

CORROSION STUDIES

By OrigaLys Instruments

Electrochemistry
OrigaLys



Photo credit : 

**Polarization for corrosion (Tafel) - Impedance (EIS) - Pitting Corrosion
General Corrosion (R_p) - Galvanic Corrosion (Evans) - Zero Resistance
Ammeter (ZRA) - Harmonic Distortion Analysis (HDA)**

MORE THAN 75 YEARS OF EXPERIENCE IN ELECTROCHEMISTRY

WHO ARE WE ?

Specialist in electrochemical analysis and measurement devices

Designing, manufacturing & selling of analytical instruments in Electrochemistry

Potentiostat, Galvanostat, Impedance meter, pH-meter, Conductivity Meter, Electrodes & accessories...



Customers all over the world



All our products are designed and manufactured in France



All our products are guaranteed for 5 years



30 distributors in 64 countries



90% of our partners are based in the Auvergne Rhône-Alpes region

MORE THAN 75 YEARS OF EXPERIENCE IN ELECTROCHEMISTRY...

1946

Tacussel



1988

Radiometer



2010

OrigalyS



2022

Origafactory



OUR PRIORITIES

CARING ABOUT PEOPLE

Participative management - Team-Building - Trust - Solidarity - Evolution



A close-knit & dynamic team

INNOVATE DIFFERENTLY & SUSTAINABLY

Initiative - Eco conception - Repairability - Sustainability - Performance



SHARE & TRANSMIT

Experiences - Preserve our know-how - Transmit - Train



INTRODUCTION

Metals are always exposed to corrosion risk because they are in permanent contact with air and humidity of environment, which cost huge irreversible damage for governments and many aspects of industries.

Despite various corrosion methods of analysis like "Wheel Test", "Salt Spray" which are based on gravimetry and visual inspection. Electrochemical methods are becoming more and more convenient for analyzing corrosion thanks to their high precision, accuracy, low costs and more efficient. They give users many information and details about the type of corrosion.

Potentiostats/Galvanostats are mighty practical instruments for electrochemical analyzing of corrosion phenomenons like:

- Comparing different metal alloys
- Comparing different corrosion inhibitors
- Probing corrosion in industry
- Qualification of coatings on metal surfaces

SUMMARY

Corrosion studies

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ORIGACORR

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ELECTROCHEMICAL METHODS OF CORROSION STUDIES

Polarization for Corrosion (Tafel)

The Polarization for corrosion tests is a linear voltammetry method at scan rates from 2 mV/sec down to 0,0166 mV/sec. The achieved polarization curves can be processed under Tafel Analysis giving practical information like as:

- Potential of corrosion
- Corrosion current
- Resistance of polarization
- Corrosion rate (mm/Y)

