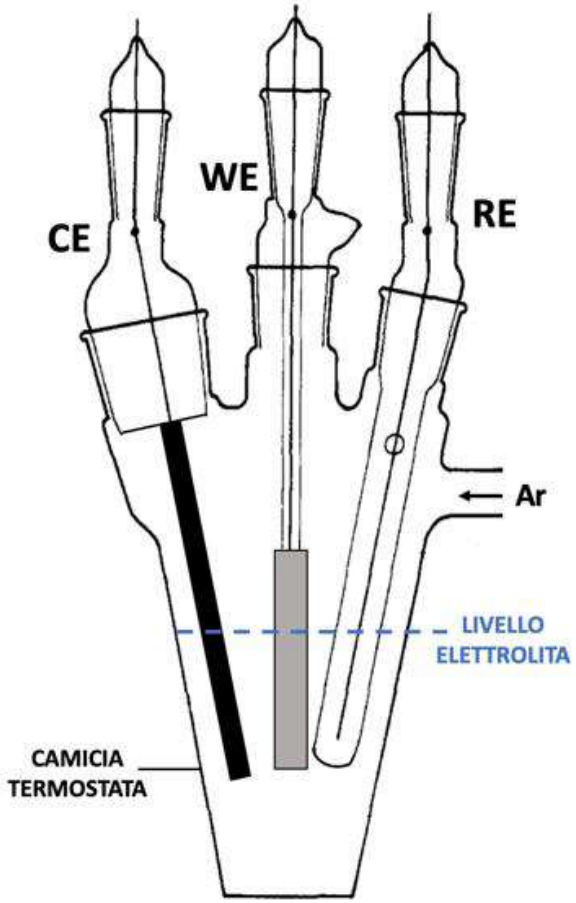
Inchiostro

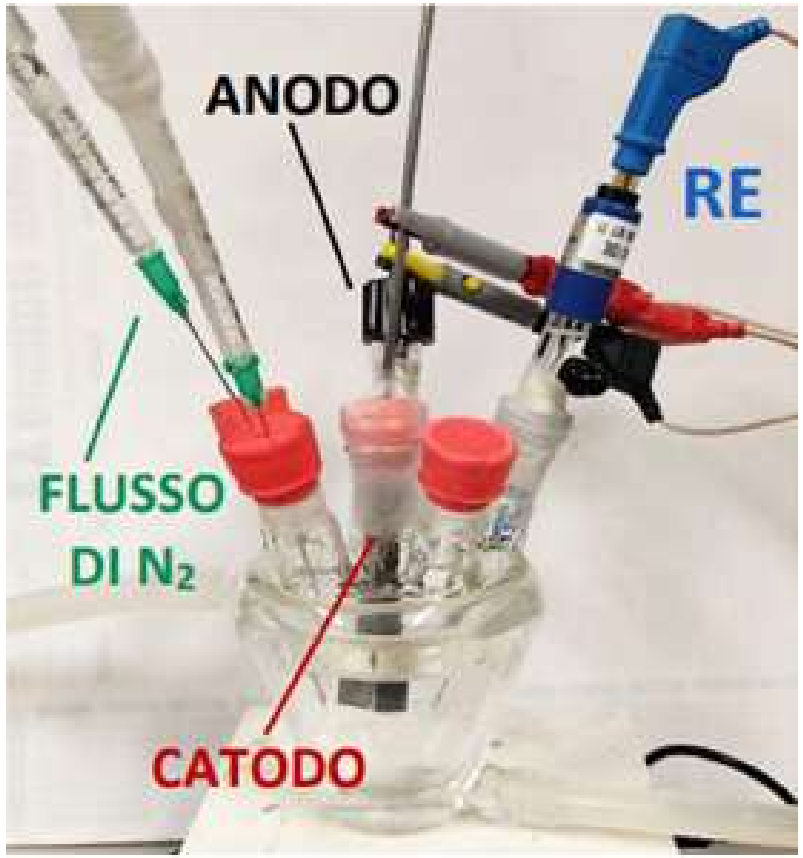
	% in volume
acqua	73%
Polipropilene	26,5%
Nafion	0,5%



