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DE LA RECHERCHE À L'INDUSTRIE



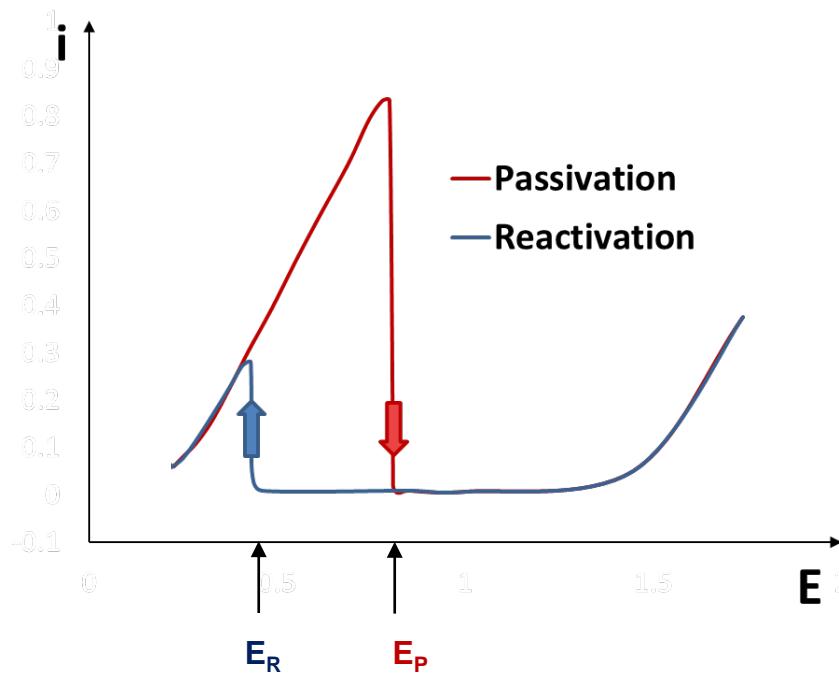
ACTIVE DISSOLUTION OF A SILICON-RICH AUSTENITIC STAINLESS STEEL IN NITRIC ACIDIC INVESTIGATED THROUGH ATOMIC EMISSION SPECTROELECTROCHEMISTRY

B. Laurent
K. Ogle (*Ecole Nationale Supérieure de Chimie Paris*)
N. Gruet, B. Gwinner (*CEA Saclay*)
F. Miserque, M. Tabarant (*CEA Saclay*)

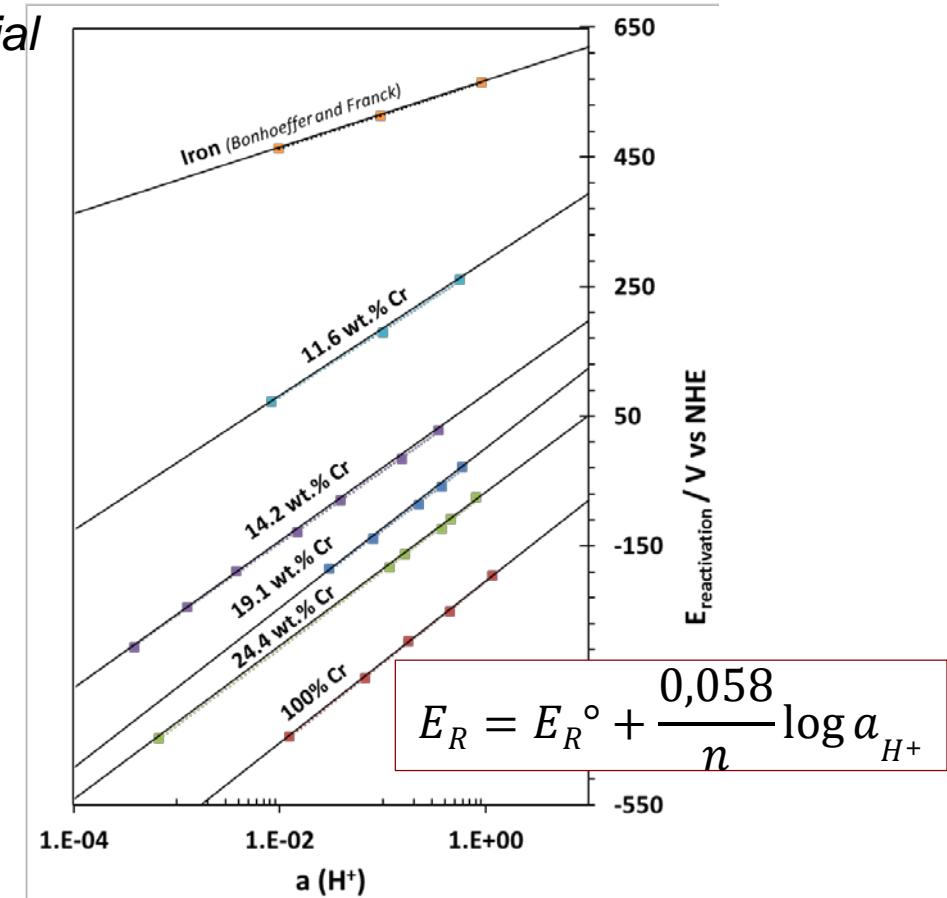
EUROCORR2016 | Montpellier (France)

11-15 SEPTEMBER 2016

In situ characterization of a passive film... ...using the reactivation potential



E_R and E_P of pure iron in **sulfuric acid**¹

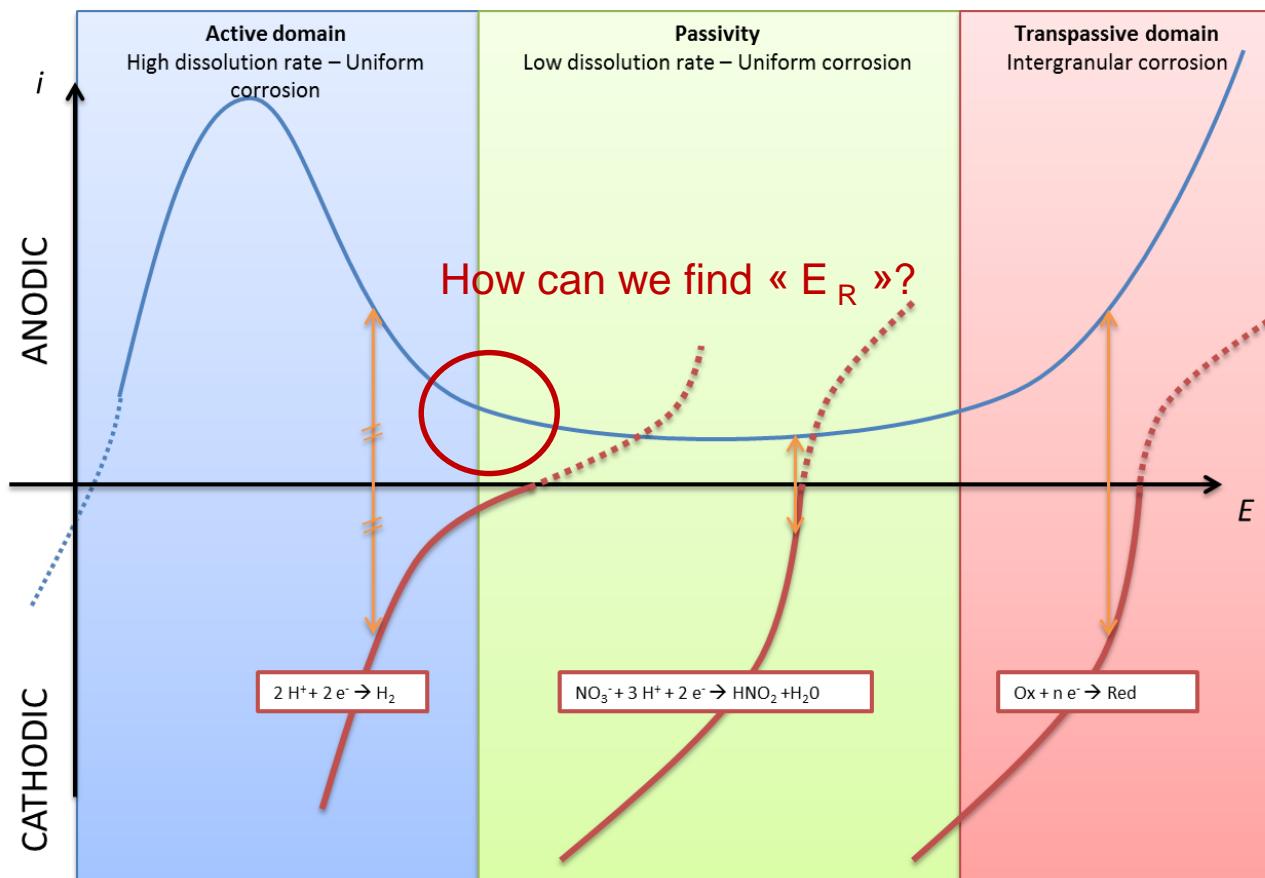


Reactivation potential E_R of various Cr-Fe alloys in **sulfuric acid**²

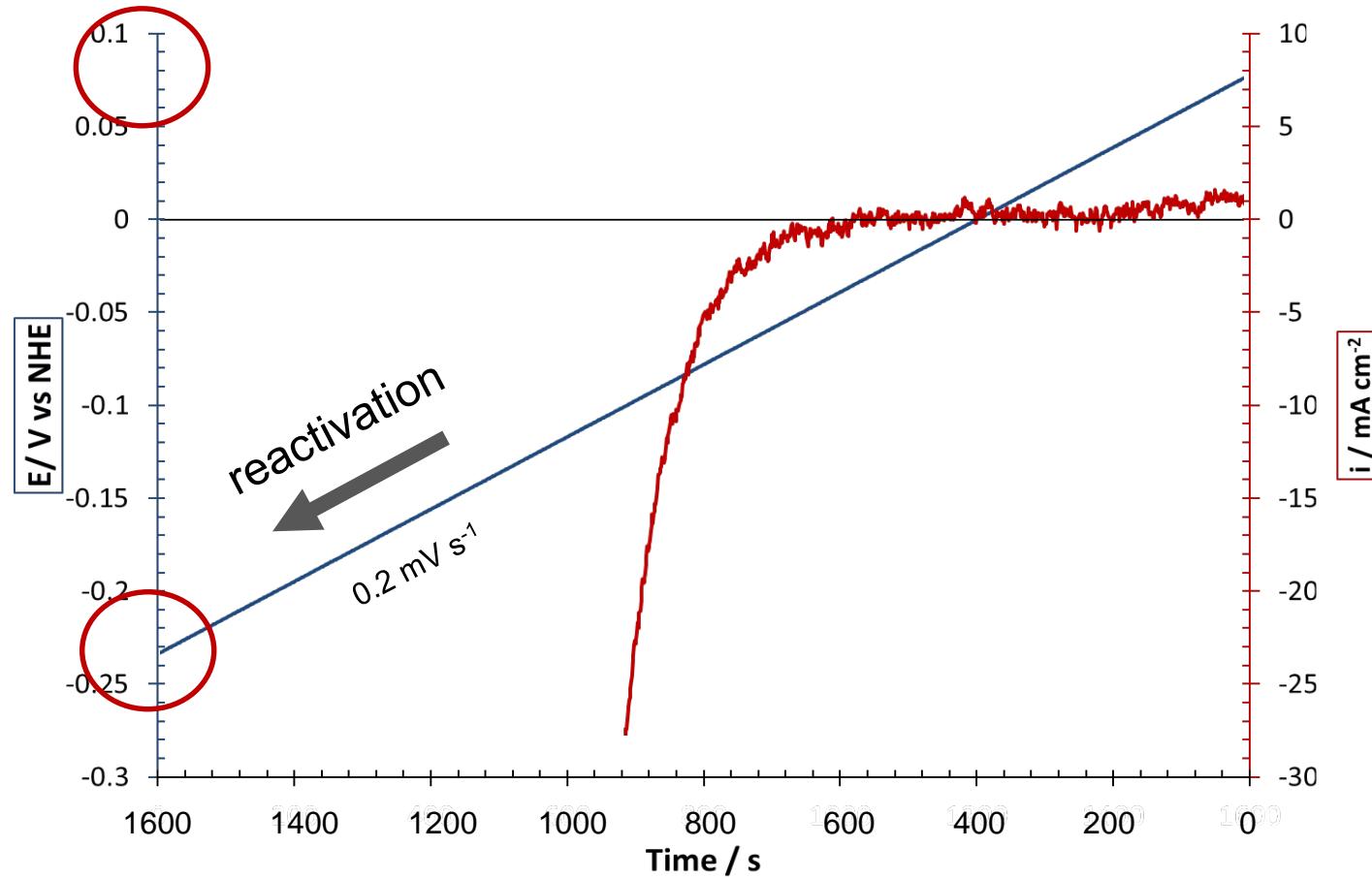
¹ (Reproduction) Lorbeer, P. and W. J. Lorenz (1981) *Corrosion Science* **21**(1): 79-86.

² (Reproduction) Rocha H-J. and Lennartz G. (1955). *Archiv für den Eisenhüttenwesen* **117**(933).