Résultats

$E(i=0)$: -278.8 mV

R_p : 99.78 kohm.cm²

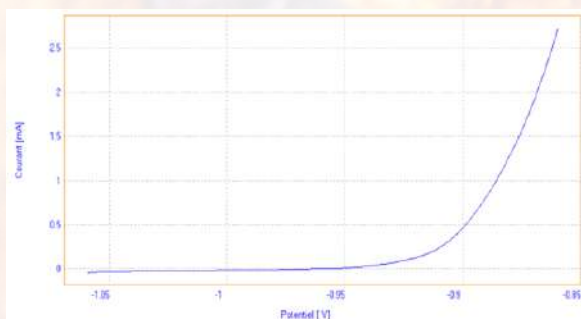
i_{corr} : 31.2445 nA/cm²

B_a : 35.7 mV

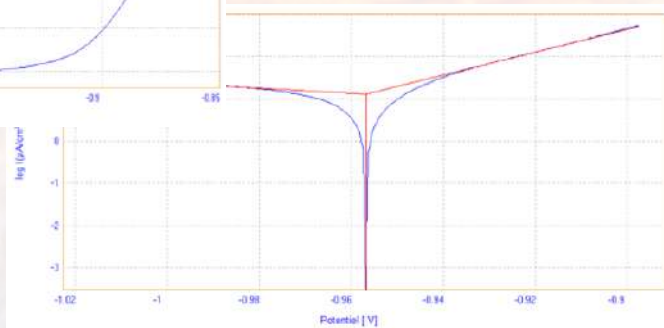
B_c : -41.4 mV

Coef. : 0.9986

Corrosion: 365.44 nm/Y



Linear voltammetry of steel in [NaCl]=0.7M

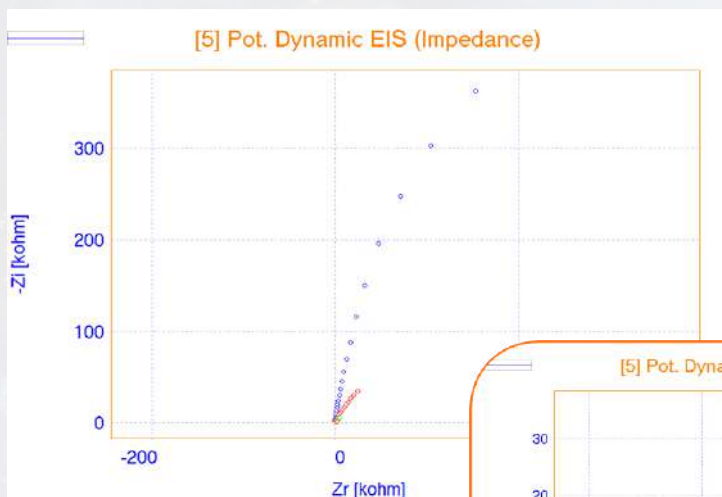


Tafel analysis on steel in [NaCl]=0.7M

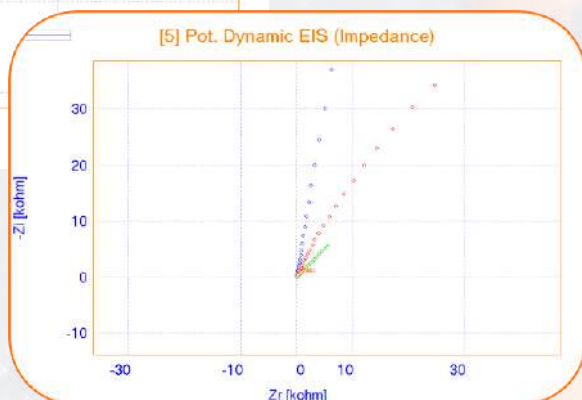
ELECTROCHEMICAL METHODS OF CORROSION STUDIES

Electrochemical Impedance Spectroscopy (EIS)

The EIS method consists of imposing a sinusoidal potential wave and the response of electrochemical system is measured. The sinusoidal wave will be scanned on a defined DC potential (most of the time OCP potential). The most important extracted data from Impedance Nyquist plot is Resistance of polarization of metal towards its environment correspond at its resistance against corrosion.



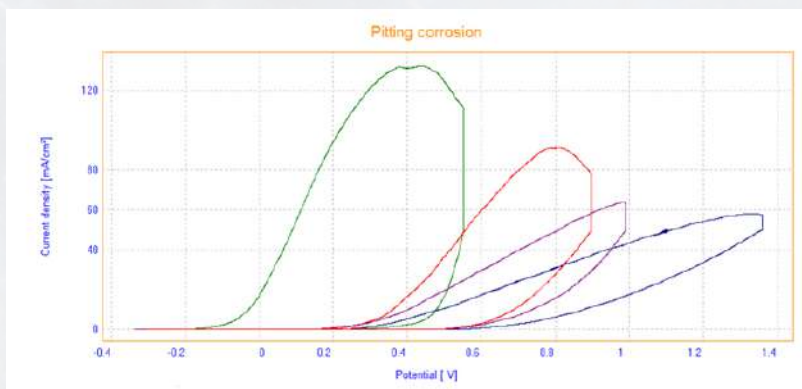
Nyquist plot of Impedance test (1kHz - 100 mHz) on stainless steel, Silver, copper and iron in 2g/L NaCl



ELECTROCHEMICAL METHODS OF CORROSION STUDIES

Pitting Corrosion

This is a voltammetry method in which potential is scanned towards anodic polarization at low scan rate and current is measured. The passive layer of metal sample and its electrochemical behavior could be investigated in different environments.



Pitting corrosion on stainless steel.

Green in 18M NaCl

Red in 14M NaCl

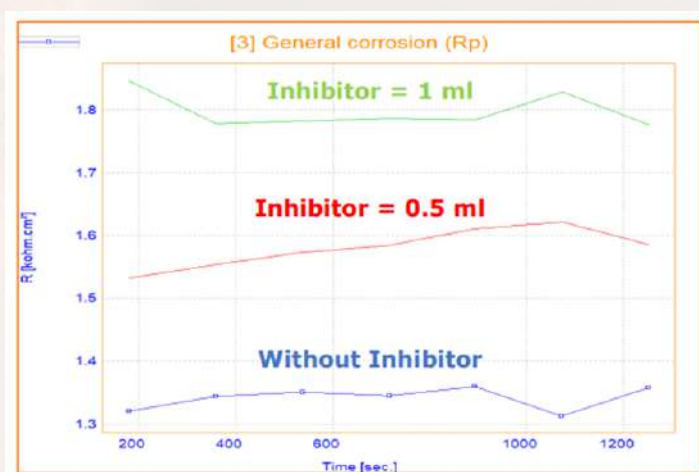
Purple in 10.5M NaCl

Blue in 0.7M NaCl

ELECTROCHEMICAL METHODS OF CORROSION STUDIES

General Corrosion (R_p)

In this method the resistance of polarization (R_p) will be calculated directly through software enabling users to investigate the efficiency of different inhibitors to prevent General (uniform) corrosion. This R_p can be used to evaluate the anti-corroding strength of an inhibitor.