0.38 mg/cm^2 per Pt Tanaka
0.44 mg/cm^2 per MoS_2
0.40 mg/cm^2 per MoS_2 su Vulcan XC-72
0.40 mg/cm^2 per MoS_2 su Carbone drogato S14%

SETUP CELLA A TRE ELETTRODI





Catodo	catalizzatore su CP
Anodo	grafite
RE	Hg/HgO
Elettrolita	40 ml 0.1M KOH
Temperatura	20°C

RESA FARADICA CELLA SIGILLATA

Pt TKK

Misure galvanostatiche a i =10mA

$$\eta_{\%} = \frac{Q}{Q_{cell}} \cdot 100$$

Legge di Faraday

$$Q = moli_{H_2} \cdot F \cdot n = \frac{V_{\%} \cdot V_{vuoto} \cdot 10^{-6} \cdot p_{atm}}{RT} \cdot F \cdot n$$

$$Q_{cell} = i \cdot t$$

n° prelievo	Time / s	Q / C	Q_{th} / C	$\eta_{\%}$ / a. u.
1	1800	11.4	18	63
2	3720	19.6	37.2	53
3	5640	26.0	56.4	46
4	7560	30.6	75.6	40
5	9420	34.4	94.2	36
6	10800	35.5	108	33

RESA FARADICA CELLA IN CONTINUO

Pt TKK

Misure galvanostatiche a i =10mA

$$\eta_{\%f} = \frac{I}{I_{cell}} \cdot 100$$

Legge di Faraday

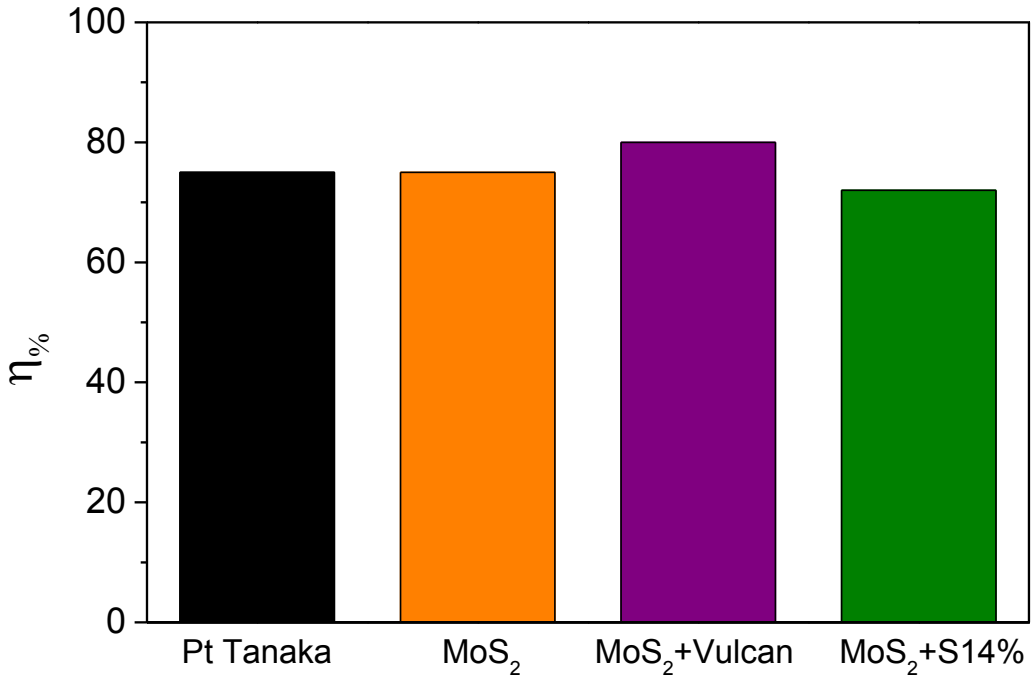
$$I = \frac{moli_{H_2}}{s} \cdot F \cdot n = \frac{\Phi \cdot V_{\%} \cdot 10^{-3} \cdot P_{atm}}{60 \cdot R \cdot T} \cdot F \cdot n$$