... of an austenitic stainless steel, directly in nitric acid

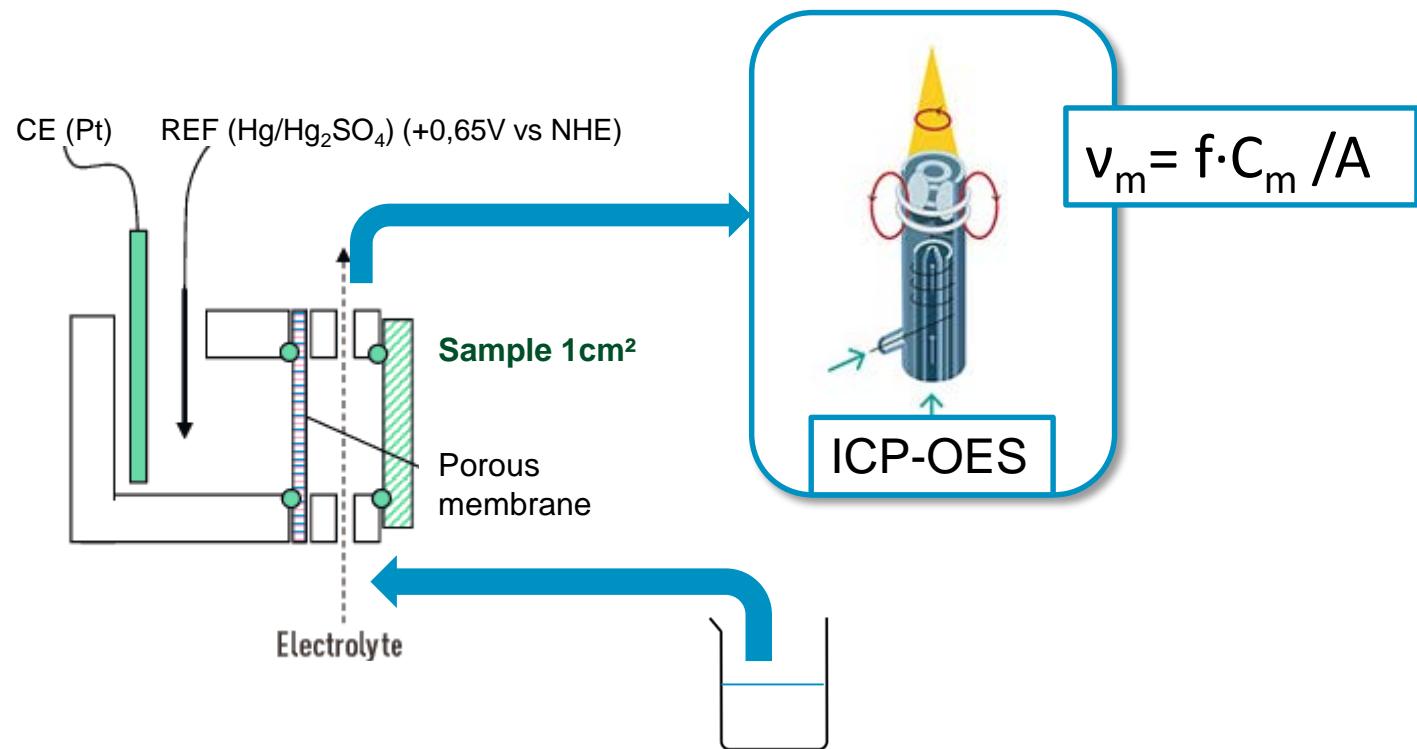


METHOD

Silicon-rich stainless steel – HNO_3 4M – 28°C

Atomic Emission Spectro Electrochemistry

Active dissolution beneath cathodic RR



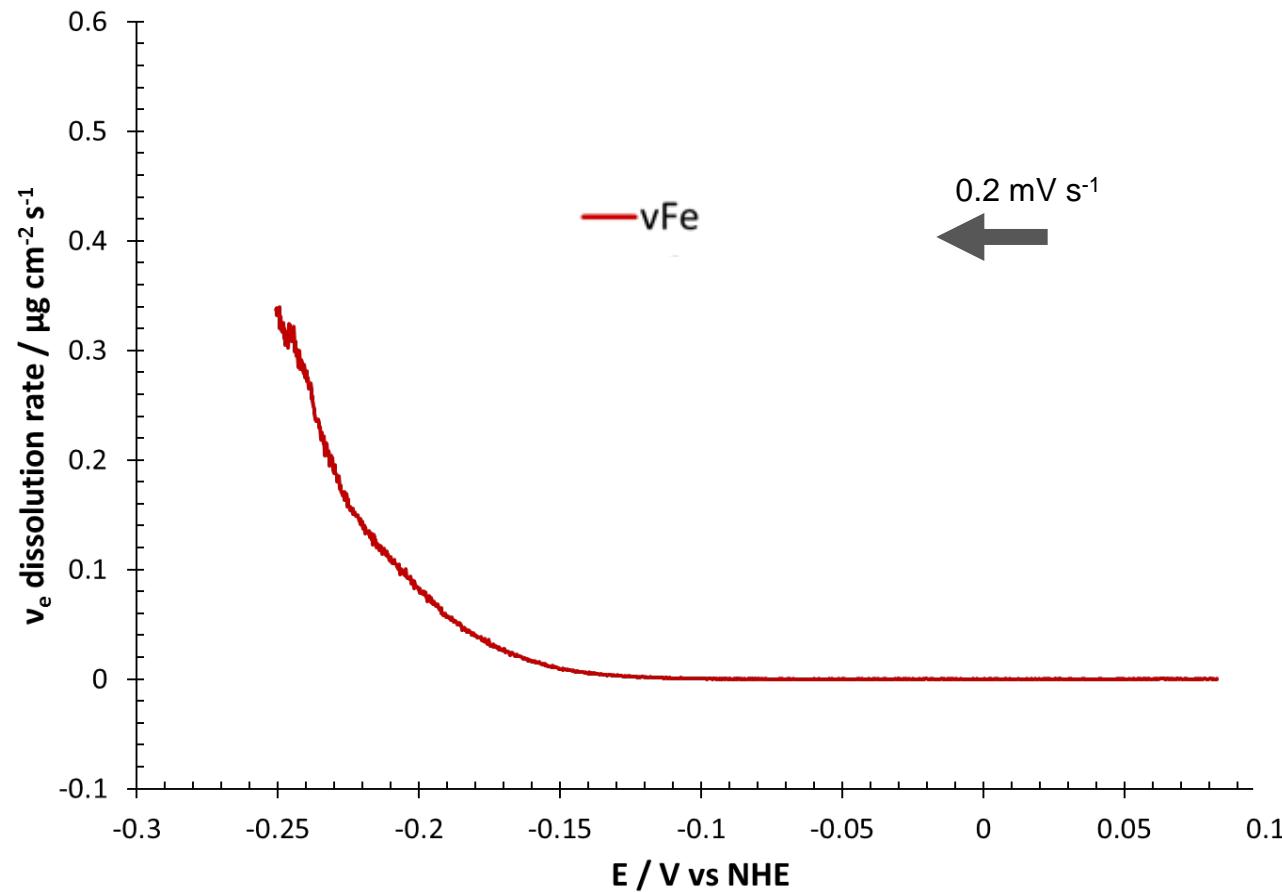
f : flow rate (2,8mL/min)

C_m : concentration

v_m : dissolution rate

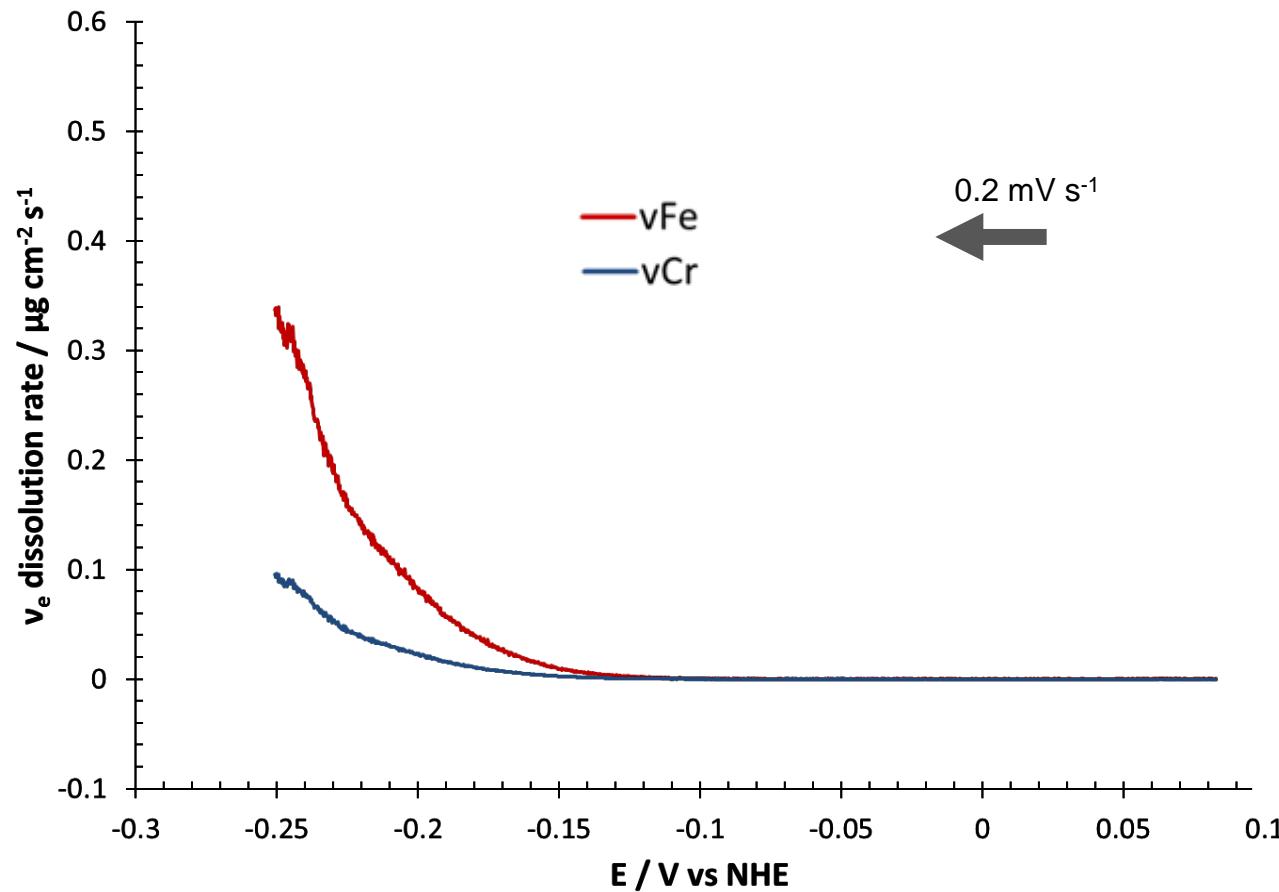
A : sample's area (1cm^2)

REACTIVATION OF THE STEEL

Silicon-rich stainless steel – HNO_3 4M – 28°C

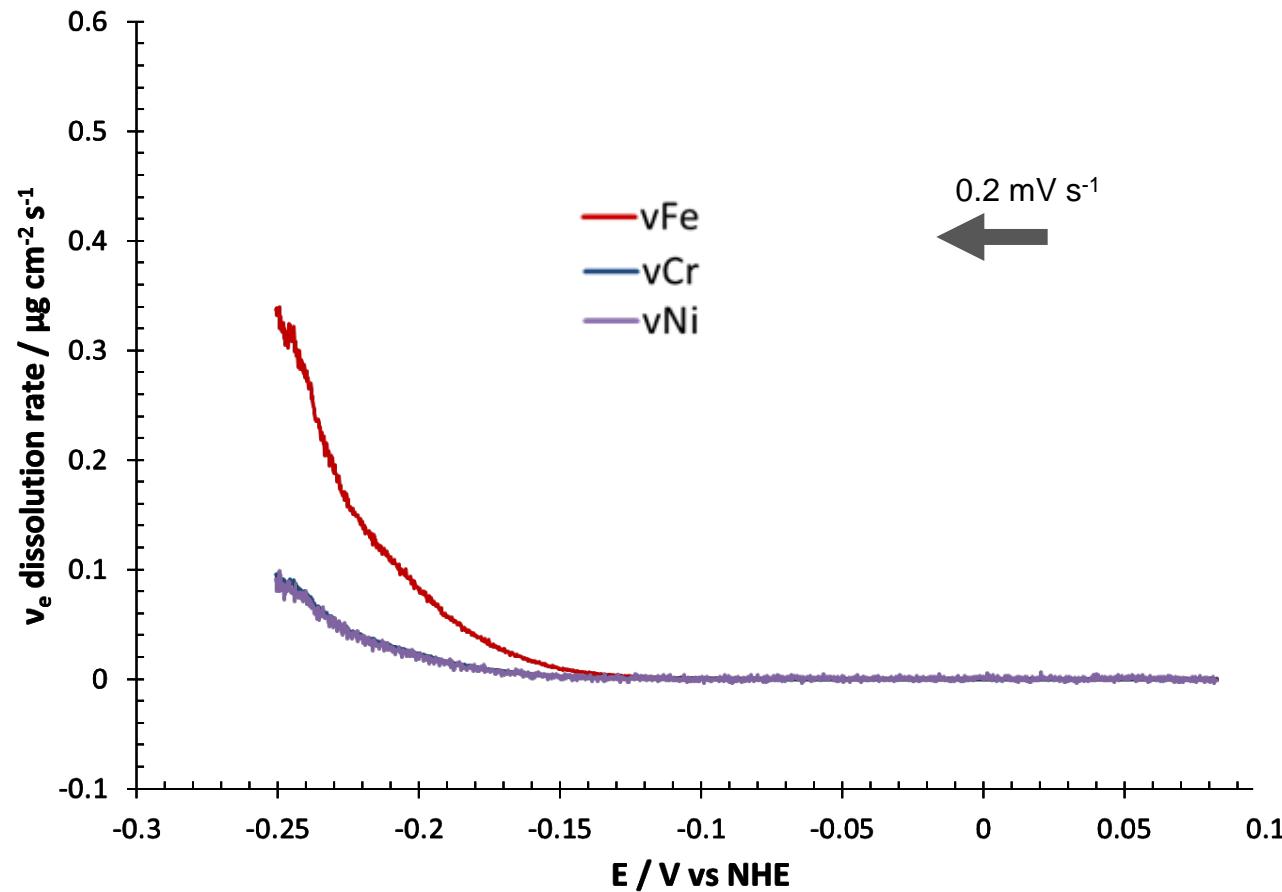
Si-rich SS	Fe	Cr	Ni	Si	C	Mn
%m ¹	59.76	18.79	15.08	3.54	0.029	1.97

