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Corrosion behavior of NdFeB permanent magnet in two neutral environents

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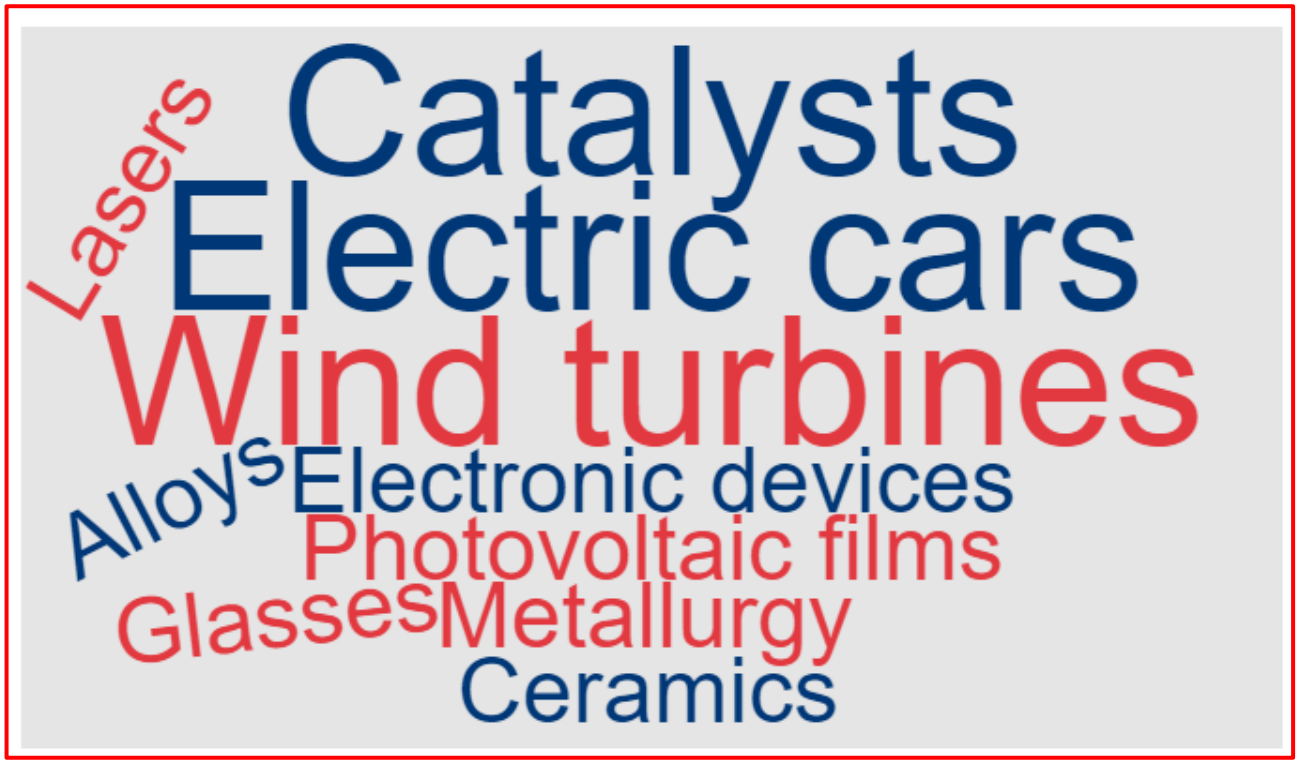
Topics

- Rare Earth Elements (REE) Uses
- Green Power
- NdFeB Magnets Uses
- Objective
- Methodology
- Results
- Conclusions

REE Uses



Chuanying Liu, Qibin Yan, Xingwang Zhang, Lecheng Lei, and Chengliang Xiao
Environmental Science & Technology **2020** *54* (16), 10370-10379
DOI: 10.1021/acs.est.0c03278