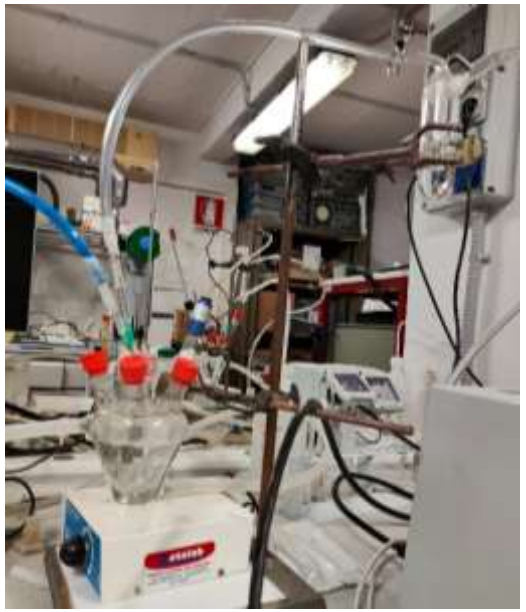
$$I_{cell} = i$$

Φ [SCCM]	$V_{\%}$	I [mC·S^{-1}]	$\eta_{\%f}$
50	0.11	7.3	73
30	0.19	7.5	75
15	0.36	7.2	72