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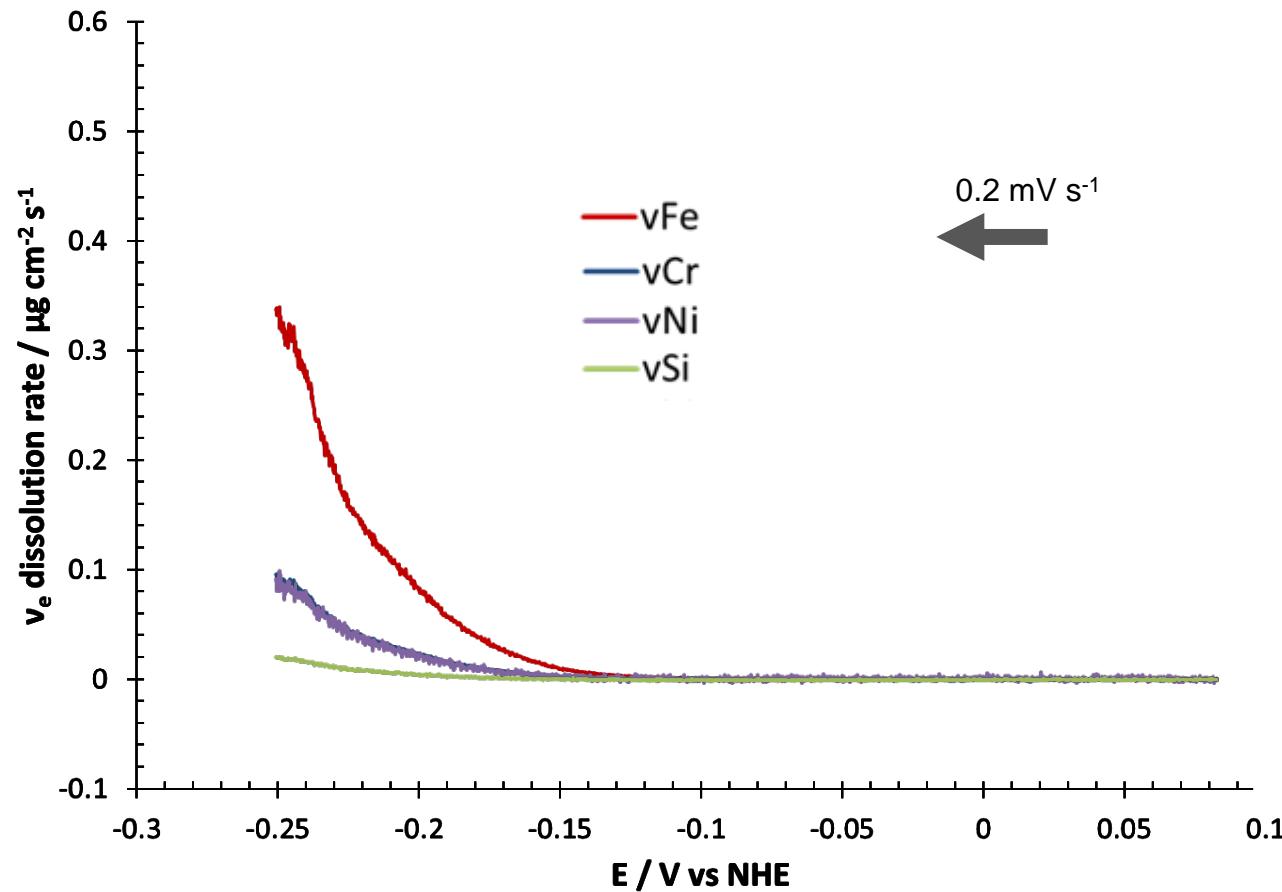
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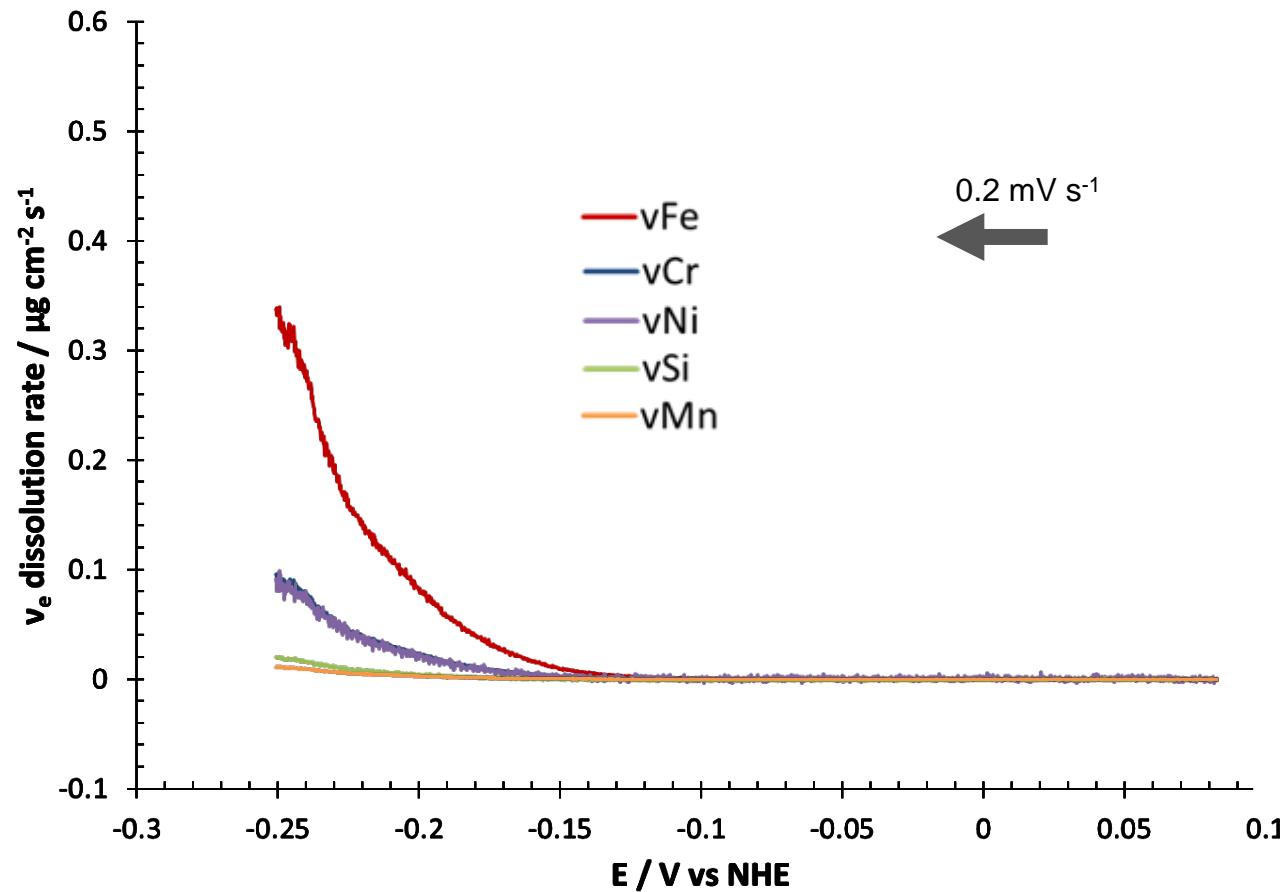
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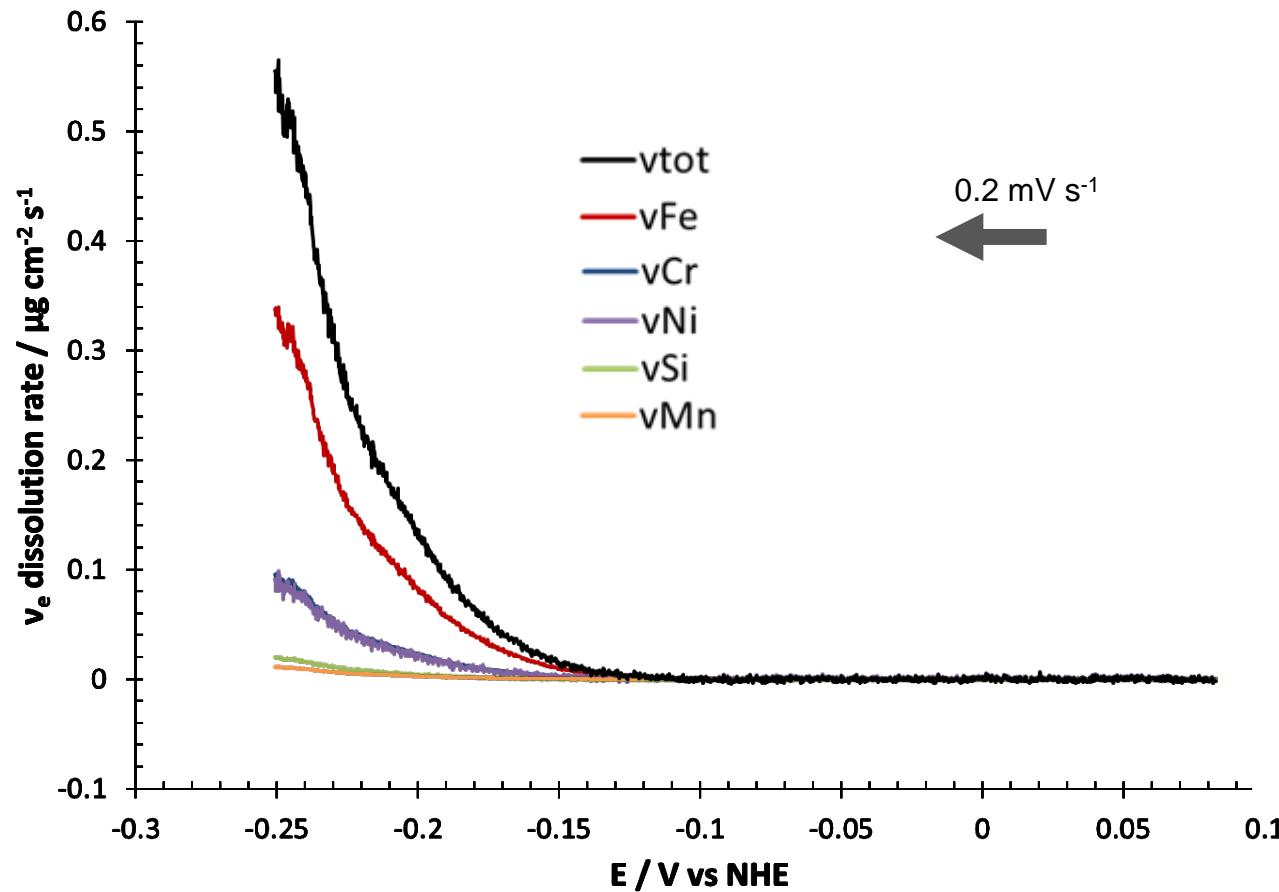
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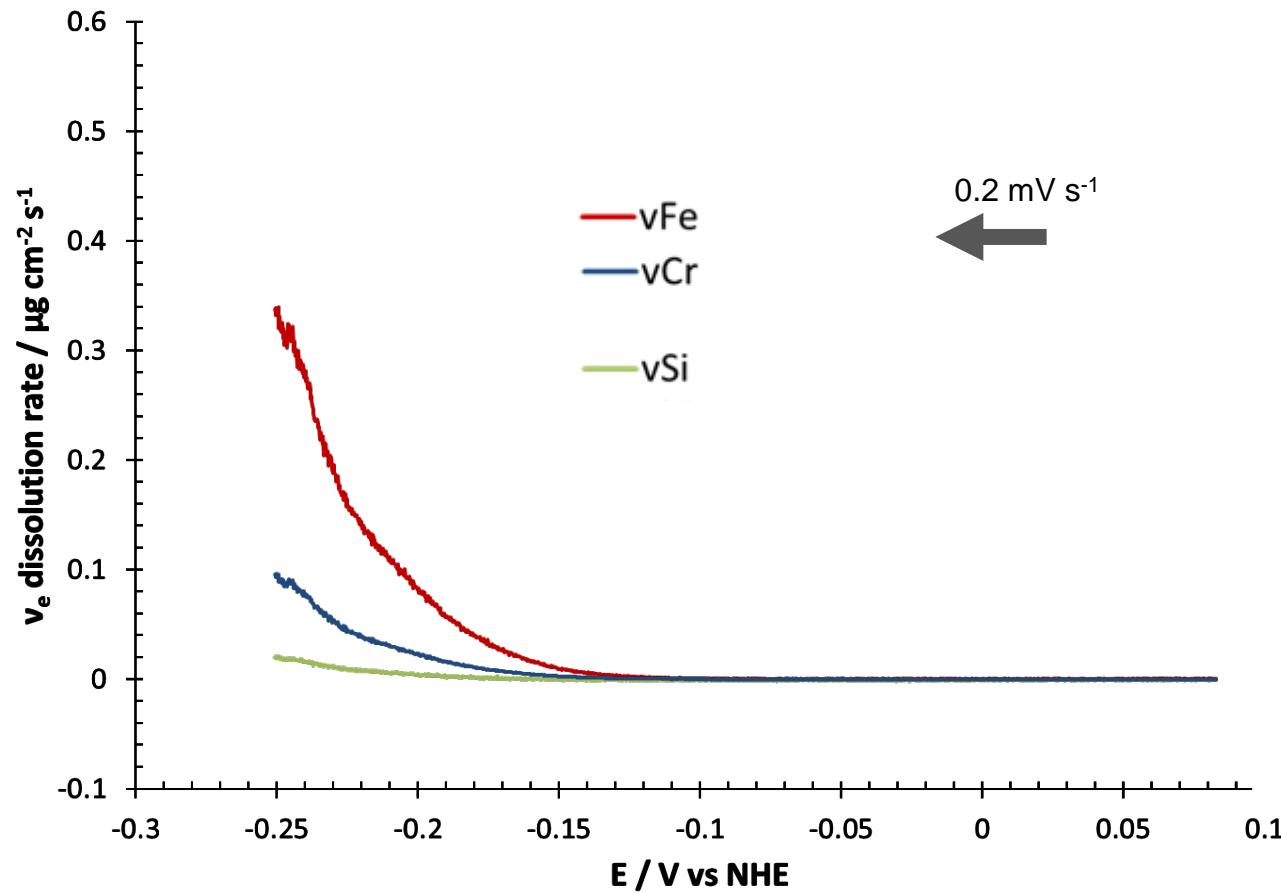