Green Power

- Wind
- Solar
- Biomass
- Geothermal
- Biogas
- Low-impact hydropower

https://www.epa.gov/greenpower/what-green-power

NdFeB Magnets Uses

https://cdnsjengenhariae.nuneshost.com/wp-content/uploads/2020/06/energia-eolica.jpg

https://www.pensamentoverde.com.br/sustentabilidade/volta-carro-eletrico/

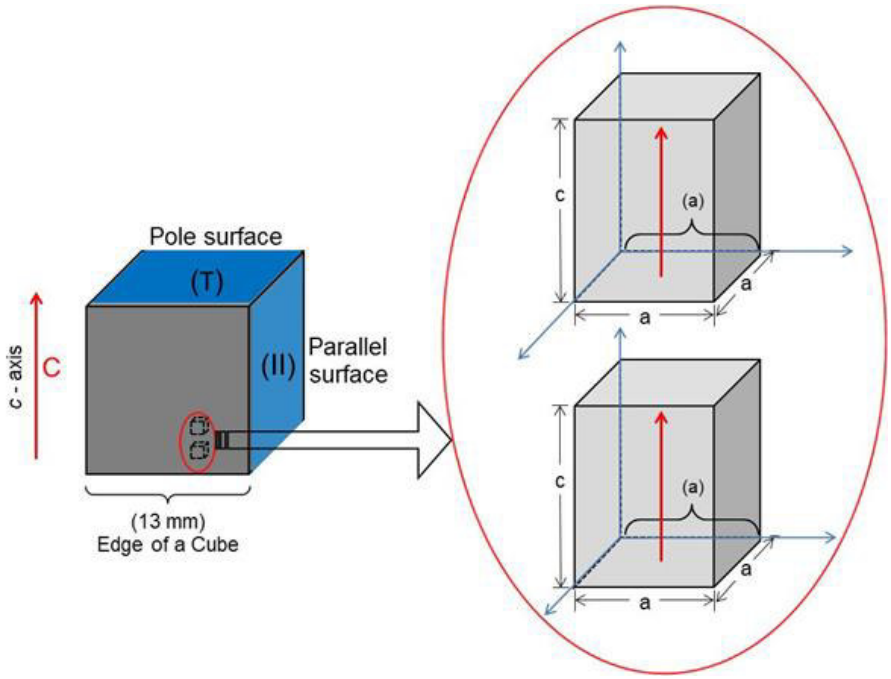
Objective

The aim of this work was to study the NdFeB corrosion behavior by accelerated and immersion tests and the role of chloride and sulfate solutions in the electrochemical tests

Methodology

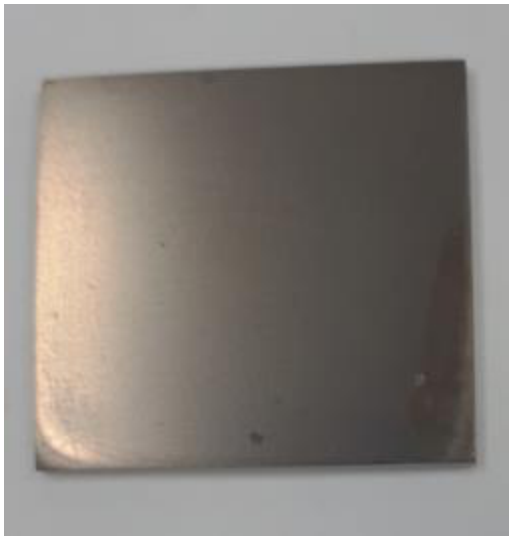
- HAST (high accelerated stress test)
- BCT (bulk corrosion test)
- EIS (electrochemical impedance spectroscopy test)
- Three cubic samples for each test (13 mm x 13 mm x 13 mm) – nonmagnetized state

Methodology



- NdFeB cubic samples were cut from a large nonmagnetized block with easy magnetization axis known
- It was possible to determine the perpendicular and parallel faces to the magnetization axis in order to observe the corrosion behavior between the faces

Methodology



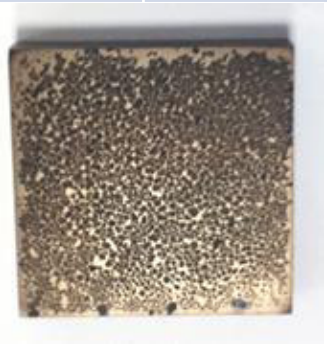
The immersion tests were done with NdFeB plates (25 mm x 25 mm x 3 mm)
Nonmagnetized state
Three samples

