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## Discussion on the relationship between passivity and reactivity of metals

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# DISCUSSION ON THE RELATIONSHIP BETWEEN PASSIVITY AND REACTIVITY OF METALS

ISE 2017 |

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K. Ogle (CNRS/Chimie-ParisTech),

C. Sanchez-Sanchez, B. Tribollet, V. Vivier (CNRS/LISE)

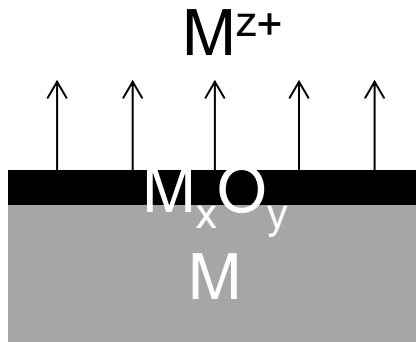
AUGUST 28<sup>th</sup> 2017

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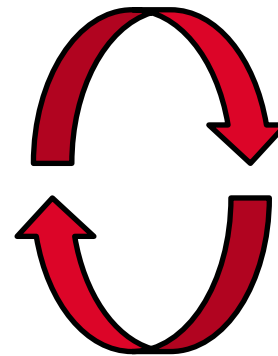
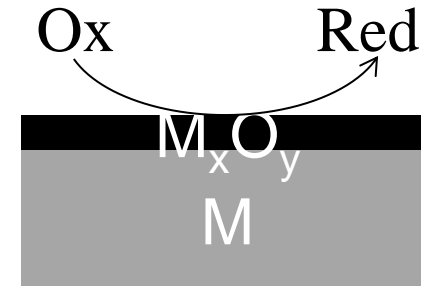
System of interest : passivated metals



Passivity  
(oxidation/dissolution  
of metal)



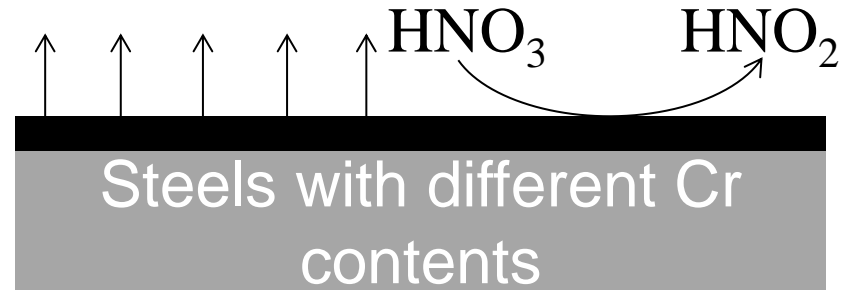
Reactivity  
(reduction of  
media)



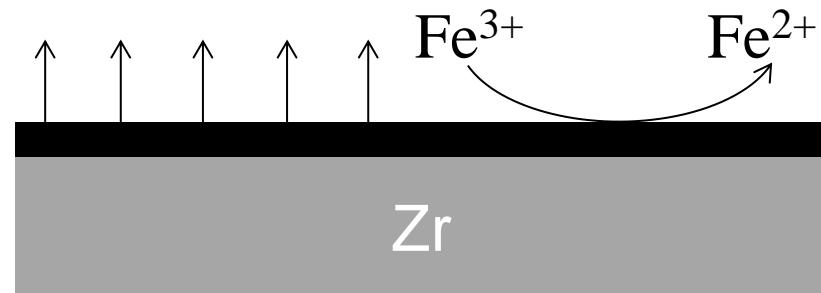
Relationship ?

# SYSTEMS STUDIED

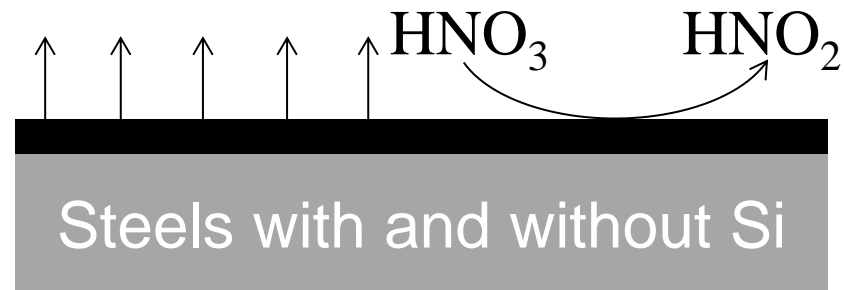
System No. 1



System No. 2

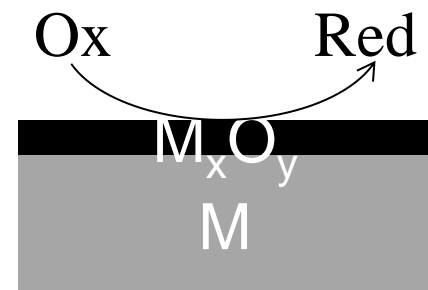
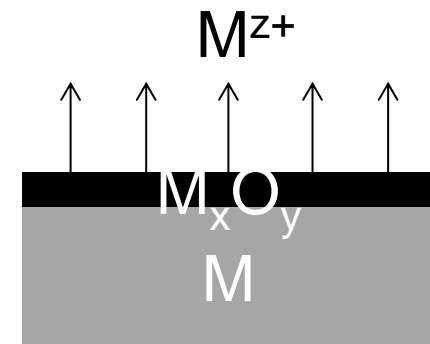