Overlay of R_p results from 3 different tests

The blue line = R_p measurements of Iron in 2M NaCl - > without inhibitor.

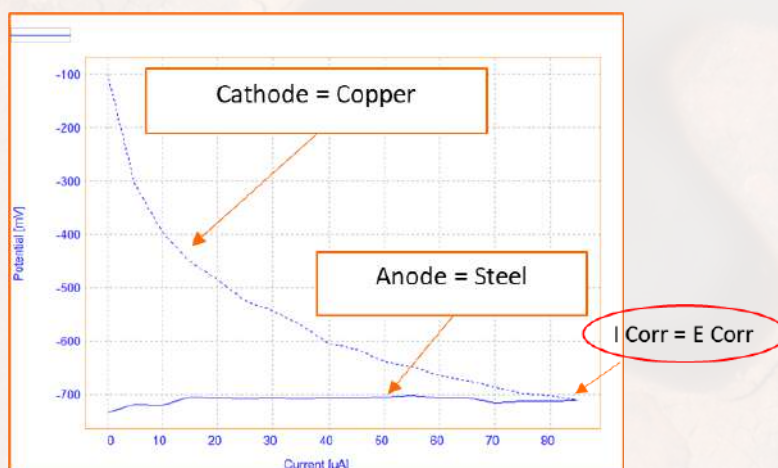
The red line = R_p measurements of Iron in 2M NaCl -> with 0.5 ml of inhibitor.

The green line = R_p measurements of Iron in 2M NaCl -> with 1 ml of inhibitor.

ELECTROCHEMICAL METHODS OF CORROSION STUDIES

Galvanic Corrosion (Coupled corrosion-Evans)

Coupled corrosion occurs when two different metals are in contact with each other in the same solution. The less noble metal (which is the more reactive) will suffer from oxidation (corrosion itself) while the more noble metal will undergo a cathodic reaction (reduction process) as predicted by the thermodynamic potentials of these metals. The Coupled corrosion (Evans) enable to determine the corrosion current (and therefore the corrosion rate) which is expected to take place at "rest" potential. This rest potential is also called a mixed potential.



Data from Coupled Corrosion Analysis in 0.7M NaCl

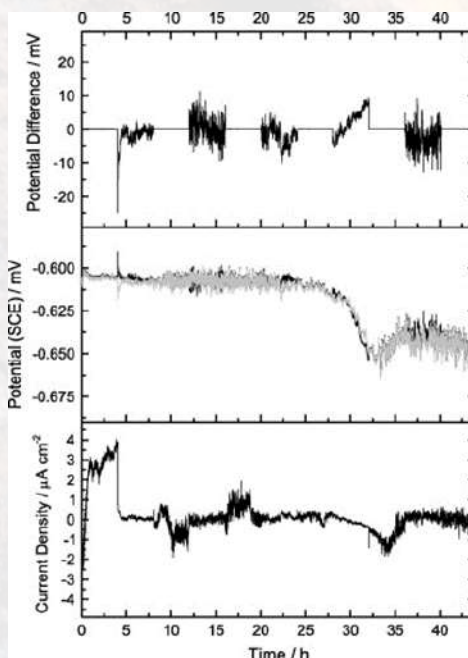
ELECTROCHEMICAL METHODS OF CORROSION STUDIES

Zero Resistance Ammeter (ZRA)

The "Zero Resistance Ammeter" (ZRA) method can be used for ElectroChemical Noise (ECN) measurement.

In order to prevent the potential induced by the shunt resistor of an ammeter, the instrument imposes a zero potential between the Working and Auxiliary outputs. Then, measure the current flowing from Working electrode terminal. This measurement represents the ECN current.