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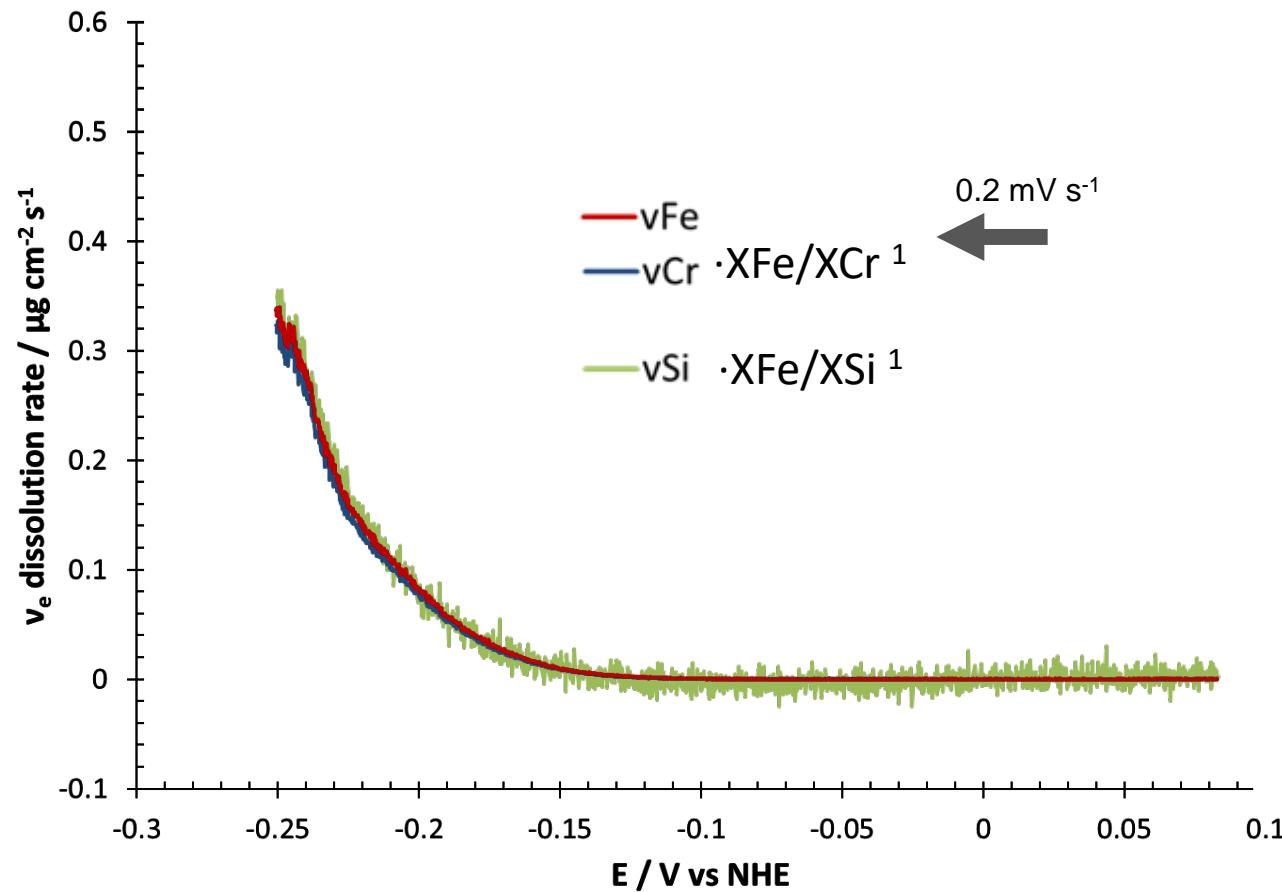
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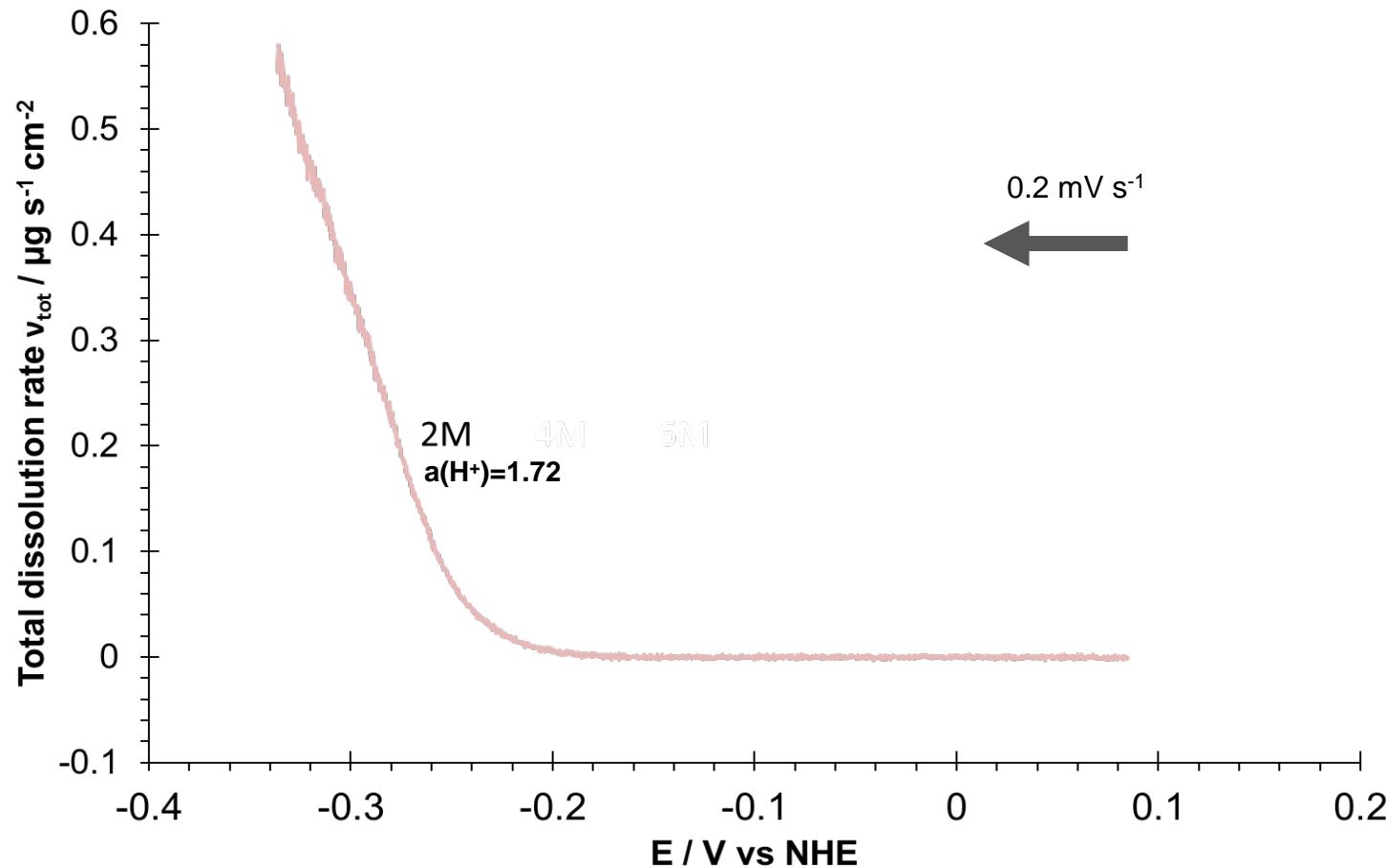
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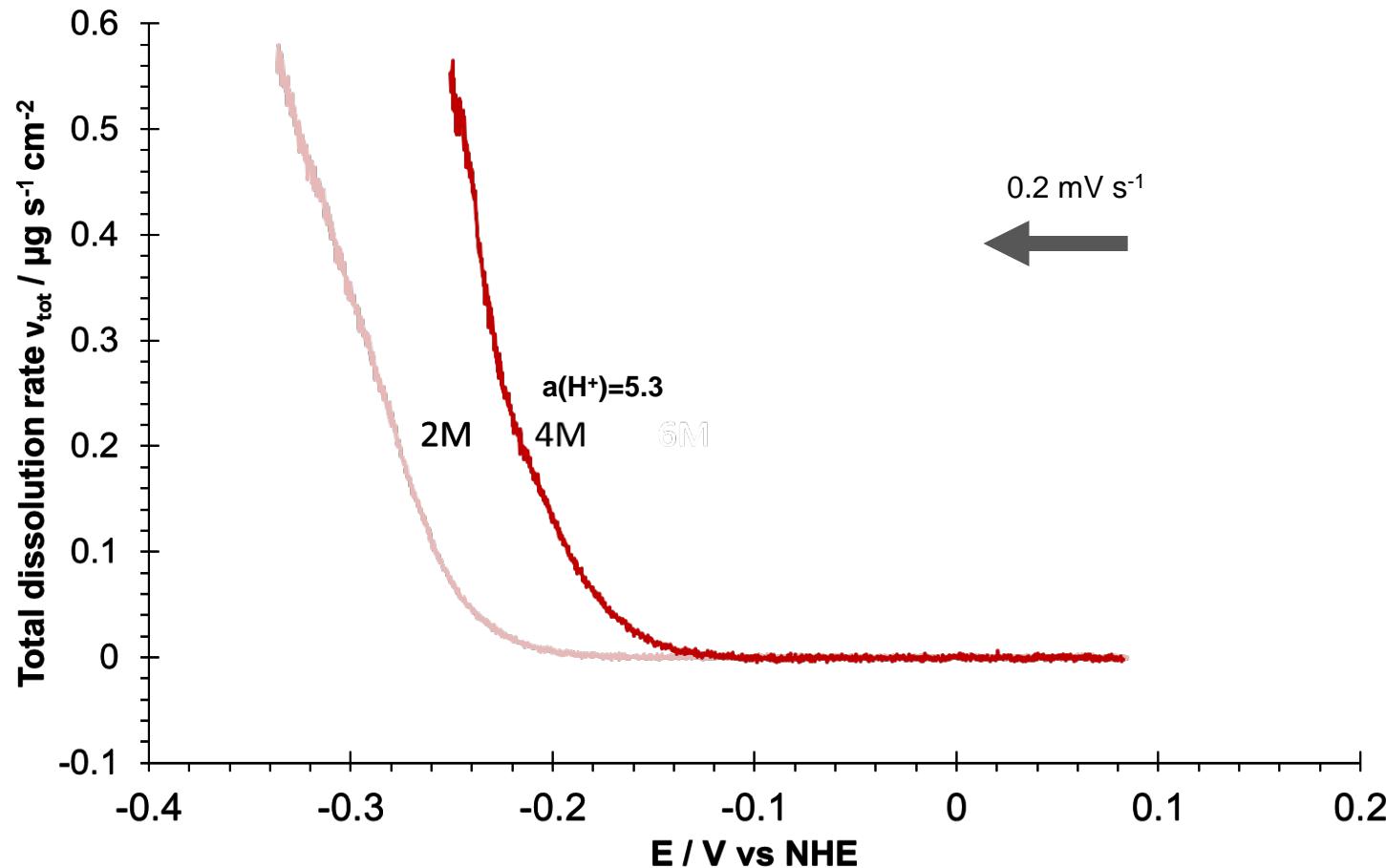
HOW DOES E_R VARY WITH $[HNO_3]$?