System No. 3

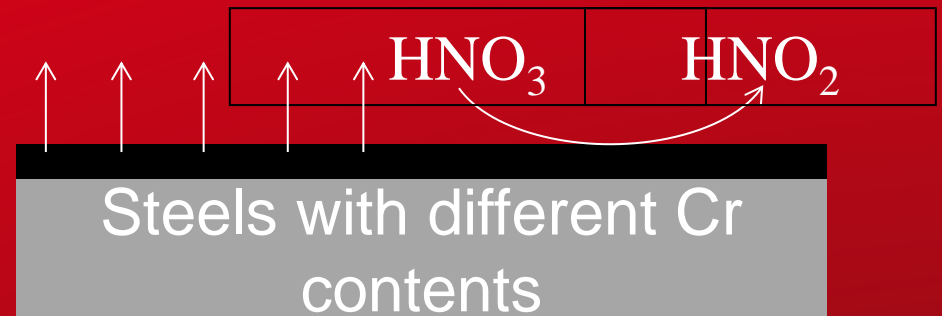


## 3 steps

- Characterization of the oxide film
  
- Characterization of passivity
  
- Characterization of reactivity



# STEELS WITH DIFFERENT CHROMIUM CONTENTS



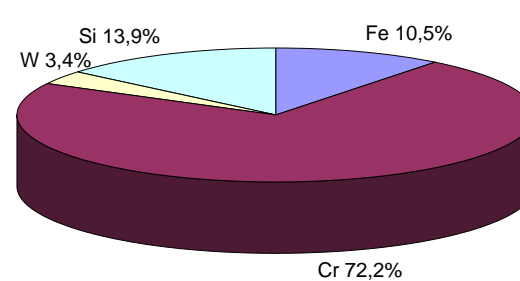
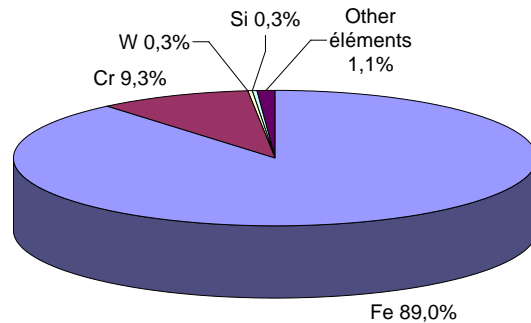
9Cr-1W-Ti ODS  
14Cr-1W-Ti ODS  
18Cr-1W-Ti ODS



## Characterization of the oxide film

- The oxide film is enriched in chromium (XPS)

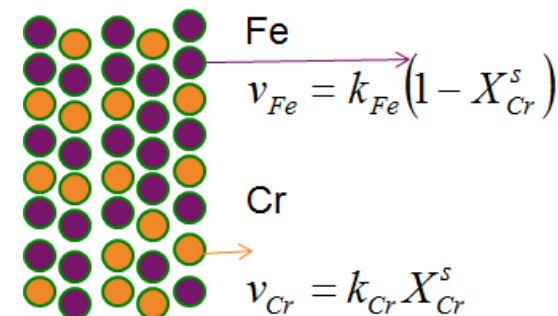
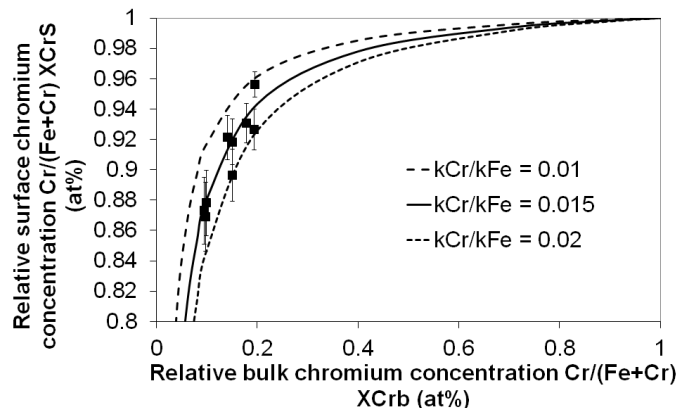
Steel composition (at%)

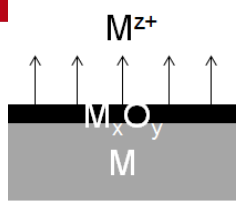


9Cr-1W-Ti ODS

Oxide layer composition (at%)