CONFRONTO RESE FARADICHE

Misure galvanostatiche a $i = 10\text{mA}$

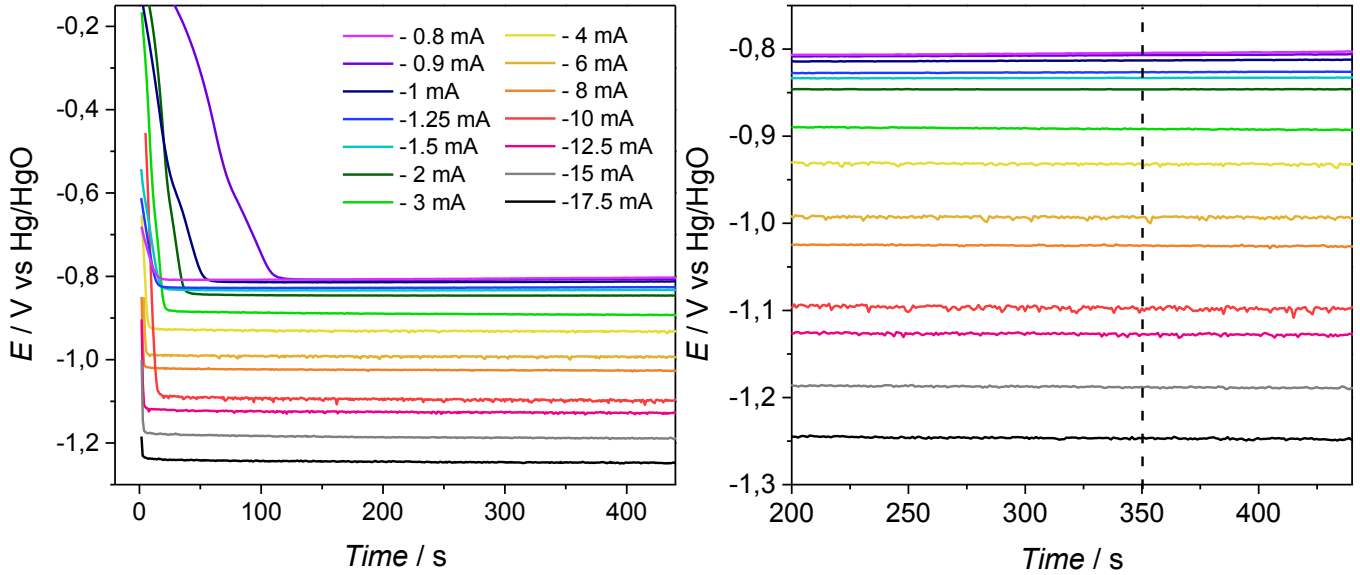


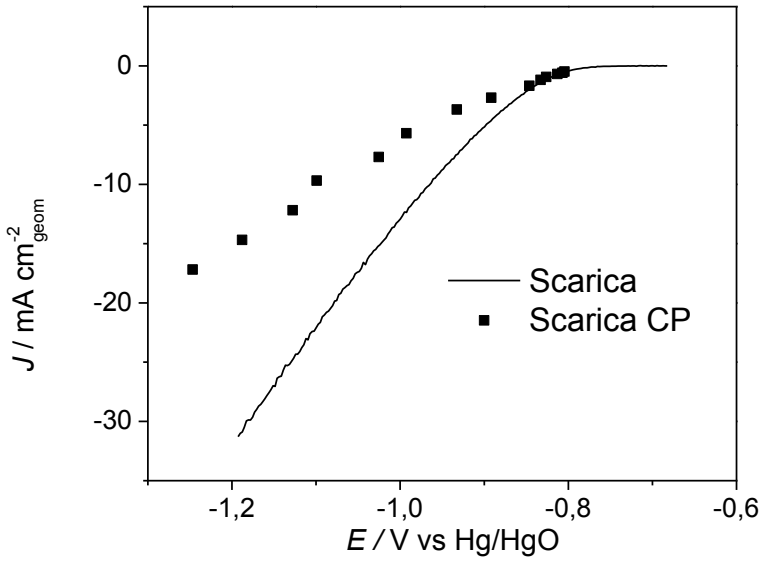


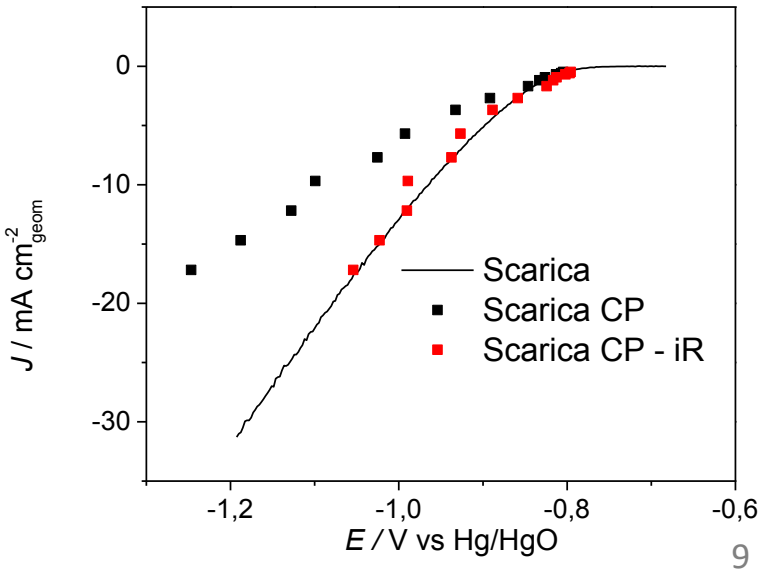
	Φ [SCCM]	I [mC s^{-1}]	$\eta_{\%}$
Pt Tanaka	30	7.5	75
MoS_2	30	7.5	75
MoS_2 su Vulcan	30	8.0	80
MoS_2 su S14%	30	7.2	72