Silicon-rich stainless steel – HNO_3 – 28°C



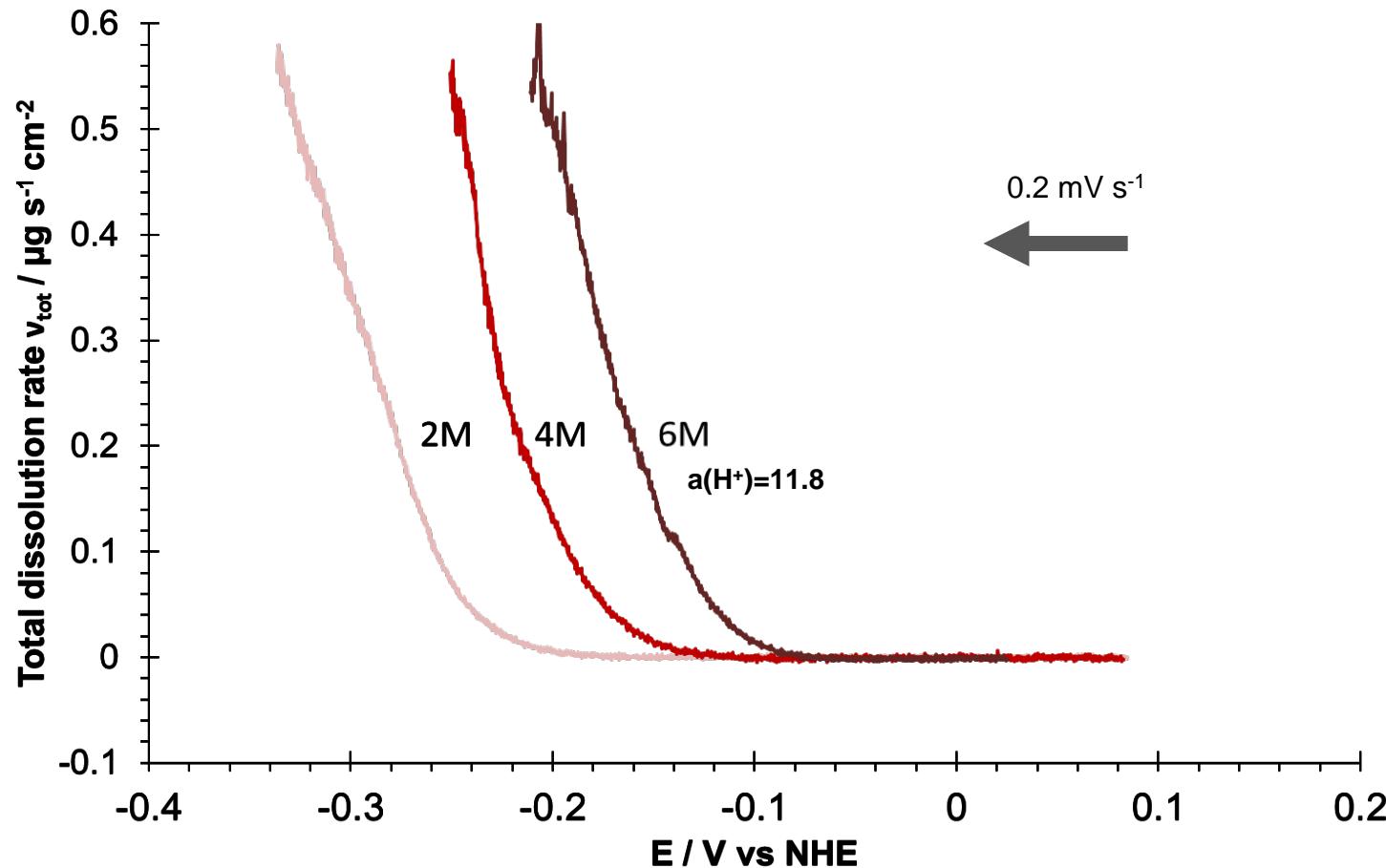
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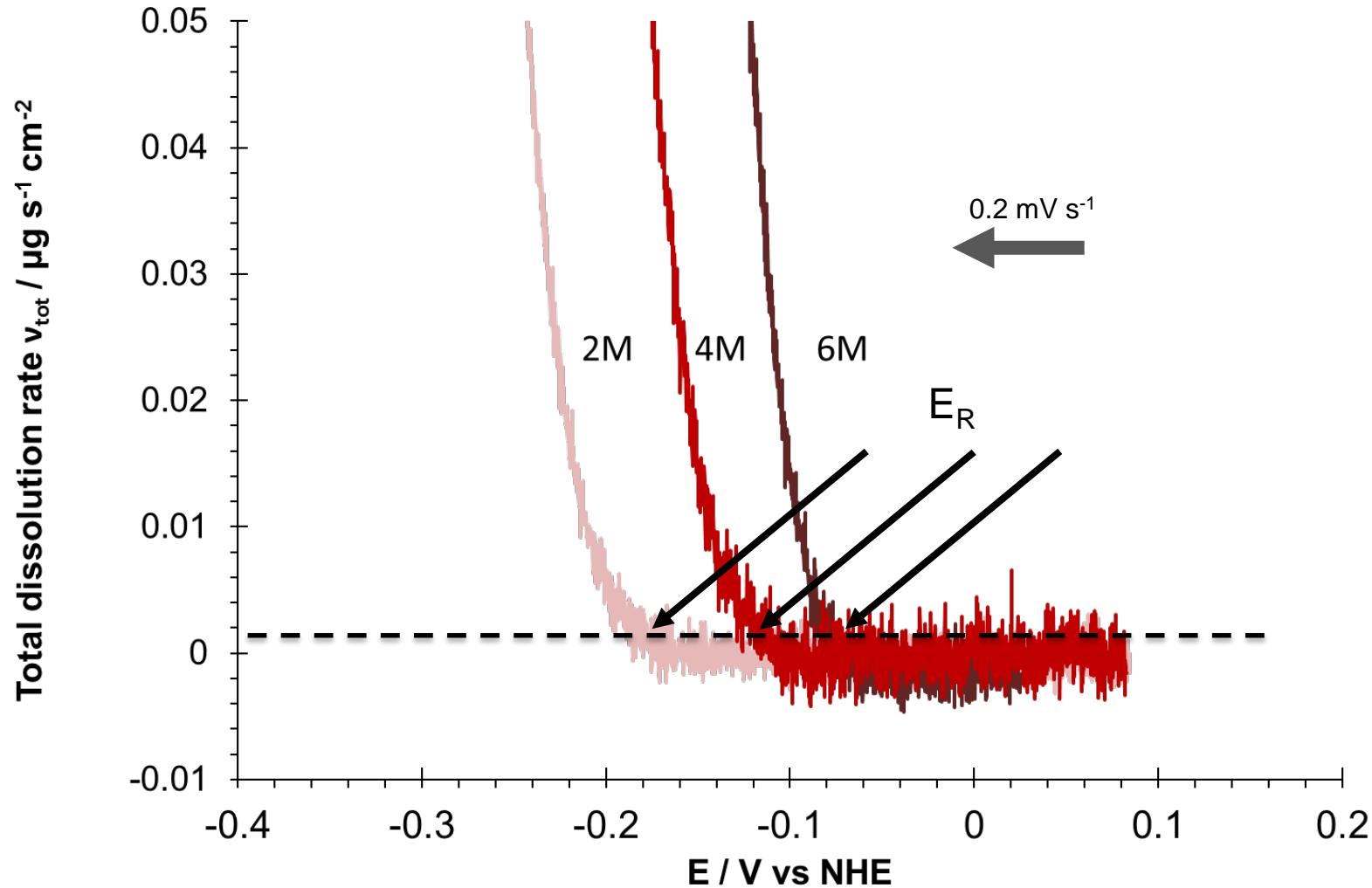
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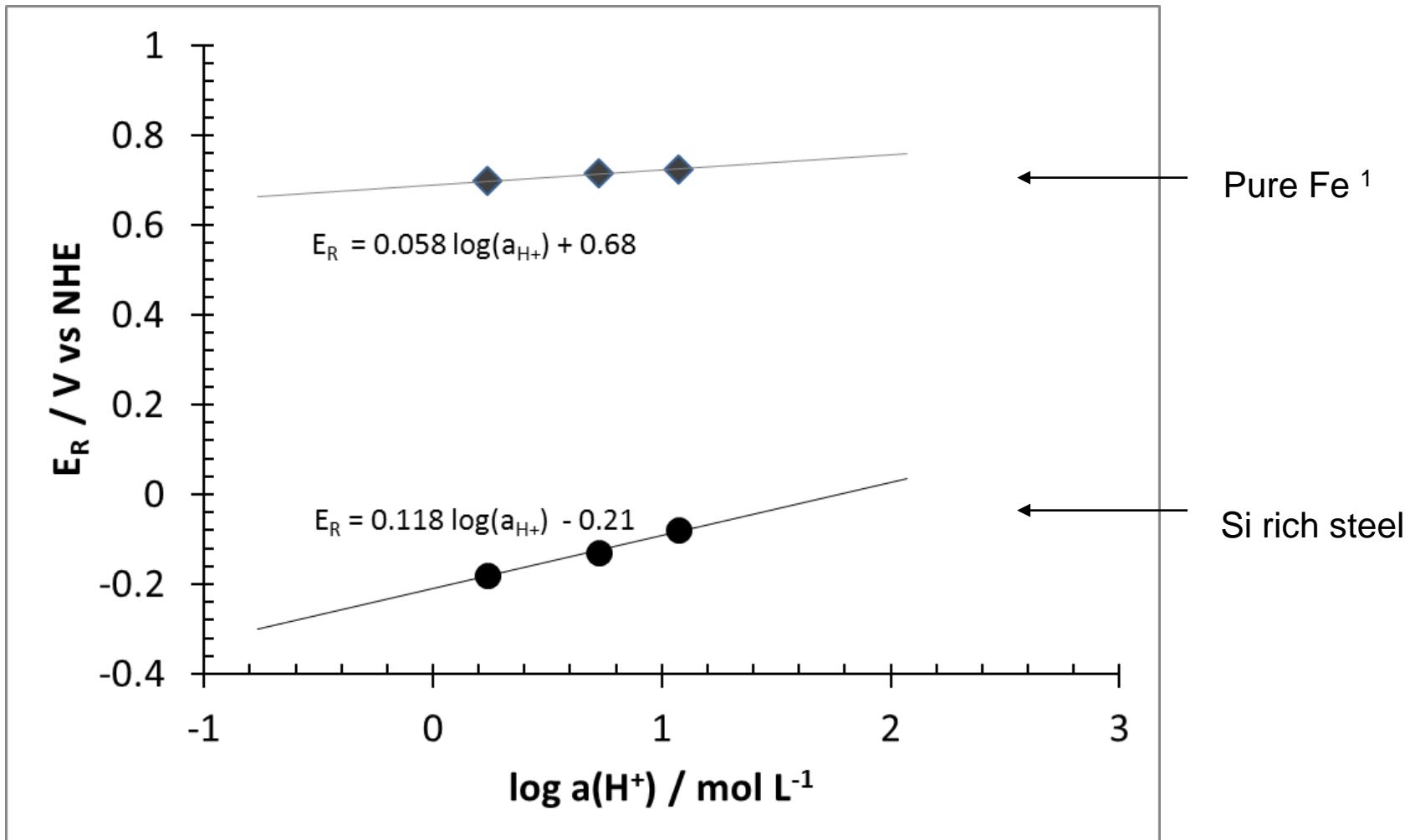
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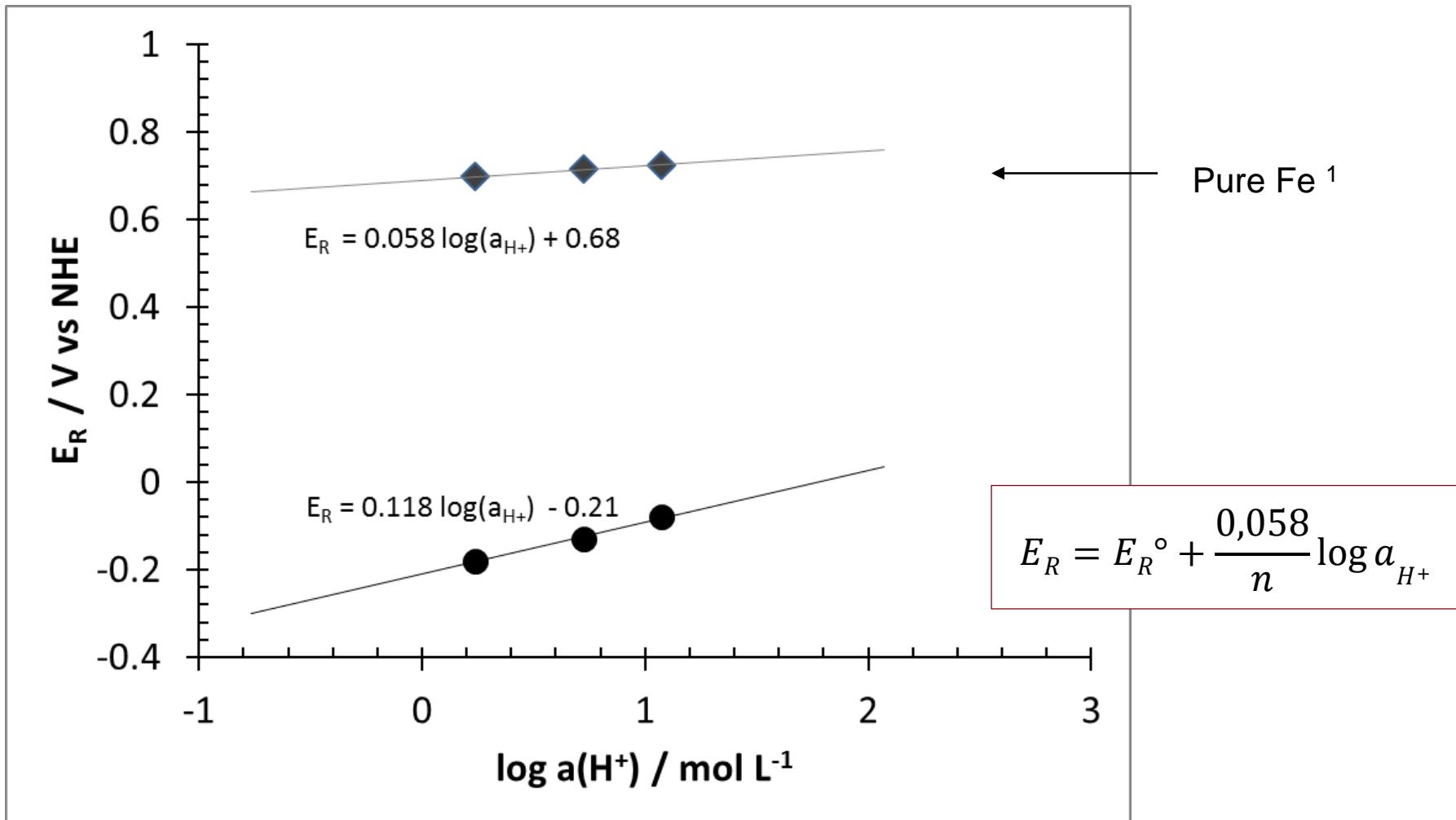