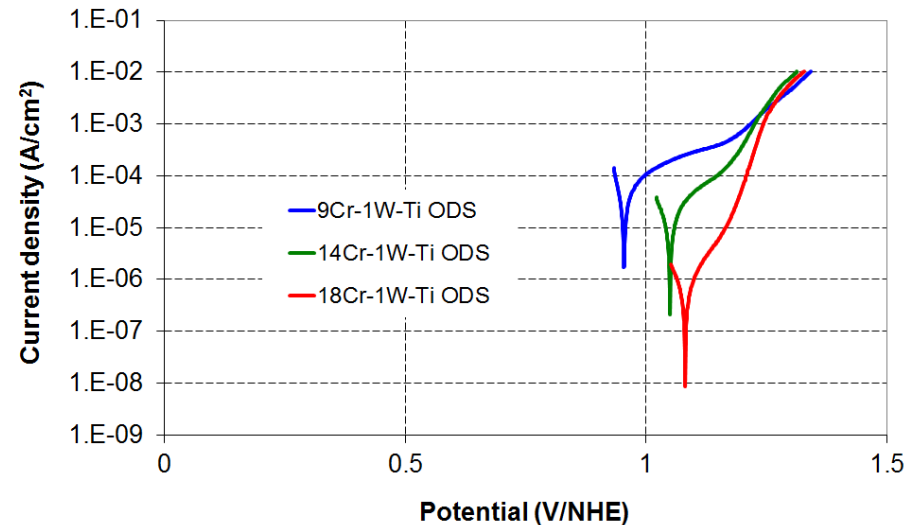
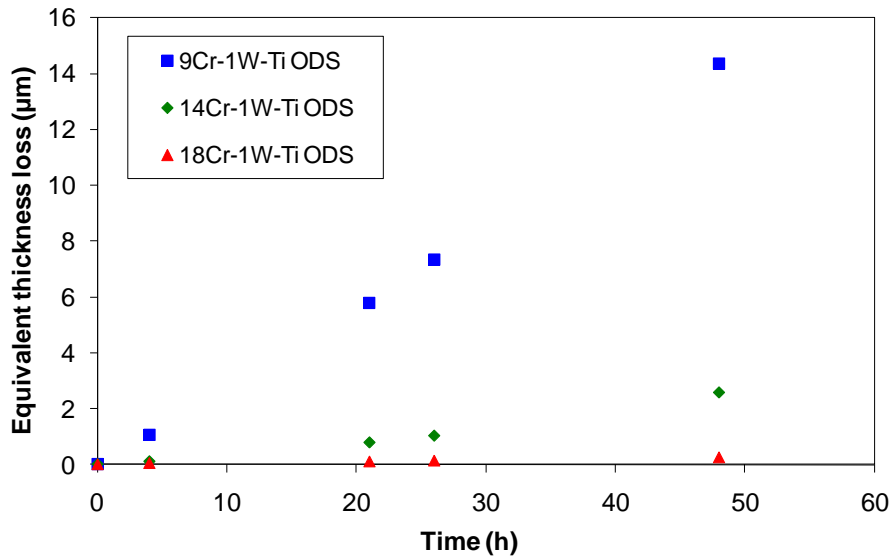
- The more steel contains chromium, the more important the concentration of chromium in the oxide



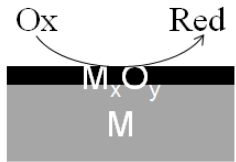


## Characterization of passivity

■ The more steel contains chromium, the better passivity

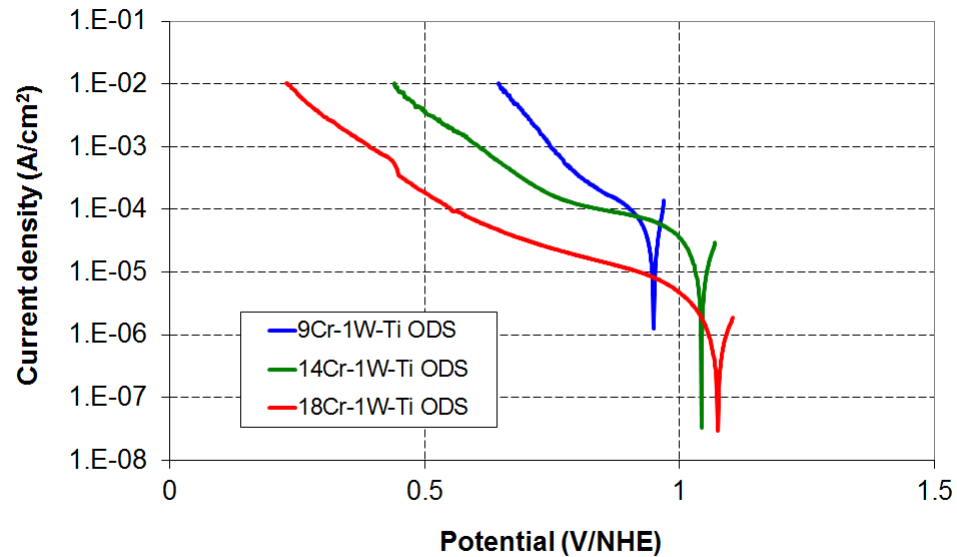




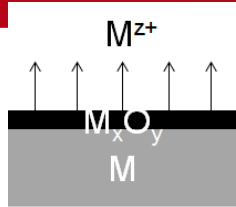


## Characterization of reactivity

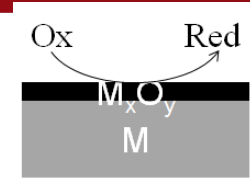
- The more steel contains chromium, the lower reactivity