CRONOPOTENZIOMETRIE E COSTRUZIONE CURVA DI SCARICA PER PUNTI

Pt TKK



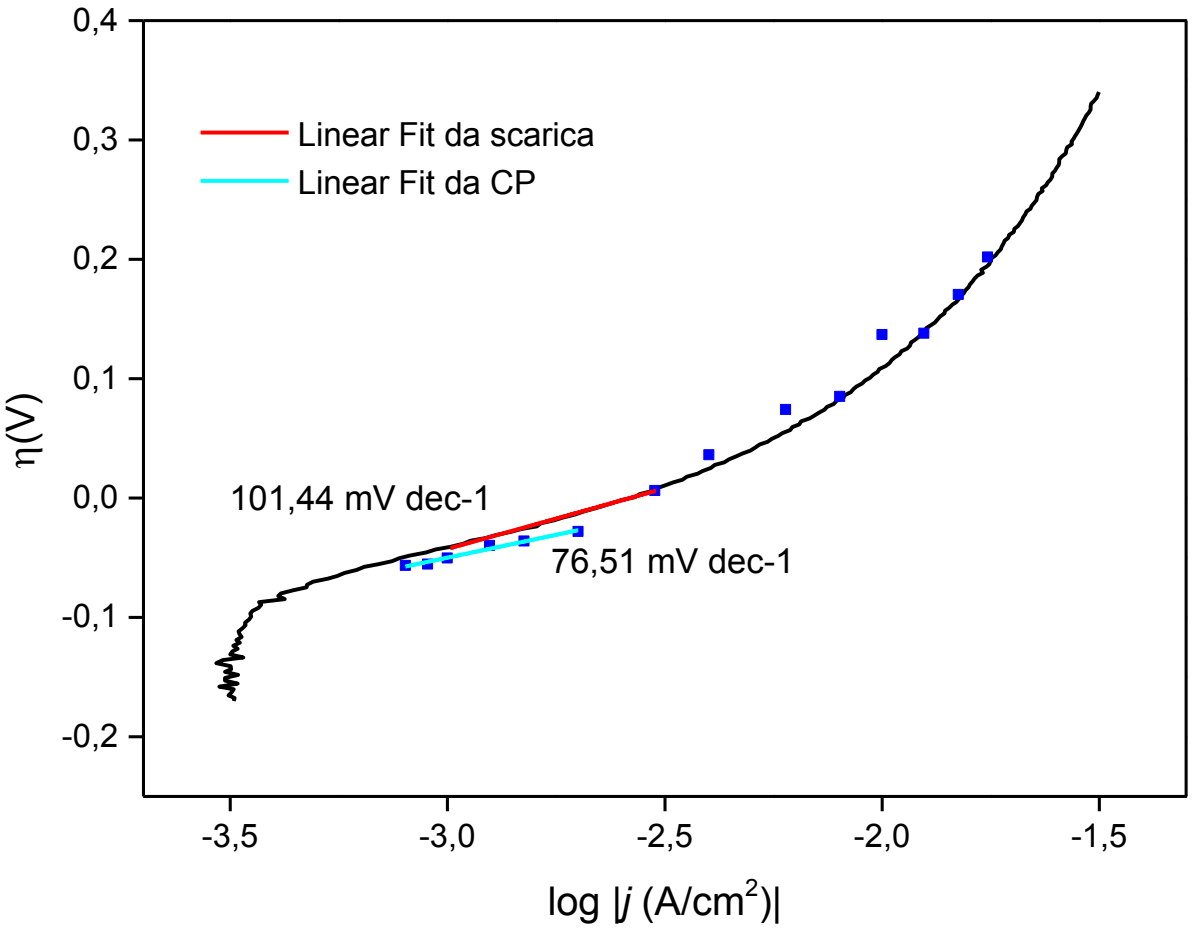




PENDENZA DI TAFEL

$$\eta = \left(\frac{RT}{\alpha n F}\right) \ln\left(\frac{j}{j_o}\right) = b \log\left(\frac{j}{j_o}\right)$$