Results – Accelerated Tests – Cubic Samples

Bulk Corrosion Test

BCT

Time	Corrosion rate (mmy)
168 h/ 7 days	**0.018**

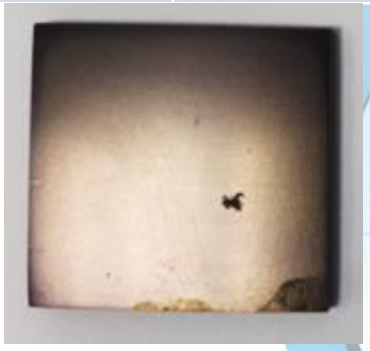


BCT: 120 °C and 100 % relative humidity with condensation

High Accelerated Stress Test

HAST

Time	Corrosion rate (mmy)
96 h/4 days	**0.001**



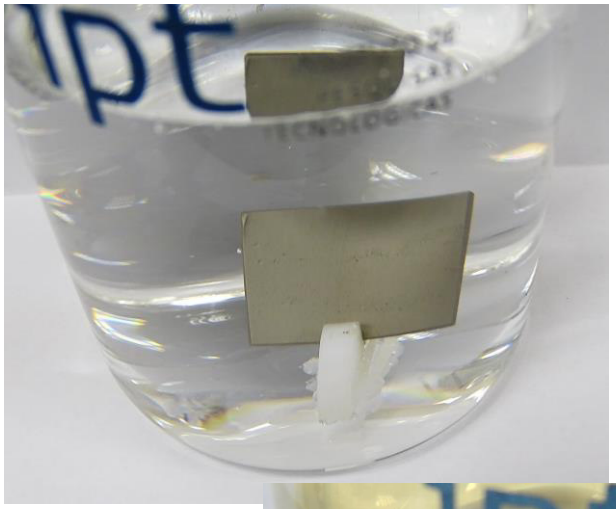
HAST: 130 °C and 95 % relative humidity without condensation