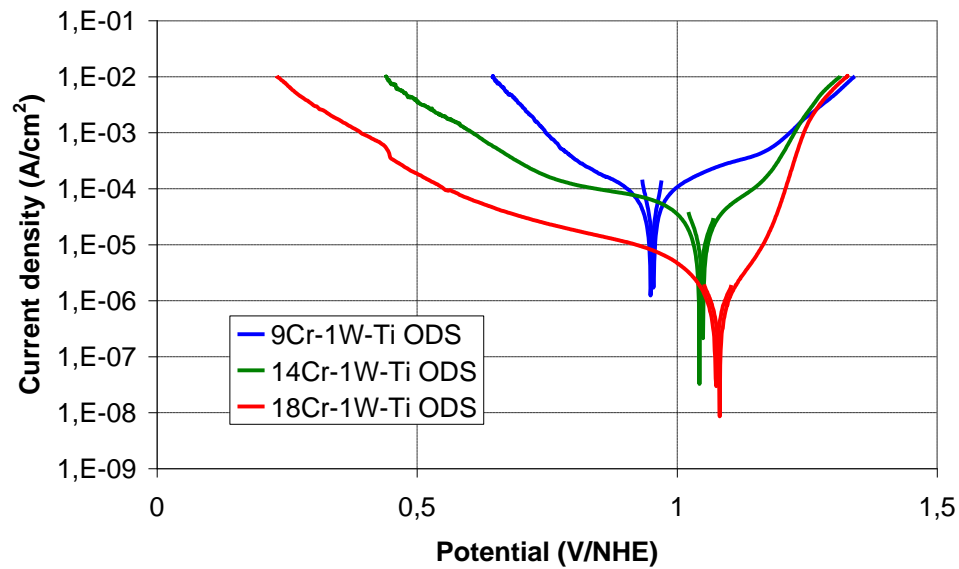
# STEELS WITH DIFFERENT CHROMIUM CONTENTS



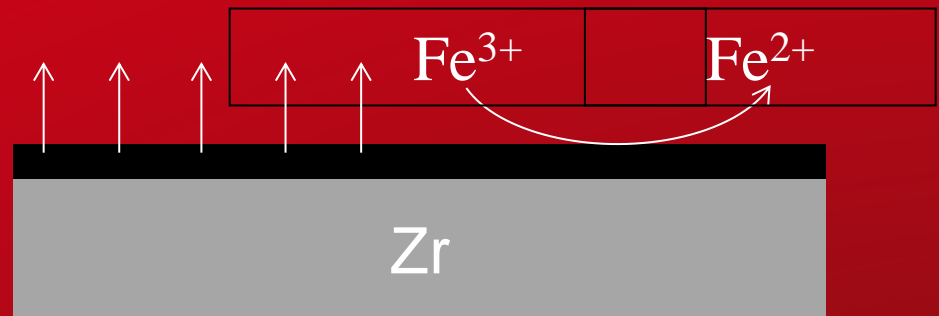
Relationship between passivity and reactivity



- In this case, the more steel contains chromium:
  - The better passivity
  - The lower reactivity



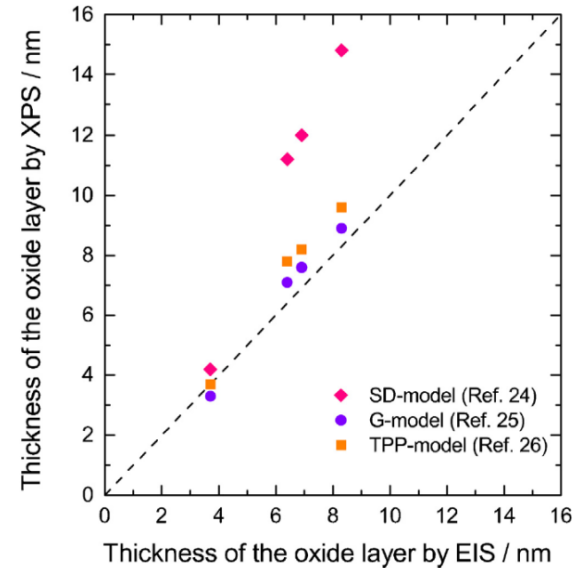
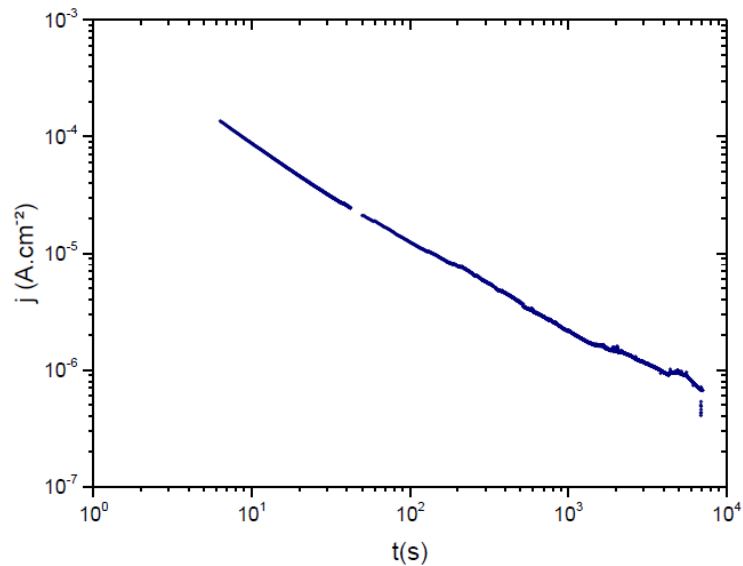
# ZIRCONIUM WITH DIFFERENT THICKNESSES OF THE OXIDE FILM