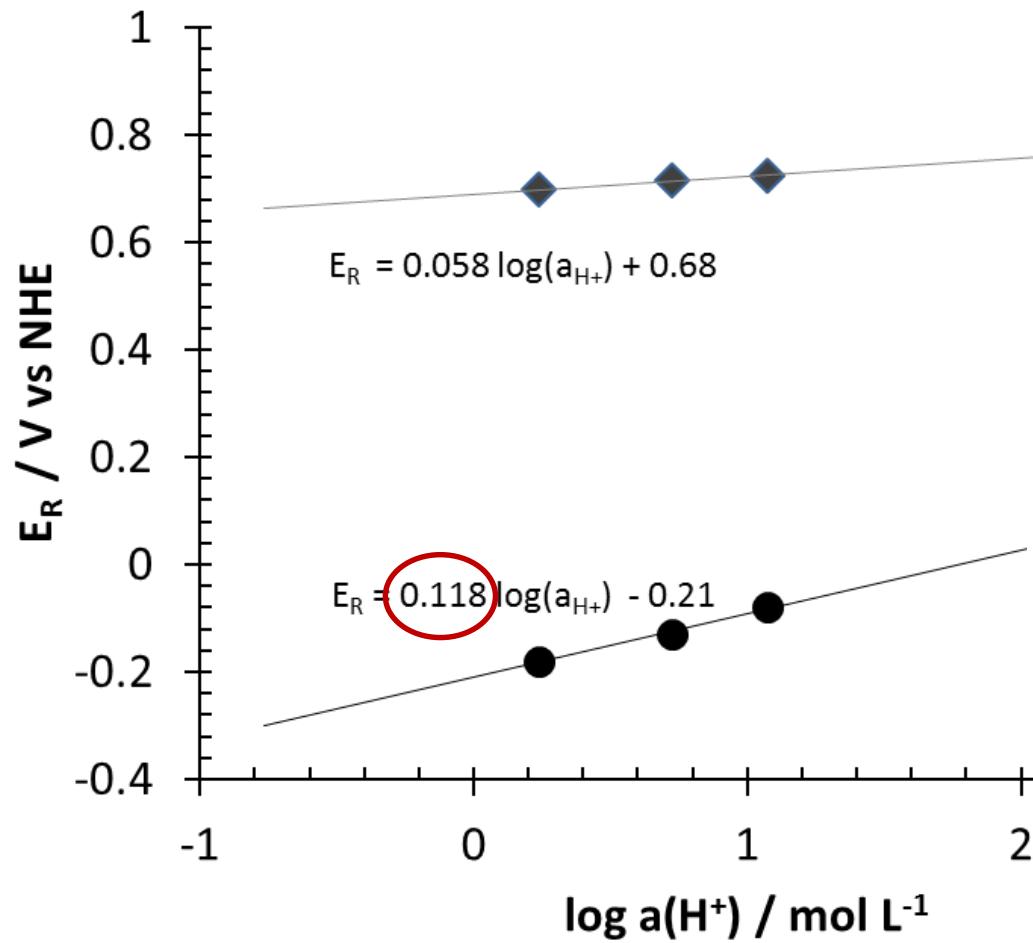
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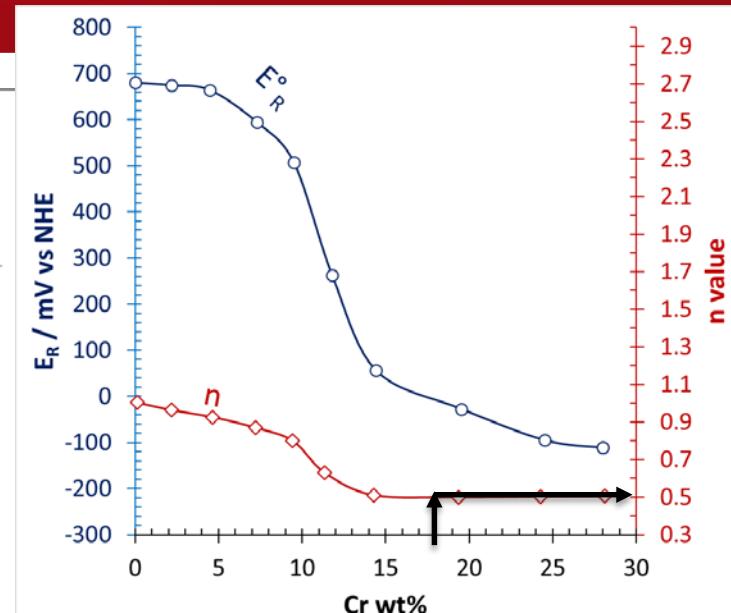


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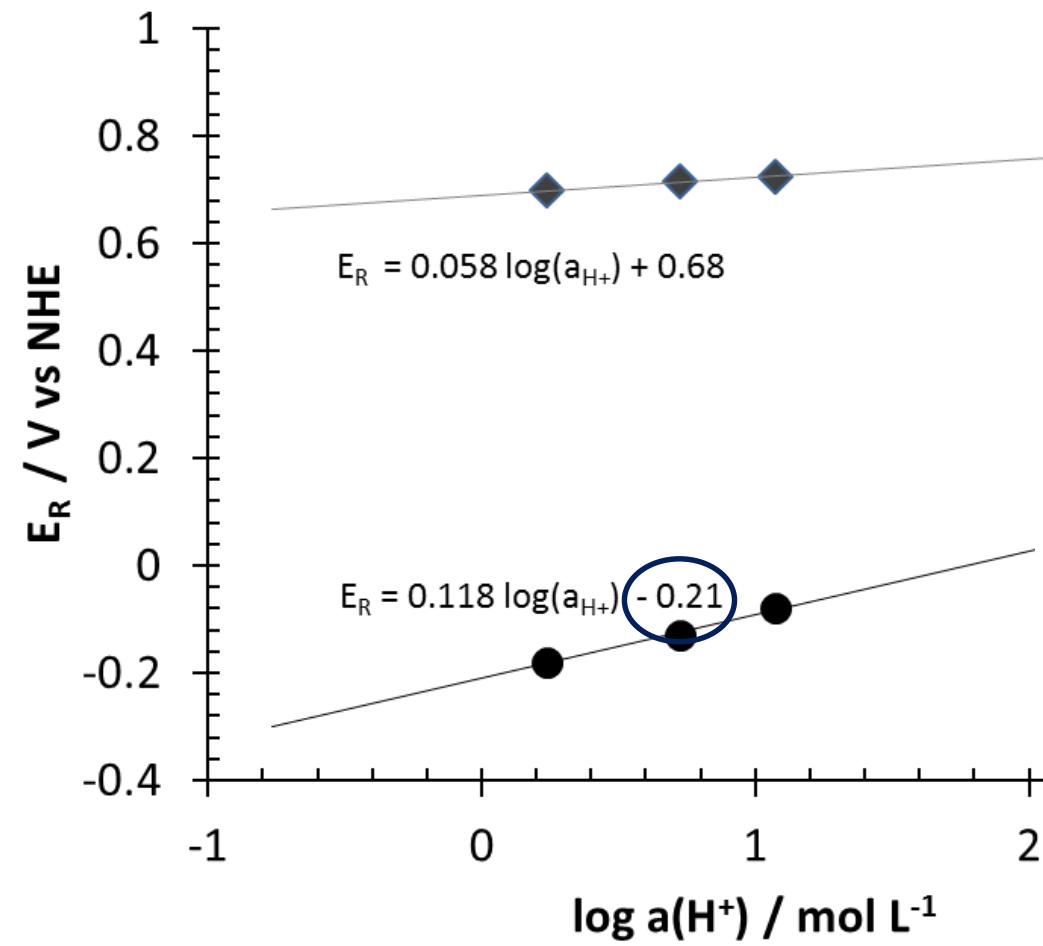
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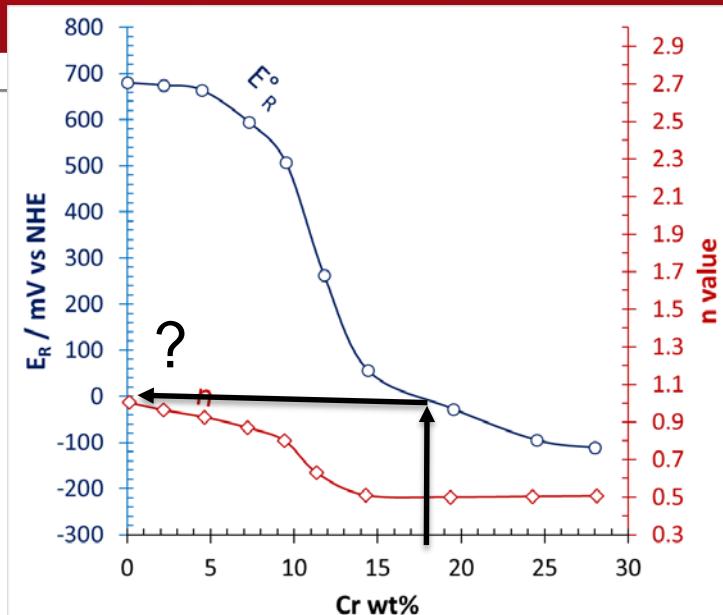
$$E_R = E_R^\circ + \frac{0,058}{n} \log a_{H^+}$$

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² Glowing discharge spectroscopy – 150µm – M.Tabarant, B. Laurent – CEA Saclay (2015)

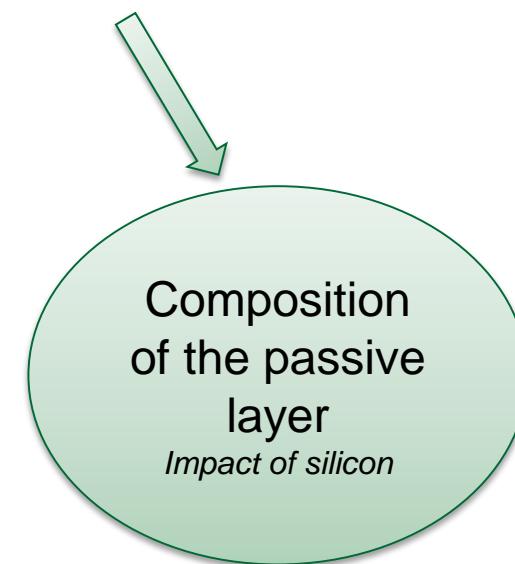
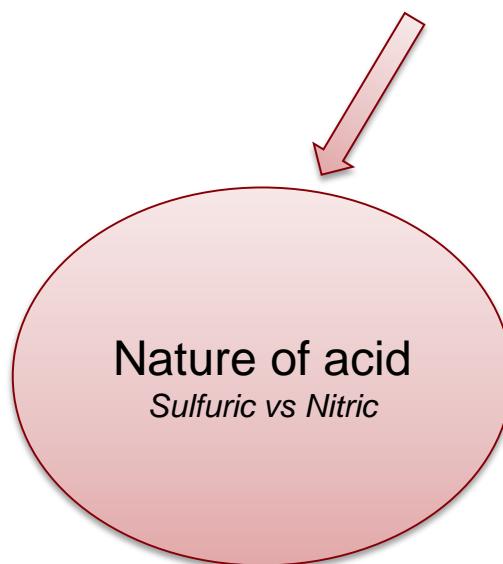
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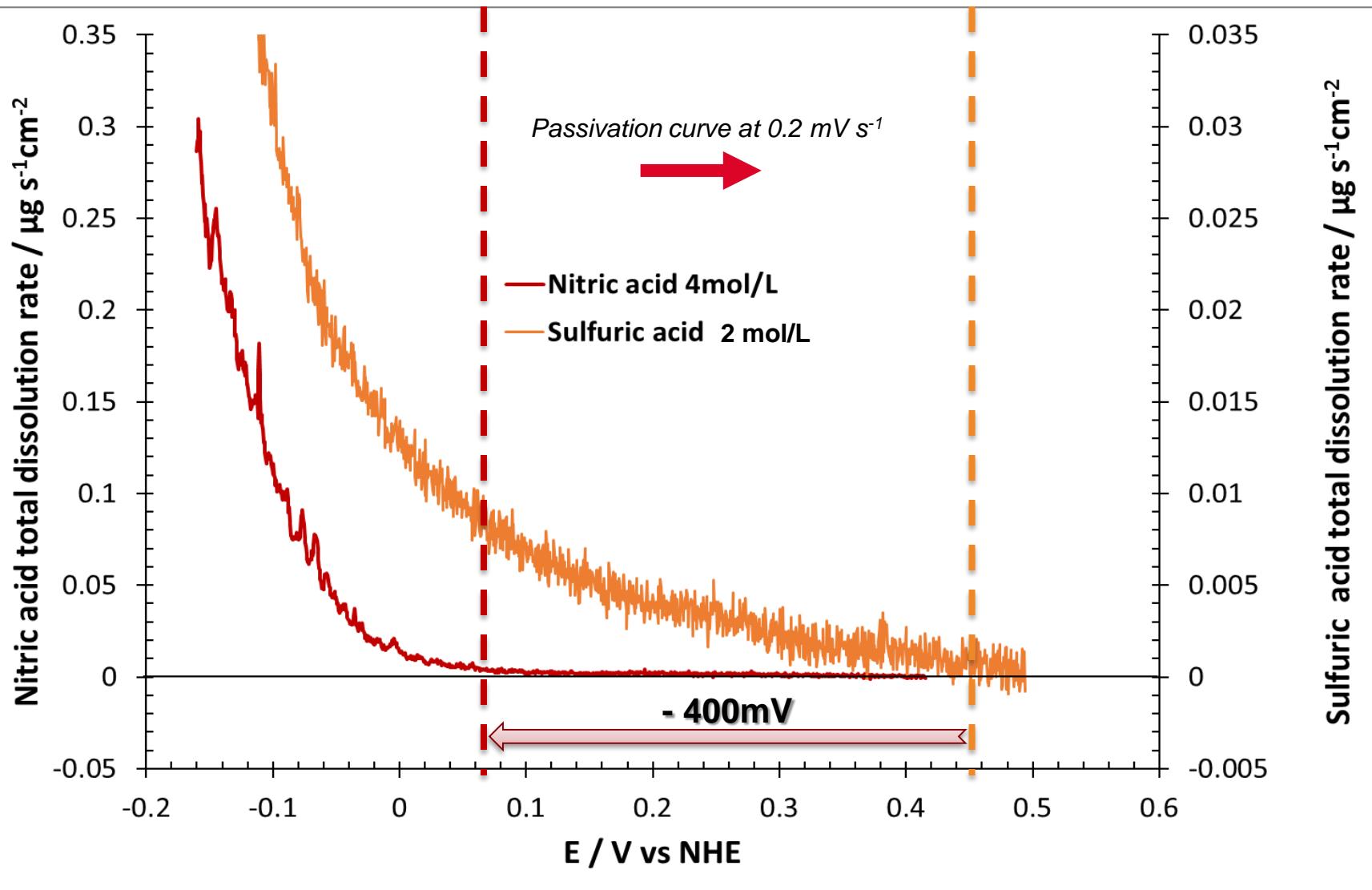
How to explain E_R° variation ?