Pt TKK

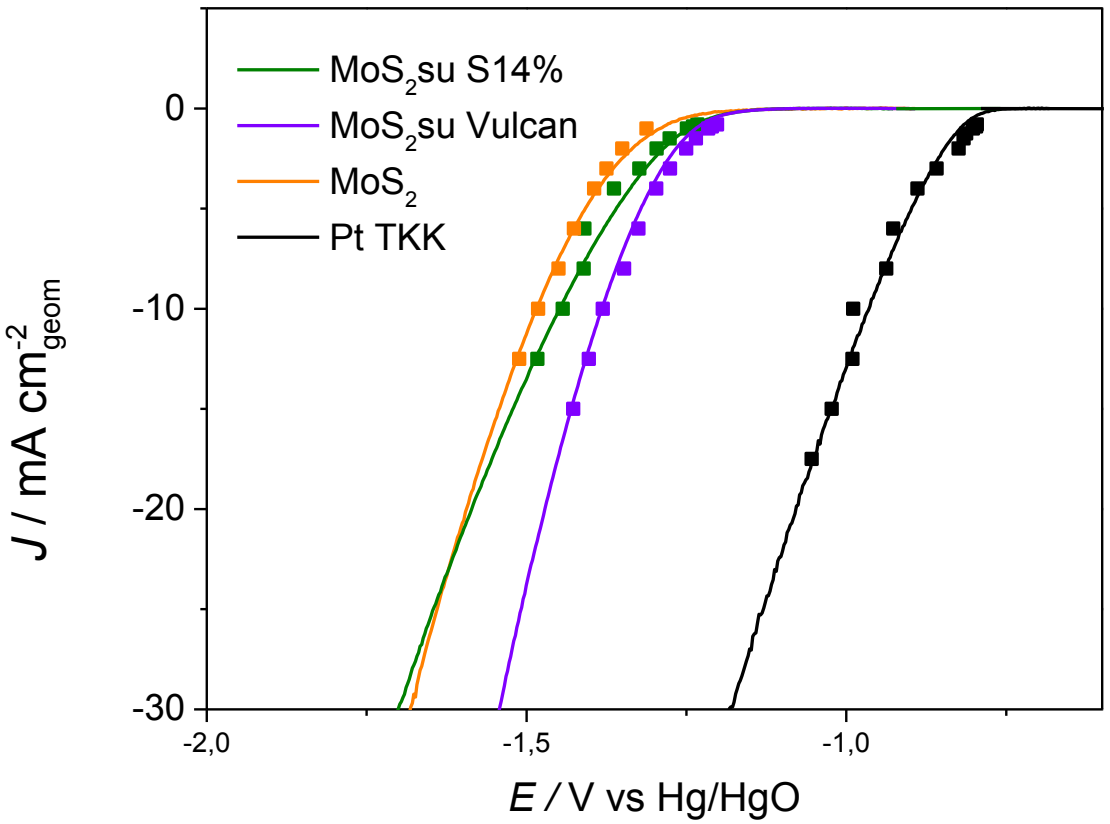


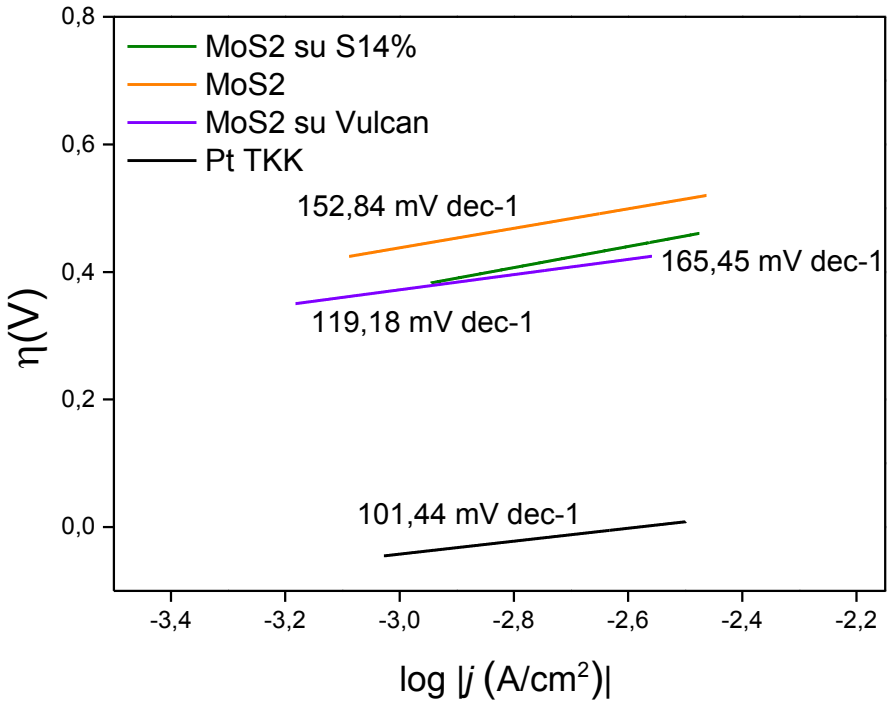
HER step *(r.d.s)*	***Tafel Slop*** / mV dec^{-1}
Volmer: $H_2O + e^- \rightarrow H^* + OH$	120
Heyrovsky: $H_2O + e^- + H^* \rightarrow H_2 + OH$	40
Tafel: $H^* + H^* \rightarrow H_2$	30