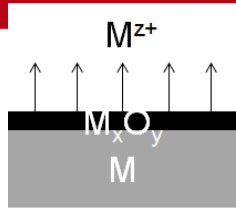




## Characterization of the oxide film

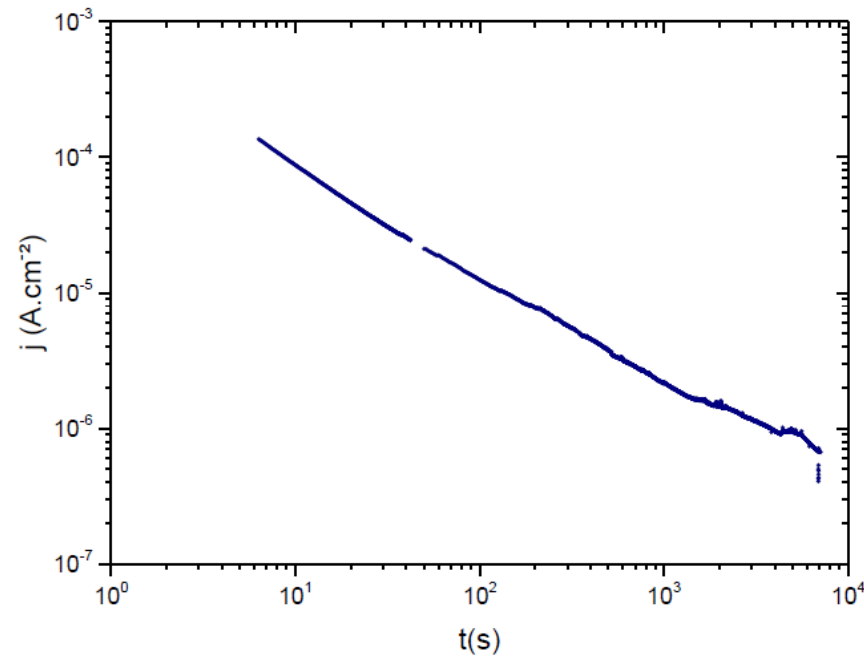
- The oxide films (ZrO<sub>2</sub>) are prepared by polarization at the same potential but with during different durations
- The thickness of the oxide films is measured by two methods: XPS and EIS

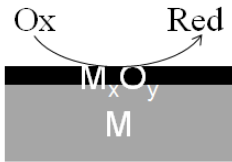




## Characterization of passivity

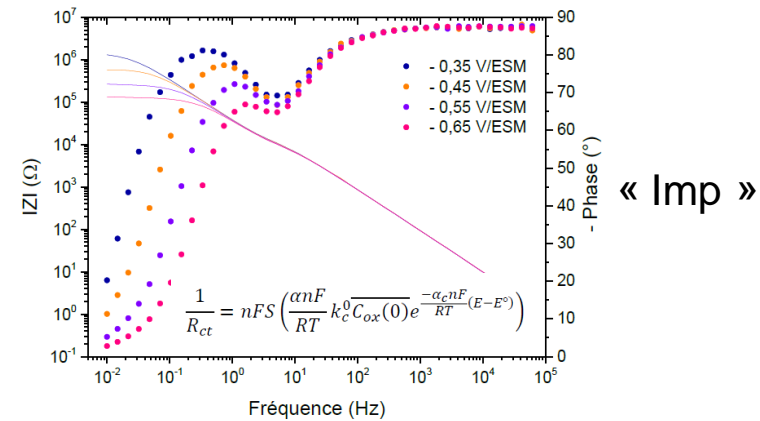
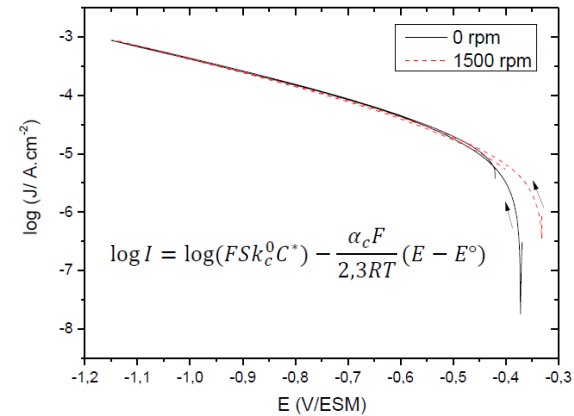
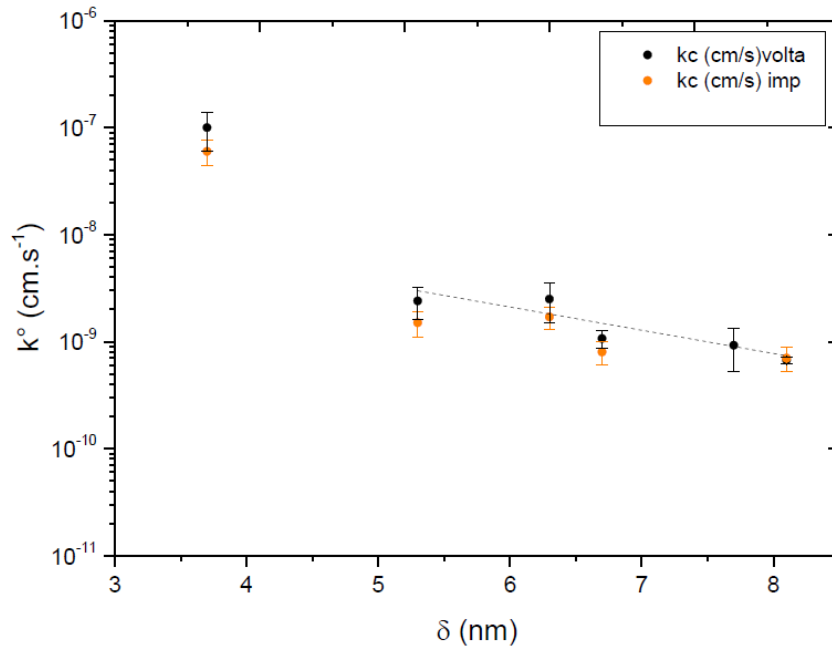
- The thicker the oxide film (the longer the polarization time), the better passivity



