ModuLab®

electrochemistry

Application Guide

DC cell analysis techniques
Electrochemical noise

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Application Guide: AGML14

Introduction

Electrochemical noise measurements are used for characterization of a wide range of corrosion effects including stress corrosion cracking and pitting corrosion. The experiment usually involves two similar working electrodes that are connected via a Zero Resistance Ammeter (ZRA). ZRAs are made up of a virtual earth amplifier circuit that can measure small current disturbances between the electrodes. It is very important that there is no voltage drop between the electrodes, and this is difficult to design while maintaining the protection of the instrument's WE input against accidental damage when it is used in normal potentiostatic operation. The ModuLab design accomplishes this requirement while also providing floating electrodes which is another requirement of the technique. Fast measurement capability is also needed, typically up to 1000 measurements per second is sufficient for the application. The ModuLab system can also provide Fast Fourier Transform analysis of the signals by utilizing the capabilities of its frequency response analyzer (FRA).

Key system capabilities used in this demonstration

- Floating measurement electrodes
- Zero Resistance Ammeter (ZRA).
- High measurement data sample rates

Equipment required for this demonstration

- ModuLab potentiostat
- 2 paper clips (or similar materials)
- Coca Cola is an excellent electrolyte for this experiment since it is acidic and non -toxic. It will rapidly corrode the sample and will demonstrate the capability of the system in a short period.

Connections

- Electrochemical noise measurement connections are used where WE and Lo connect to the two similar electrodes in solution. RE1 can connect to a reference electrode and RE2 to the Lo.

Experiment setup

Select "AGML14 Electrochemical Noise" in the "ModuLab Application Guide" project

Step #	Purpose
Step 1	Run a DC test in voltage control mode and monitor voltage and current vs. time

Additional test possibilities:

- A frequency response analyzer can be used to measure the Fast Fourier Transform of voltage and current vs frequency. This gives information about the type of noise that is being measured.

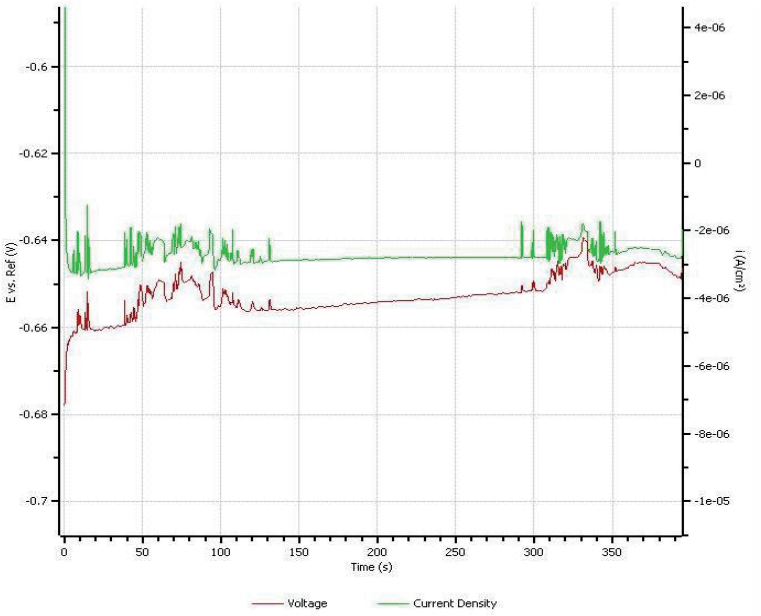
Notes on setup

Consult the setup files in the ModuLab demonstration software for more details.

Data presentation and analysis

A very powerful feature of the ModuLab software is the ability to vary the speed of data acquisition during a step. Since electrochemical noise occurs on a short timescale (10 ms to 1 second being typical), it is necessary to sample the current and voltage response of the cell rapidly. This could result in very large data files which might limit the duration of the test. ModuLab eliminates this problem by allowing the user to change the data capture speed as a function of the rate of change of the current. For example, in Figure 1, the background sampling rate was 1 sample per second. If the current changed by 2 µA between samples, the instrument was programmed to sample at 1000 samples per second. The transition from 1 sample per second to 1000 samples per second can clearly be seen.

The raw current and voltage data can be exported to third party programs for further statistical analysis. For example, one can perform an FFT analysis to determine the frequency characteristics of noise results which can help to identify the electrochemical processes occurring.



Conclusions

The ModuLab's unique floating zero resistance ammeter (ZRA) design provides the ideal tool for researchers investigating a wide range of corrosion phenomena. High measurement capture rates and the use of Fast Fourier Transform analysis which aids in the identification of corrosion phenomena provide a wide range of options for this application.

Further measurement possibilities include

- Ability to sample full frequency spectrum as a function of time that can aid identification of electrochemical processes
- Multi-sine/FFT can be sequenced with DC ECN steps to provide detailed information of processes
- Ability to record changes in impedance as a function of time at discrete frequencies

For a detailed description of Electrochemical Noise techniques and analysis of data, we recommend consulting the work of Prof. Bob Cottis at the University of Manchester, UK.

Application Guide

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