$$b_{scarica} = 101{,}44 mV\ \text{dec}^{-1}$$

$$b_{cp} = 76{,}51 mV\ dec^{-1}$$

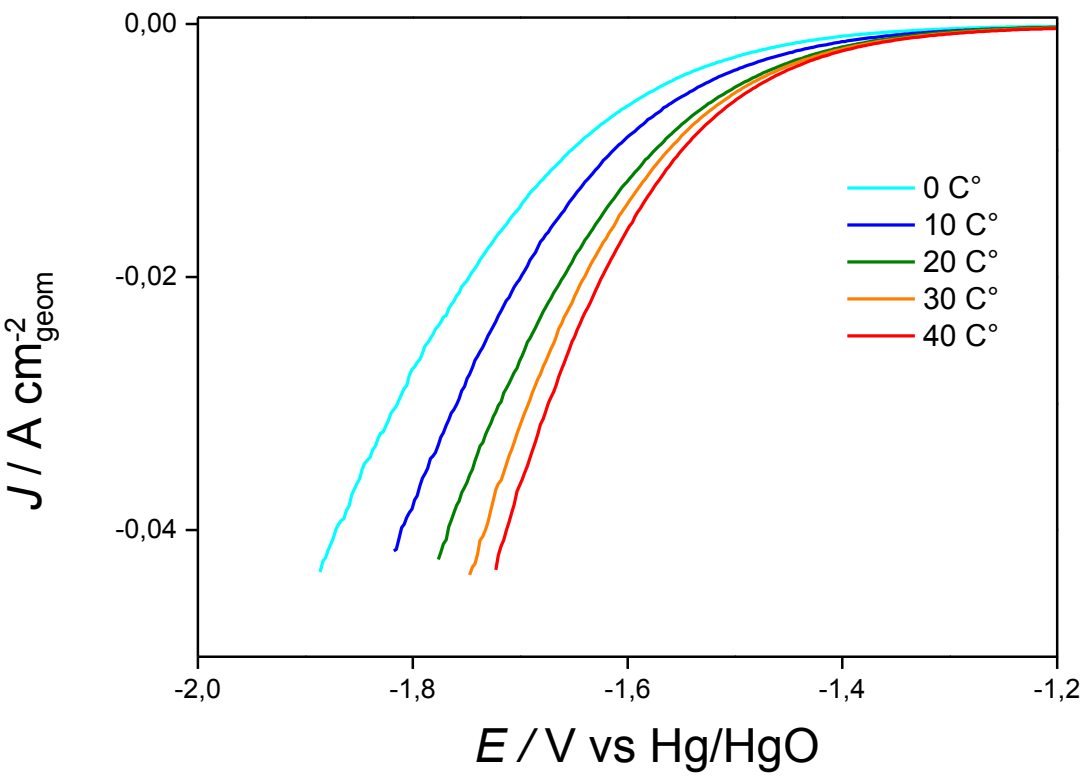
CONFRONTO ALTRI ELETTRODI



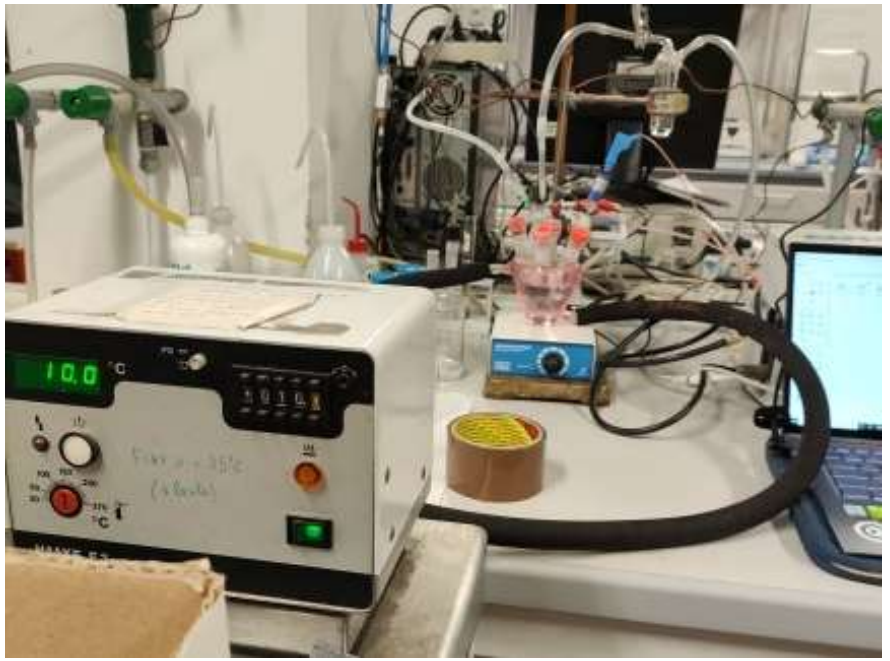


	b_{CV}[mV dec^{-1}]	b_{CP}[mV dec^{-1}]
Pt Tanaka	101	77
MoS_2	153	130
MoS_2 su Vulcan	119	114