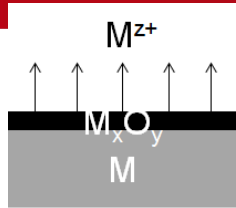


## Characterization of reactivity

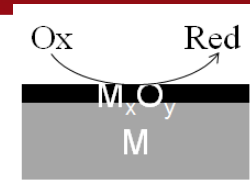
- The thicker the oxide film (the longer the polarization time), the lower reactivity



# ZIRCONIUM WITH DIFFERENT THICKNESSES OF THE OXIDE FILM

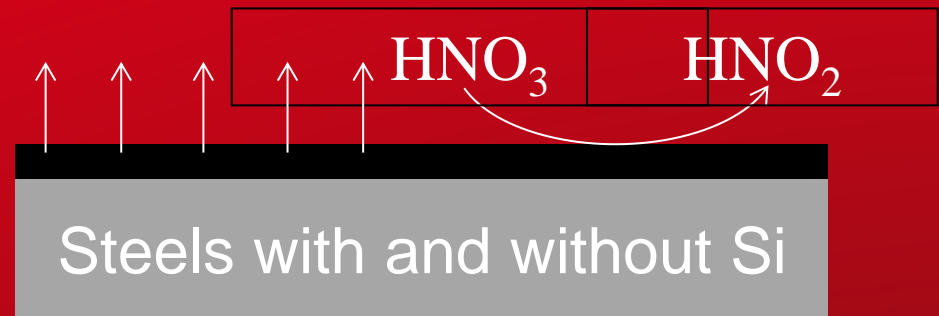


## Relationship between passivity and reactivity



- The thicker the oxide film (the longer the polarization time):
  - The better passivity
  - The lower reactivity
  
- In this case, the trend is similar to the previous example

# STEELS WITH DIFFERENT SILICON CONTENTS



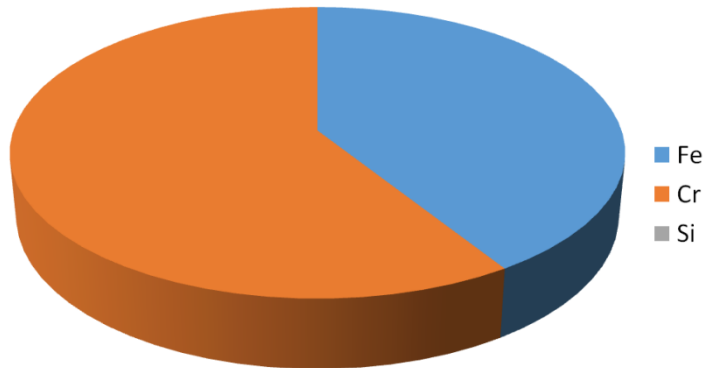
	Fe	Cr	Ni	Si	Mn	Add.
Si-rich SS	59.8	18.8	15.1	3.5	2.0	0.8
304L SS	70.3	17.8	9.5	0.3	1.5	0.6



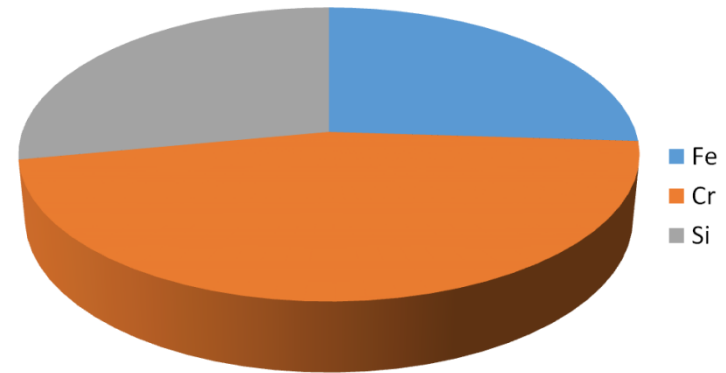


## Characterization of the oxide film (XPS)

- For 304L SS, the oxide is enriched in chromium (no silicon measured)
- Si-rich SS, the oxide is enriched in chromium and silicon