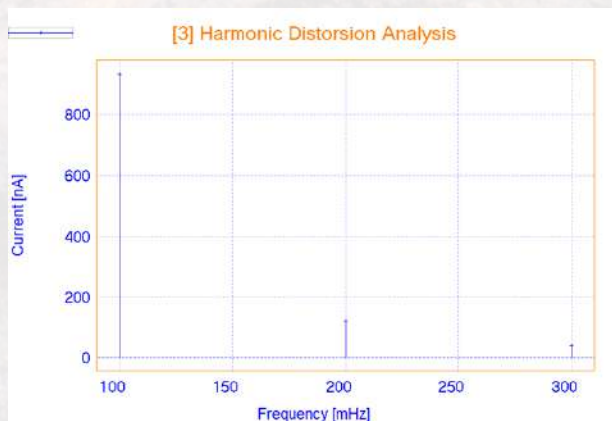
*Example of ZRA Analys
Ref: Corrosion Science
Volume 77, December 2013, Pages
281-291*



ELECTROCHEMICAL METHODS OF CORROSION STUDIES

Harmonic Distortion Analysis (HDA)

The HDA method is a non-destructive technique which imposes a sinusoidal potential wave at fixed frequency and amplitude following analysis of the distortion peaks. While not all the materials have perfect linear comportment, the choice of the weak amplitude is more recommended to not disturb the system. The informations obtained are identical to the TAFEL method as well as tacking less time. HDA brings together the advantages of both EIS and TAFEL methods which gives us indications on how corrosion develops.



*HDA curve related
to silver sample in
2g/L NaCl*

HDA Post Analysis - NaCl - 2g/L - Ag_N851_02h...

Settings

Atomic mass : 55.85 g
Valence : 2
Density : 7.8 g/cm3

Inputs

Freq. : 100.00 mHz
Voc : 25.0 mV

Measures

I 1 : 934.02 nA
I 2 : 122.84 nA
I 3 : 40.804 nA

Results

I corr. : 506.11 nA
ba : 32.444 V-1
bc : 51.049 V-1
Ba : 70.970 mV
Bc : 45.105 mV
B : 11.977 mV
Corrosion : 5.9215 $\mu\text{m}/\text{Y}$

POTENTIOSTATS

PACK ORIGASTAT - ORIGAFLEX



PACK OGS200 - SURFACE TREATMENT



This surface treatment pack is a potentiostat, galvanostat and impedance meter allowing you to use all the classic methods of electrochemistry and many others at an excellent value for money.

THIS PACK CONSISTS OF THE FOLLOWING ELEMENTS:

- Potentiostat/Galvanostat/Impedancemeter with its cell kit OGS200
- Its Rotating Electrode, OrigaTrod
- Its 8mm diameter sample holder
- All necessary electrodes
- All connection cables
- The control software, OrigaMaster 5

MAIN TECHNICAL SPECIFICATIONS:

- Maximum current: ± 2 A
- Current ranges: 20 nA to 2 A
- Applied potential: ± 15 V
- Compliance: ± 35 V

PACK OGF⁺01AEIS



The OGF01A Pack is a turnkey, autonomous and independent system, with a maximum current of 1 A. Available in version 500 mA, 05 A and 10A.

THIS PACK CONSISTS OF THE FOLLOWING ELEMENTS:

- The OrigaFlex OGFPWR pilot channel
- The OrigaFlex OGF01A Potentiostat/Galvanostat
- The integrated impedance channel
- All connection cables
- The control software, OrigaMaster 5

MAIN TECHNICAL SPECIFICATIONS:

- Current ranges: ± 10 nA to ± 1 A
- Max potential applied: ± 15 V
- Maximum current: ± 1 A
- Integrated EIS: 5 MHz - 10 μ Hz:

ZRA method

TTL communications

Voltage ranges: ± 3 V / ± 6 V / ± 15 V

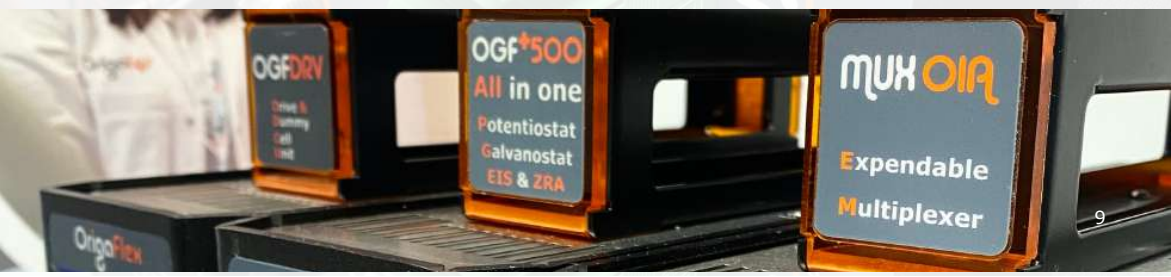
MULTIPLY YOUR RESEARCHES!