MoS_2 su S14%	165	161

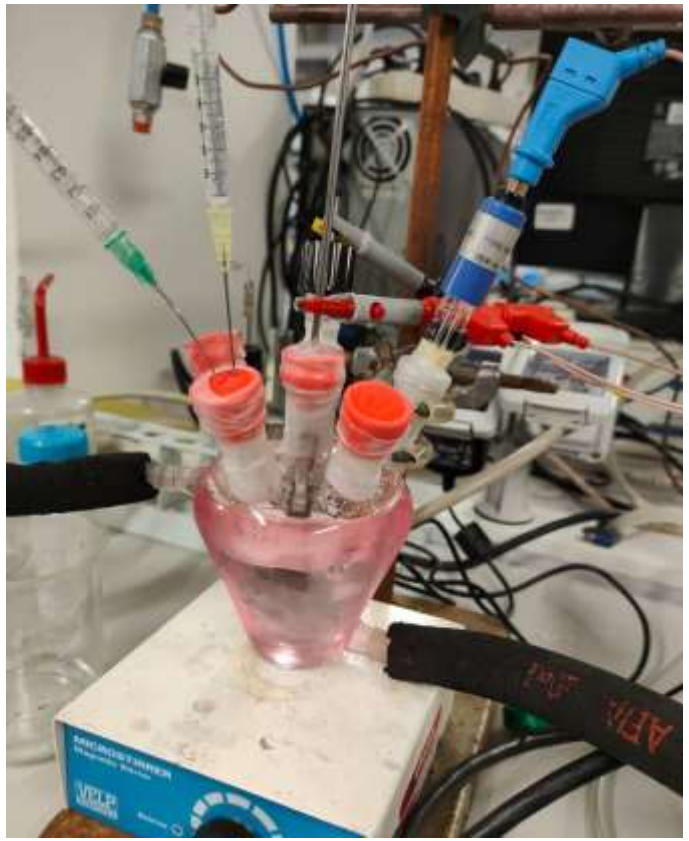
MISURE DI SCARICA A DIVERSE T



Mo S_2 su S 14%
Loading: 0,38 mg cm^{-2}



EFFICIENZA FARADICA A DIVERSE CORRENTI



Mo S_2 su S 14%
Loading: 0,38 mg cm^{-2}

I [mA]	Φ [SCCM]	$\eta_{\%}$
1	30	21
3	30	69
5	30	75
7	30	75
10	30	81