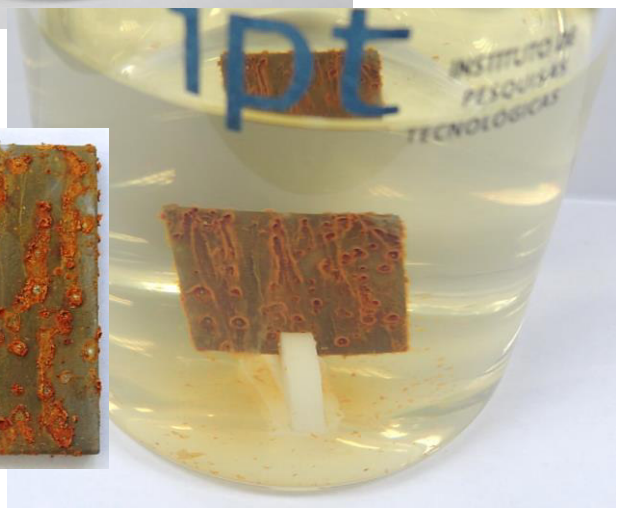
Chamber: Espec EHS – 212M

Results – Immersion Tests – Plate Samples

H_2O ultra pure, pH= 6.6

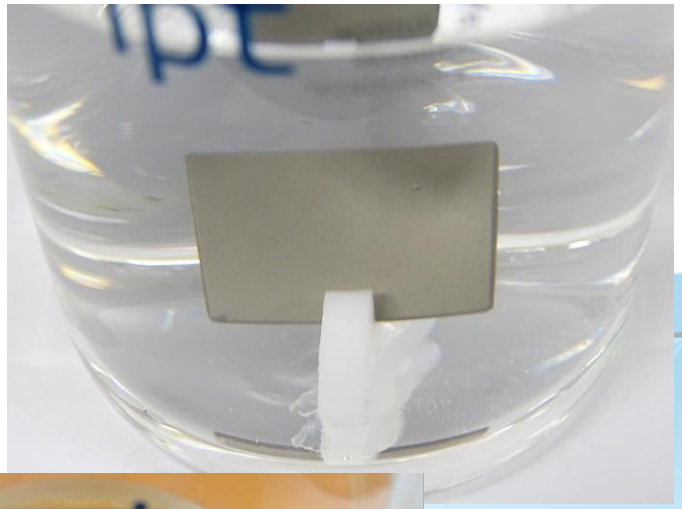
120 h/5 days, aerated





NaCl 0.05 mol/L, pH= 6.6

120 h/5 days, aerated



Results – Immersion Tests – Plate Samples

H_2O ultra pure, pH= 6.6 aerated

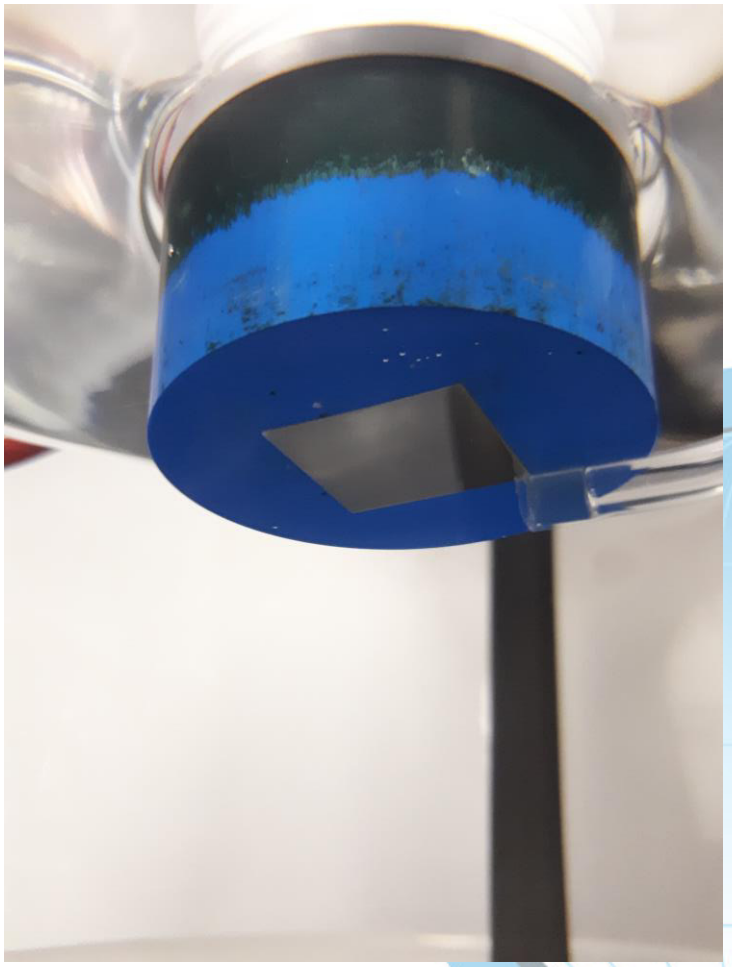
Time	Corrosion rate (mmy)
120/5 days	**0.10**

NaCl 0.05 mol/L, pH= 6.6 aerated

Time	Corrosion rate (mmy)
120/5 days	**0.17**

Results – EIS Tests - Cubic Samples

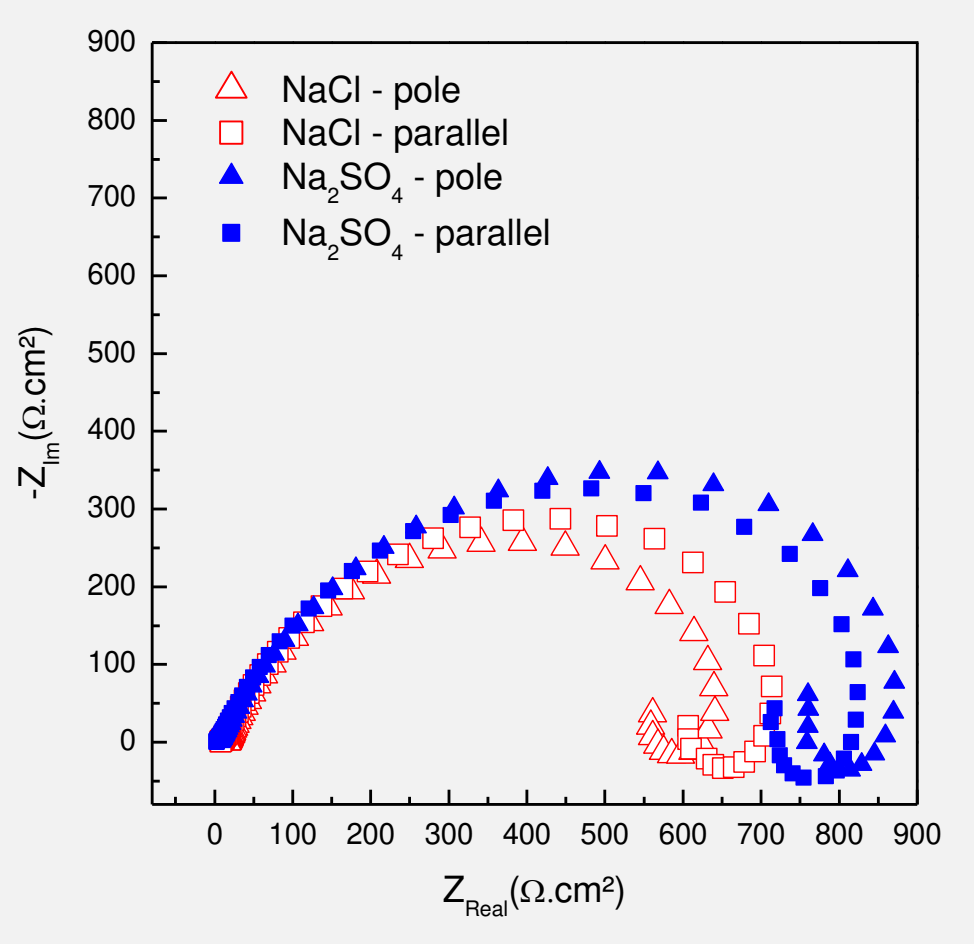
Cubic samples were embedded in thermoset resin in order to expose only pole or parallel faces