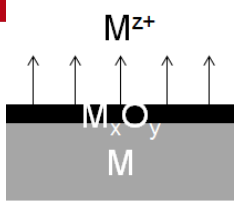


304L SS



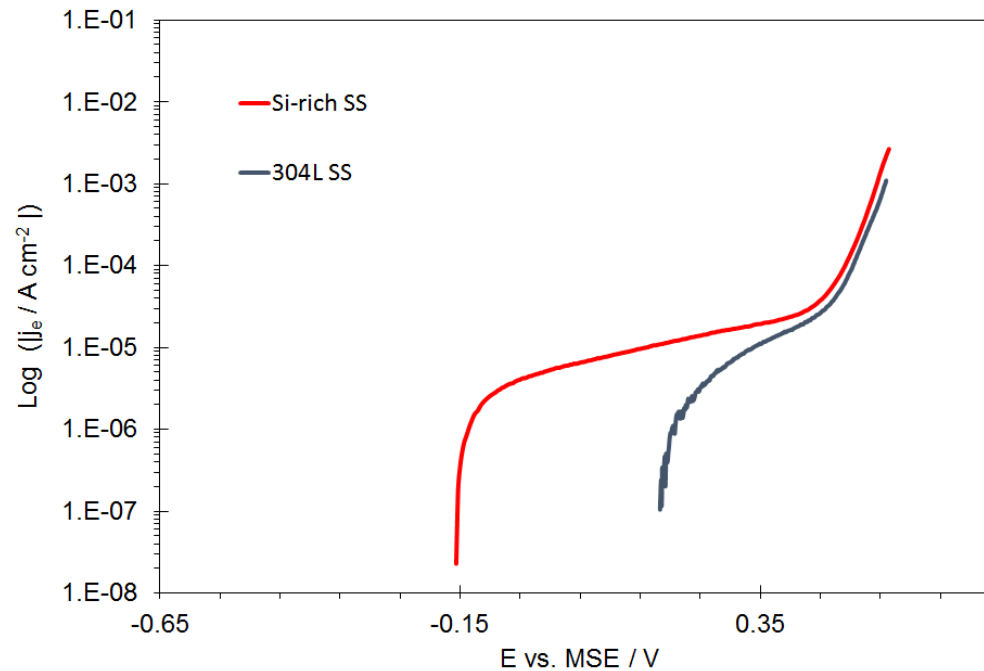
Si-rich SS

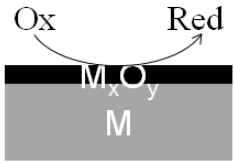
# STEELS WITH DIFFERENT SILICON CONTENTS



## Characterization of passivity

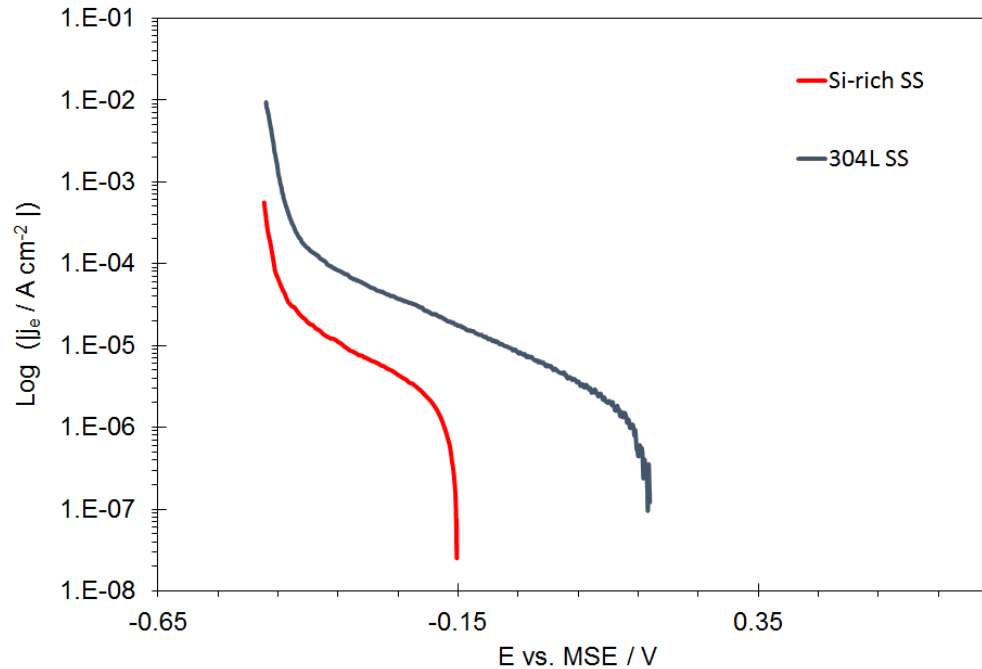
- With silicon, passivity is worse



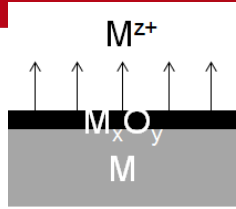


## Characterization of reactivity

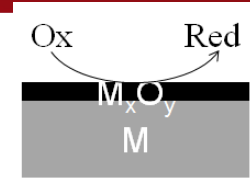
■ With silicon, reactivity is lower



# STEELS WITH DIFFERENT SILICON CONTENTS

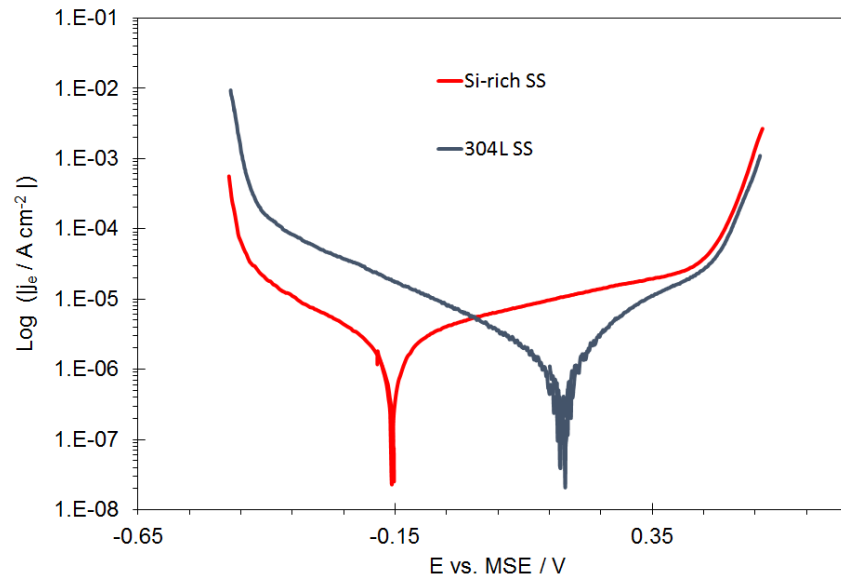


## Relationship between passivity and reactivity



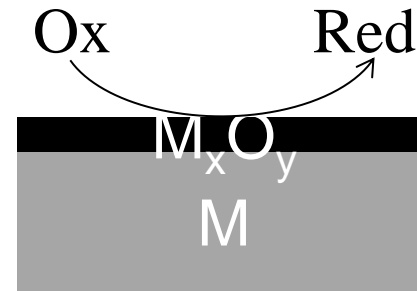