Two main factors might influence E_R°



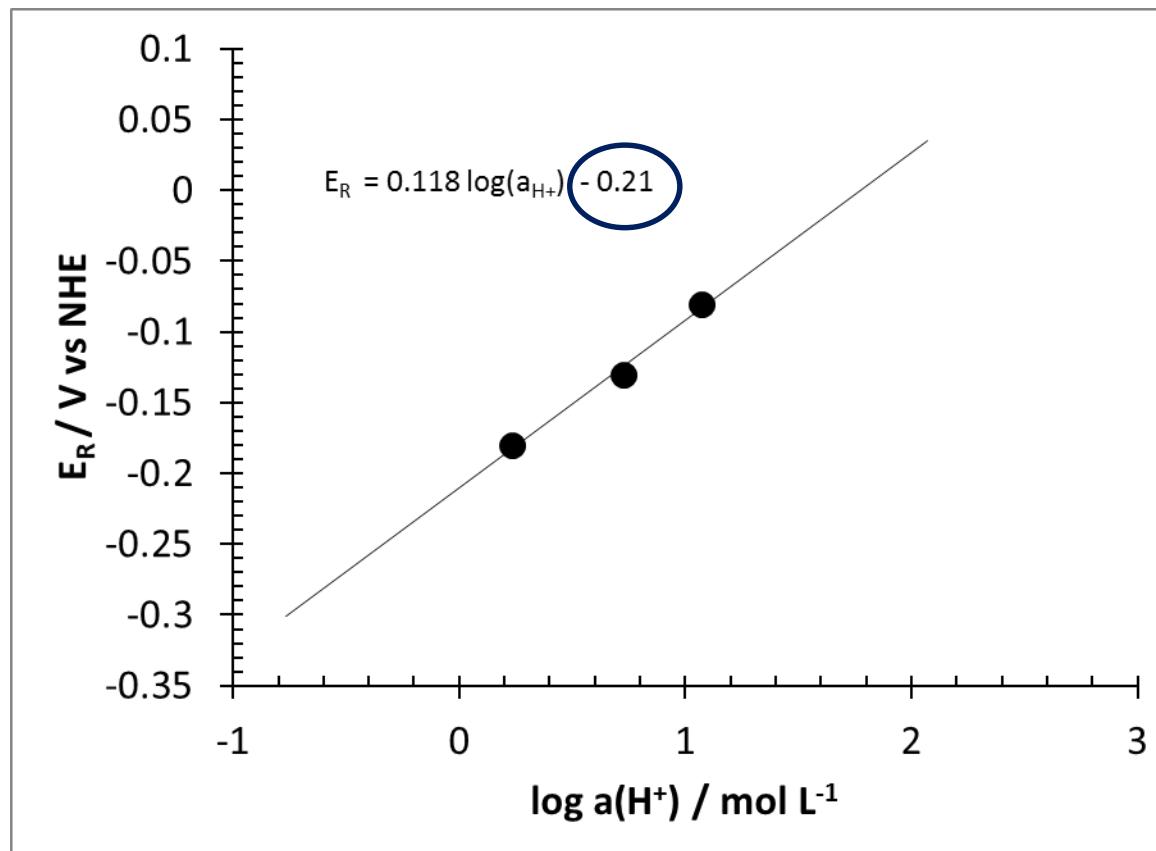
1. HOW DOES E_R VARY WITH NATURE OF ACID ?

HYPOTHESIS : E_R & E_P VARY WITH THE SAME SLOPE

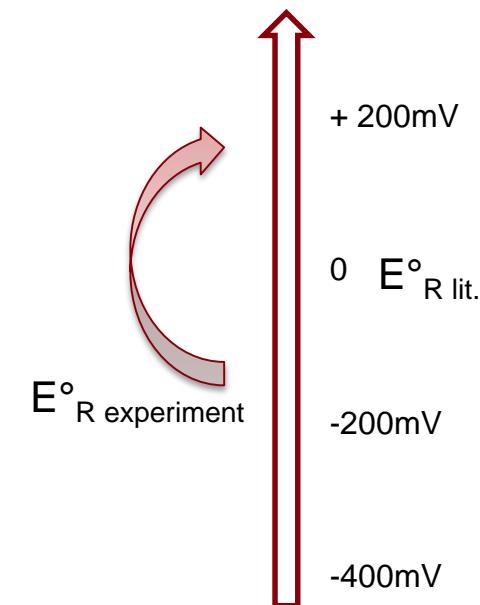


E°_R VARIATION

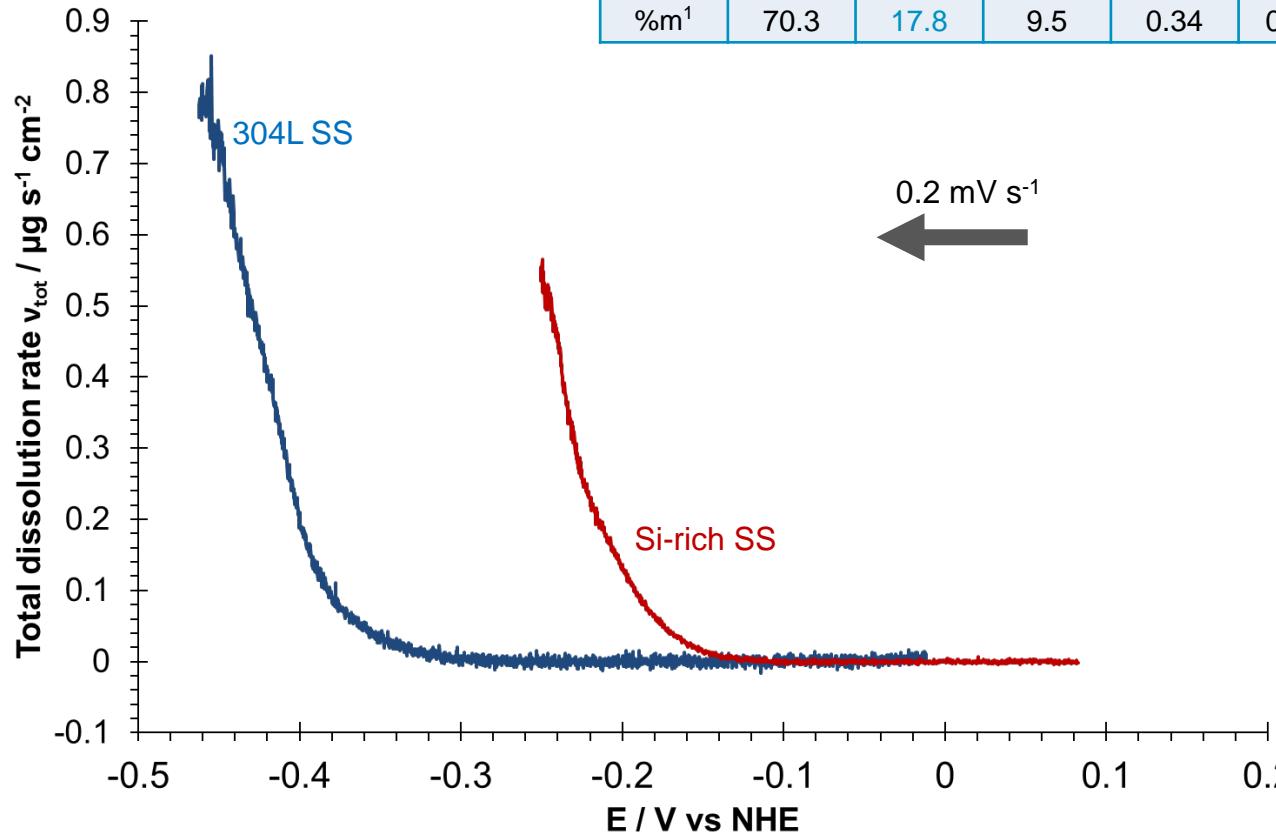
How to explain E_R° variation ?



E_R° remains high when compared to literature...



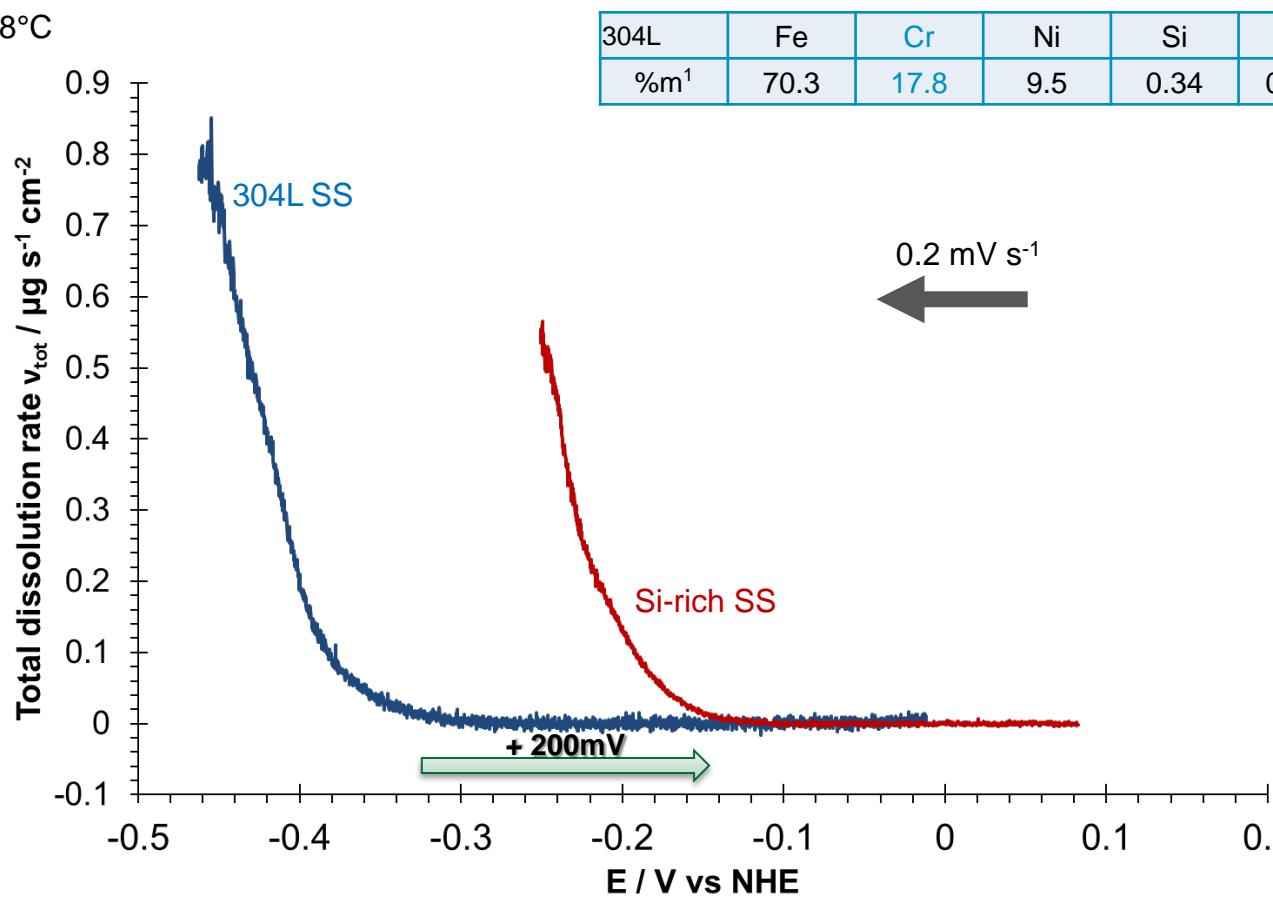
2. WHAT IS THE IMPACT OF SILICON ENRICHMENT ?