Duplicate your measurement channels with our Origamux multiplexer!

This instrument allows user to multiply their research thanks to the 8 integrated cells. Your measurements will be made sequentially with the presence of LEDs to indicate the selected cell.

ZRA mode allows for hold potential at 0 V with automatic recovery of your data in the event of a power failure. The different applications linked to the Origamux can be:

- Corrosion monitoring
- Corrosion inhibitor test
- Galvanic corrosion
- Surface treatment



CAREFULLY ANALYZE THE IN-SITU CORROSION SPEED!

Perform non-destructive measurements of corrosion rates with our field instrument!

This instrument is dedicated to corrosion research by giving direct results as corrosion rate, corrosion current, resistance of polarization.

No need to connect the instrument to PC during the test and it could be left for long time performing defined methods of corrosion. At the end user can collect the data just by connecting the instrument to the PC and open the related excel file.

- All the specifications of OGS potentiostat



ACCESSORIES

OrigaCell



Galvanic corrosion cell



Corrosion cell (Flow Cell)



More information :
www.origalys.com

ACCESSORIES

OrigaCell



Thermostatic corrosion cell



Corrosion cell (CEC/TH)



More information :
www.origalys.com

TESTIMONIALS

By OrigaLys Instruments



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We are working with an OrigaLys Multichannel system, testing different electrocatalytic materials used as anodes for fuel cells and we are also searching for methods of Photocatalytic Decontamination. The effects of using different catalysts are evaluated by electrochemical measurements of the generated species. The flexibility of the OrigaFlex System is a strong point for these instruments, as well as the high resolution and precision.



Scientific Research Center for CBRN
Defense and Ecology, Romania



“



We work on the anticorrosion coatings and we need to make measurements on characterizations and on production electrolyte research. By using this potentiostat, we develop the analysis method to anticipate the weak aspect of a process metal deposition. This device can be monitored, thus we can easily control the experiment conditions. It brings us a huge capacity to realize measurement on research field, and mainly on the process itself. The results are very relevant. The instrument is also useful to analyze metals in aqueous solution. It is a good environment advantage.



Aéroprotec, expert in aeronautic
coatings, Pau, France



“



A corrosion test is very delicate to realize for several reasons. It is necessary to know how to interpret the curves of corrosion and understand the phenomena. It is necessary to give to the laboratory series of implants with several qualities of state of surface and several thicknesses of passivation layer. It is only with such a level of trial report that we can hope to win the trust of an auditor of CE or FDA marking.



AMF, manufacturer of medical
implants, Lury sur Arnon, France



“



The miracles of the Electrochemistry



Haute Ecole Arc Conservation
restauration, Neuchâtel, Switzerland



TESTIMONIALS

By OrigaLys Instruments



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I like OrigaLys because they are a good quality/price ratio. In addition, the after-sales service is very efficient: my laboratory is in Chile and despite the distance, once a year I receive the visit of Cédric Martínez who updates my equipment both in hardware and the software.



Pontificia Universidad Católica de Chile, Chile



“



We chose to work with ORIGALYS© because this company is close to our values with Made In France equipment; devices are designed and manufactured in France. Pricing was also a criterion of choice regarding equipment, accuracy, robustness and reliability. In addition, OrigaLys has offered us the services of its engineering office to propose us a custom solution, that perfectly fit our needs. The machines are very easy to use with a "user-friendly" software. Programmable methods, graphics and different data export solutions facilitate measurement and result interpretation. The instrument is also useful to analyze metals in aqueous solution. It is a good environment advantage. The technical support of ORIGALYS© has contributed to the success of internal projects by being pro-active, fast and effective



Bic® Ecriture, writingsystems, Marne-La-Vallée, France



“



The CETIM has been working with OrigaLys for 10 years. It was one of our first suppliers of electrochemical equipment. We started with the acquisition of a multichannel potentiostat (8 channels with 1 impedance channel) which is still very functional today. OrigaLys is much more today than just a supplier, it has become a true partner and has accompanied us for all its years in our electrochemical tests. We can highlight the great listening and availability of the OrigaLys team. It ensures this quality technical follow-up and does not hesitate to go further to help us reflect on areas of improvement and development relevant to our tests. OrigaLys, for example, helped us develop an electrochemical test method to qualify a sacrificial anode following the requirements of a specification from one of our customers. Today, we set up with their technical support electrochemical permeation tests to measure the amount of hydrogen entering a metallic material.



CETIM, Nantes, France



CORROSION STUDIES

By OrigaLys Instruments



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