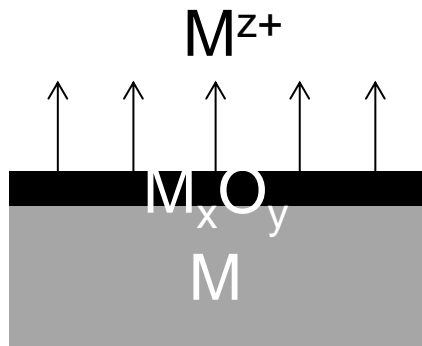
- With silicon:
  - Passivity is worse
  - Reactivity is lower

- In this case, the trend is the opposite of the previous two examples



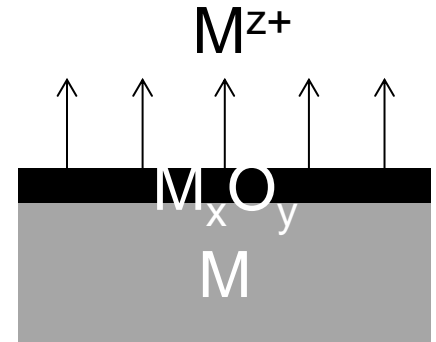
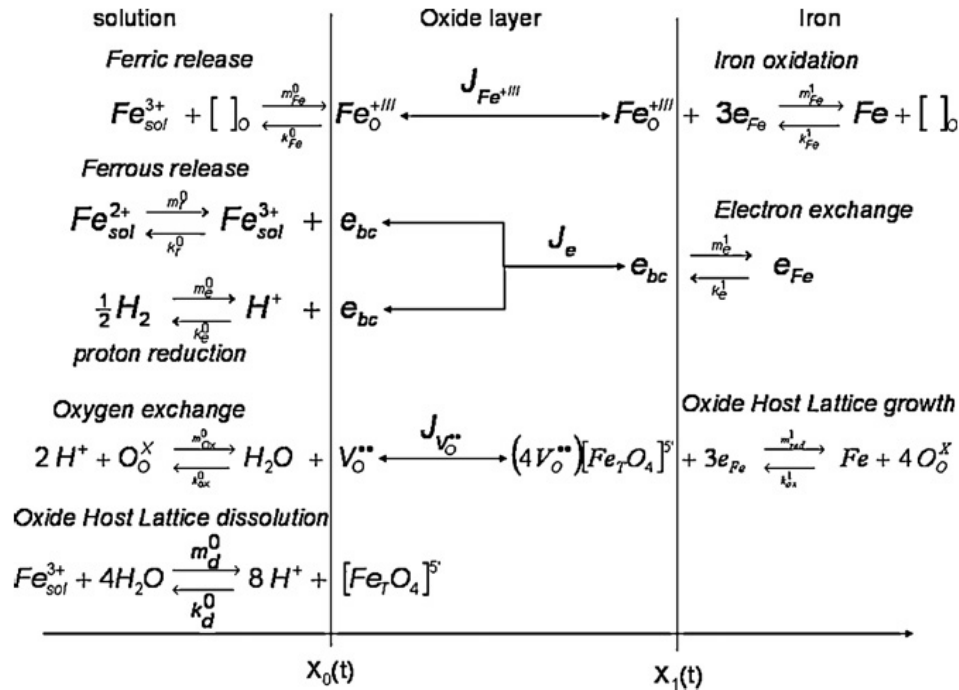
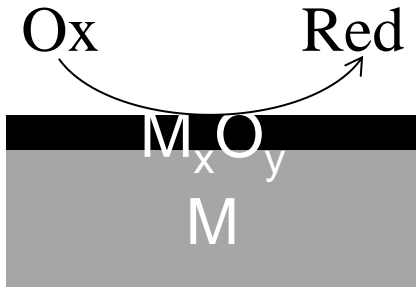
# SUMMARY

What kind of relationship is there between passivity and reactivity of metals?



- Depending on the system, the relationship can in one direction or in the other

What could that mean?



I let you give me your opinion...

## Acknowledgements to :



■ You for your attention

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