HNO₃ 4M – 28°C

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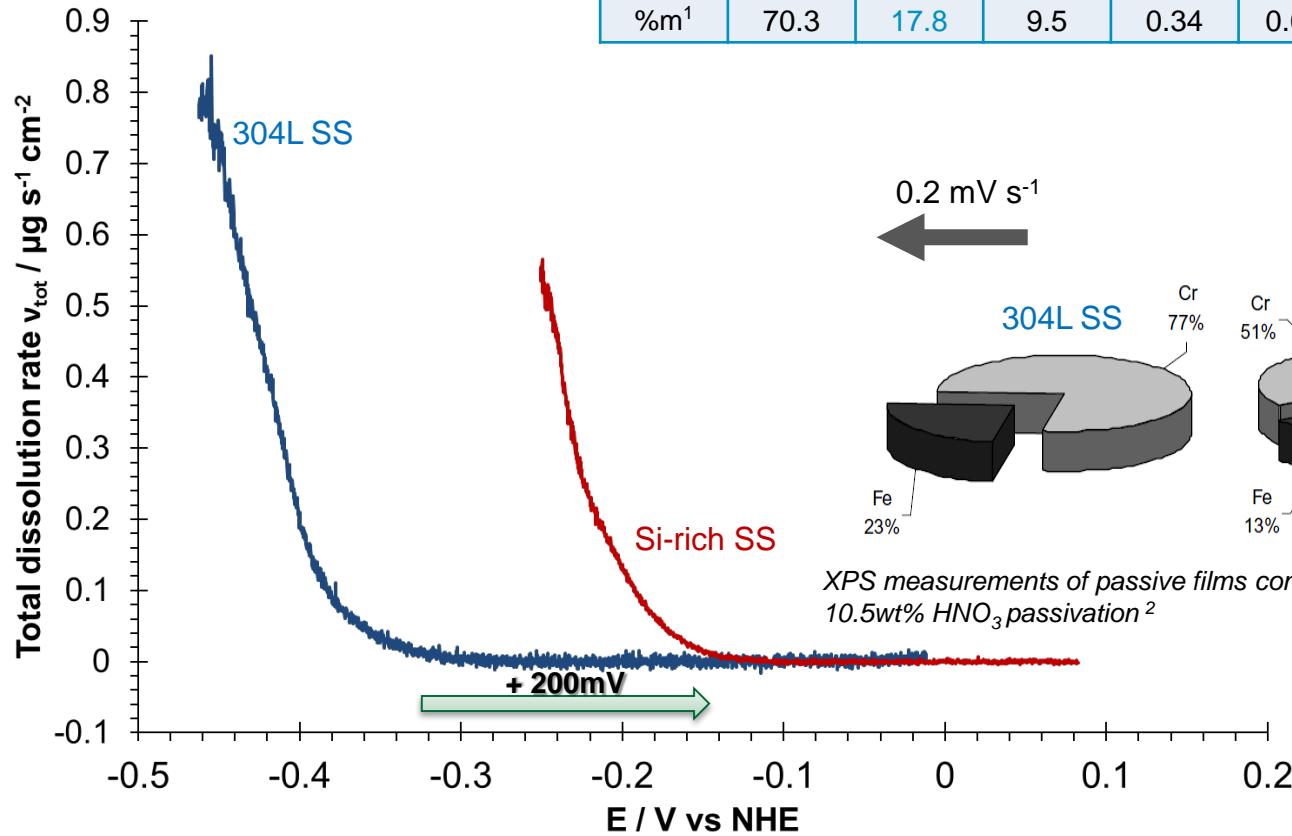
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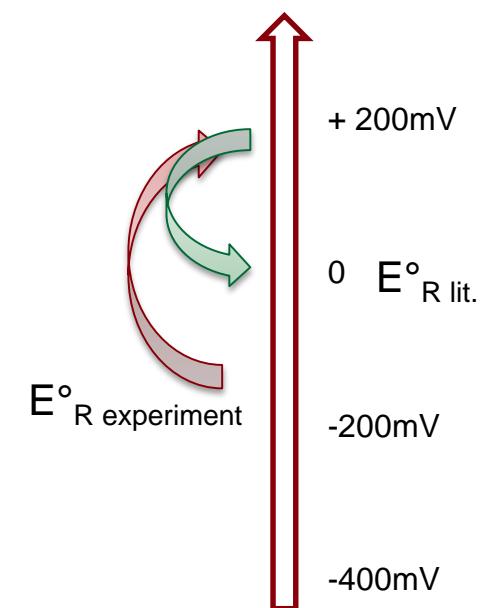
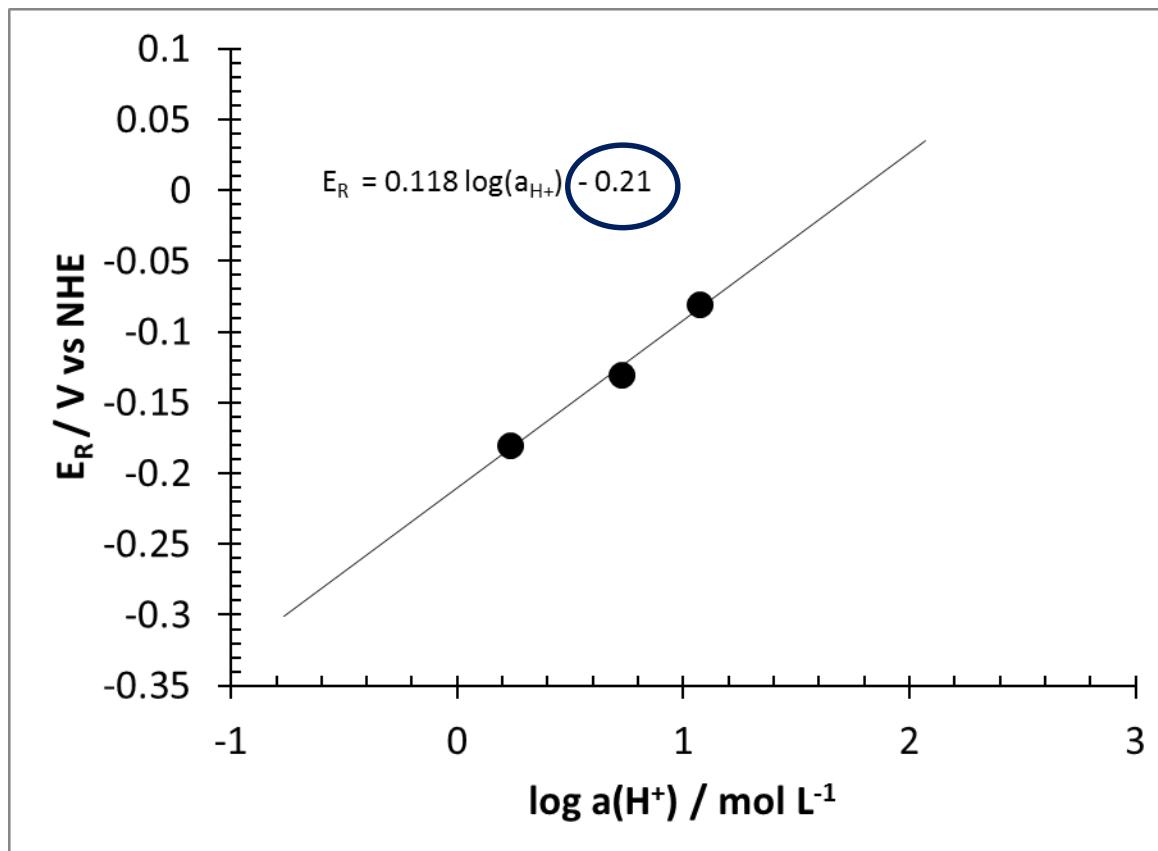
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² Robin, R., Miserque, F., et al. (2008). *Journal of Nuclear Materials* 375(1): 65-71.

E°_R VARIATION

How to explain E_R° variation ?



Conclusion

- AESEC technique made possible HNO_3 in situ measurements of the E_R potential and reveal different passive layer characteristics depending on $[\text{HNO}_3]$
- Following have to be taken into account :
 - Nitric acid media impact
 - Metallurgy of the studied steel :
Silicon in the passive layer ($\sim 36\%_{\text{at.}}$) → easiest passive layer to dissolve
- Research in progress : linear dependance on temperature
 - Such steel are designed for higher temperatures
 - AESEC membrane and cell can hold up to 80°C

Thank you for your attention !

Special thanks

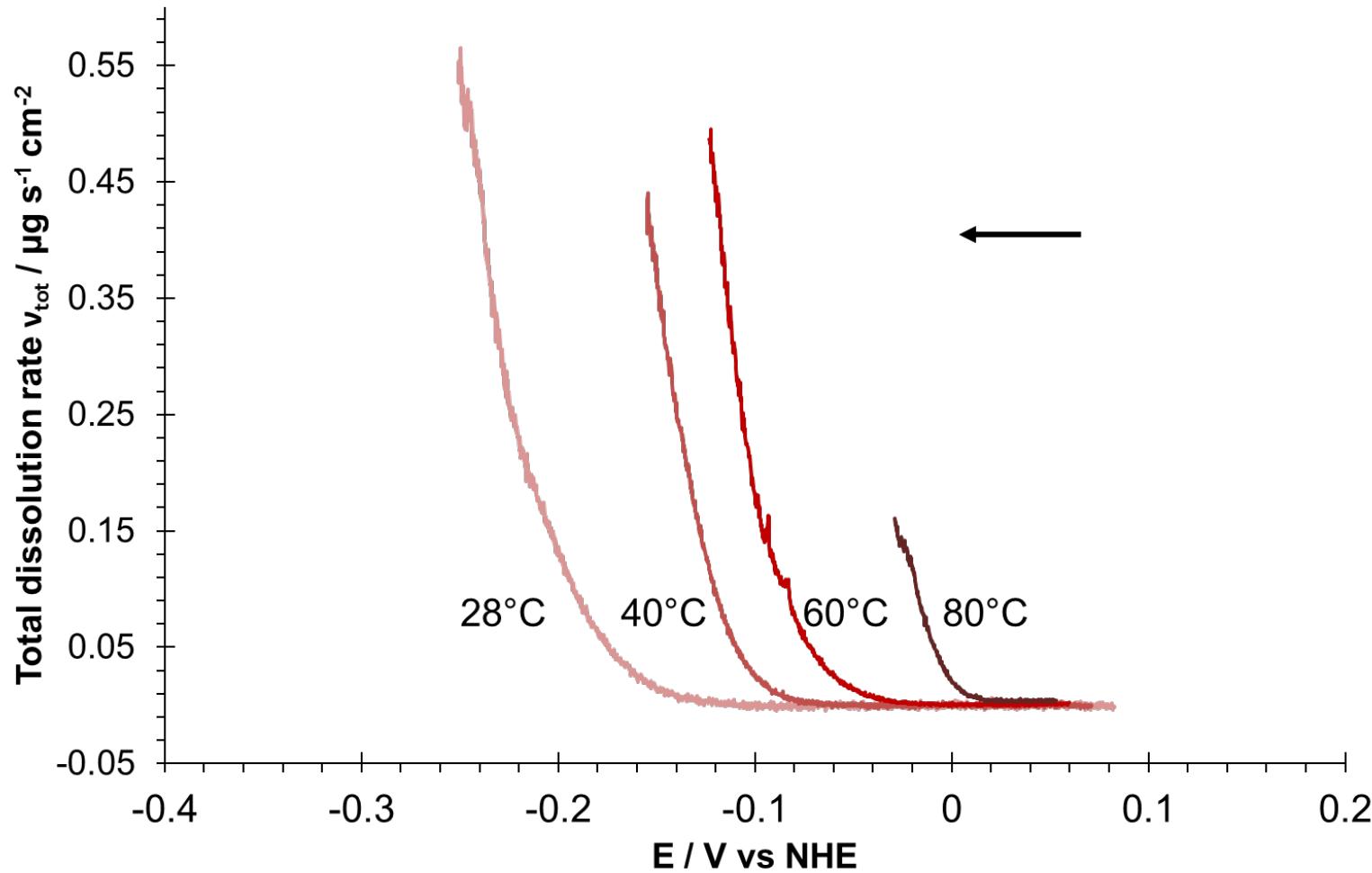
Bataillon C., Benoit M., Bigot M., Brijou-Mokrani N., Cavaliere N., Fallet A., Fauvet P., Geneve O., Gharbi O., Han J., Heurthault S., Keddam M., Laghoutaris P., Pasquier-Tilliette S., Puga B., Rivollier M., Robin R., Shkirskij V., Soulié V., Zhou P.

The industrial partner



REACTIVATION OF THE STEEL (VS T°)

Silicon-rich stainless steel – HNO₃ 4M – 28°C



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Silicon-rich stainless steel – HNO₃ 4M – 28°C