Three eletrodes: **nonmagnetized** NdFeB ($E_{working}$); Graphite ($E_{auxiliar}$); $E_{reference}$ (SCE) or ($Hg/HgSO_4/K_2SO_4$)

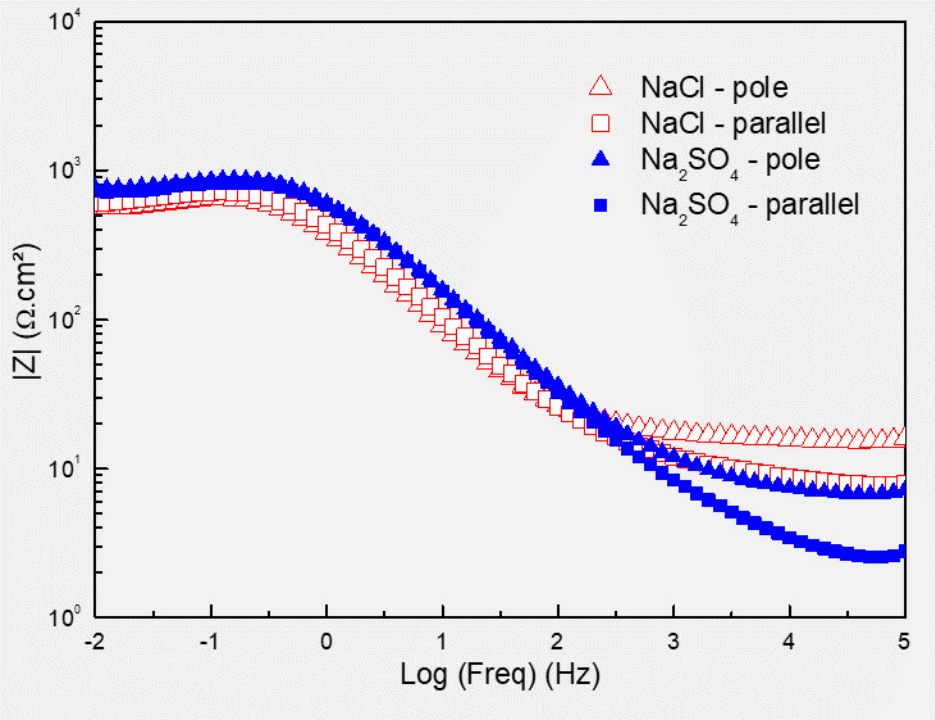
Electrolyte: NaCl 0,15 mol/L; 0,5 mol/L Na_2SO_4

Results – EIS Tests - Cubic Samples



Identification	R_{CT} (Ω.cm²) (Z View)
NaCl - pole	565,97
NaCl - parallel	639,10
Na_2SO_4 - pole	787,67
Na_2SO_4 - parallel	749,90

Results – EIS Tests - Cubic Samples



Identification	|Z| (Ω.cm²) (10^{-2} Hz)
NaCl - pole	525,25
NaCl - parallel	606,98
Na_2SO_4 - pole	762,40
Na_2SO_4 - parallel	720,08

Conclusions

- Comparing BCT and HAST tests, the water vapor condensation in BCT test intensified the corrosion process of magnets
- The immersion tests presented differential aeration corrosion for sodium chloride medium
- The EIS tests showed that the sodium chloride medium was the most aggressive and indicated a slight difference in the corrosion behavior between parallel and pole faces

Acknowledgments

Thank you for your attention!

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CNPq
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FAPESP

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