

How to make Cyclic Voltammetry (CV) with the BaSyTec Test System

Introduction

Within electrochemical material research CV is a well known analysing method. It shows the potentials and speed of the oxidation and reduction reactions of the analysed material.

Therefore a three electrode arrangement with the working electrode, the counter electrode and a reference electrode is used:

Working electrode (WE): The electrode that will be analysed

Counter electrode (CE): Only necessary for current flow.

Reference electrode (RE): Electrode for potential measurement. The potential is measured between the working electrode and the reference electrode. During the CV this potential is controlled.

The following two figures show measurement set-ups for positive and negative electrodes:

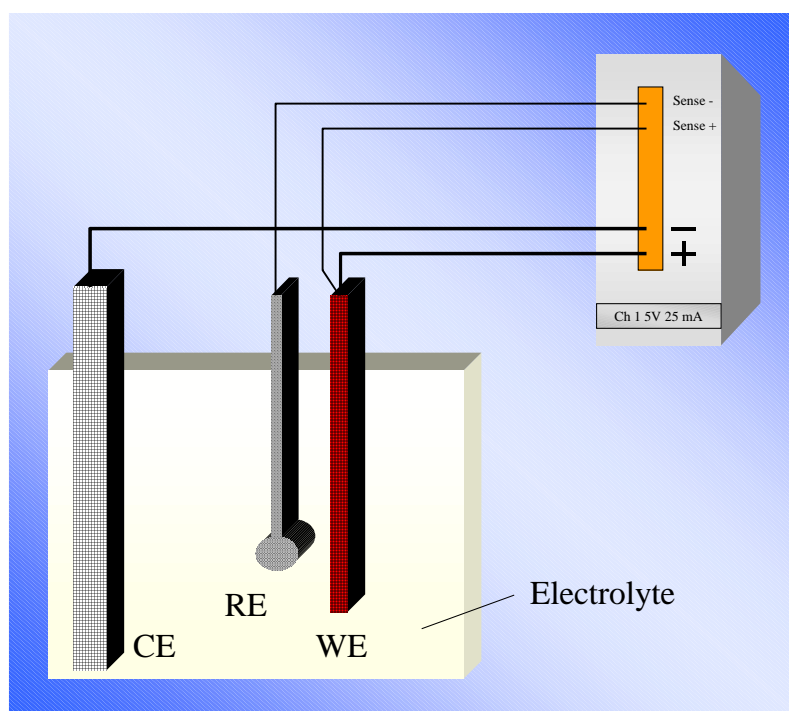


Figure 1: CV measurement set-up for a positive electrode

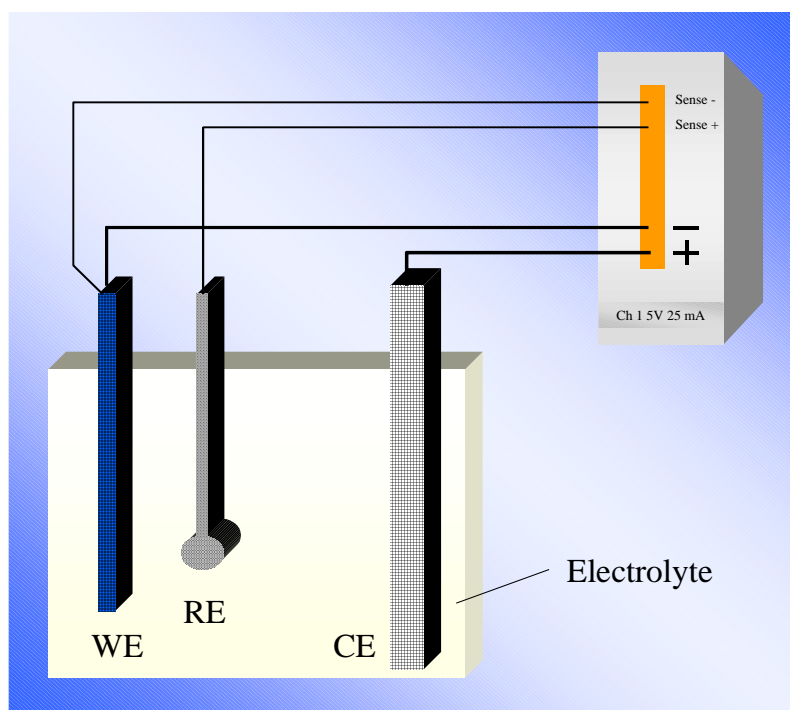


Figure 2: CV measurement set-up for a negative electrode

For the CV itself both measurement set-ups can be used. But take care of the right sign of the voltage. If the electrode is pre-polarized before the CV is carried out and this procedure is done by a constant current-constant voltage method the electrode type (negative/positive) must be taken into account for choosing the right measurement set-up (see figure 1 and 2).

During the CV the potential between reference and working electrode is cyclically changed and the current response is measured. For analysing a current vs. voltage plot is used.

Test-plan

The following figure shows an example for a CV of a lead probe. The reference electrode is a Hg/HgSO₄. The measurement set-up of figure 1 was used. Therefore the potentials are positive in the test-plan.

Line 2 is used to pre-polarize the electrode to the initial potential of the CV. The CV is carried out between line 3 and line 7. In total three cycles are carried out (line 3 and line 7). Line 4 is used to reset the settable counters. Within line 5 the potential is increased from -1200 mV to -800 mV with a slope of 1 mV/second. In line 5 the electrode potential is reduced from -800 mV to -1200 mV with -1 mV/second.

The change of the sign is caused by the use of a negative electrode with the experiment set-up for positive electrodes. The same experiment could be carried out with the set-up for the negative electrode. In this case all signs of voltages must be changed.

	Level	Label	Command	Parameter	Termination	Action	Registration	Comment
1			Start					
2			Charge	U=1200mV	t>5min		t=30s	Pre-polarisation
3			Cycle-start					CV cycle
4			Set	t-Aux=0.0s Ah-Ch-Set=0.0Ah Ah-Dis-Set=0.0Ah				
5			Ramp-u	U1=1200mV Slope=-1mV/s U2=600mV	U<800mV		t=1s	
6			Ramp-u	U1=900mV Slope=1mV/s U2=1500mV	U>1200mV		t=1s	
7			Cycle-end	Count=3				
8			Stop					

Data Analysing

The following figure shows the result of the above described measurement. CV measurement. Only one cycle is displayed and the sign of the values is changed again to get the true potentials.

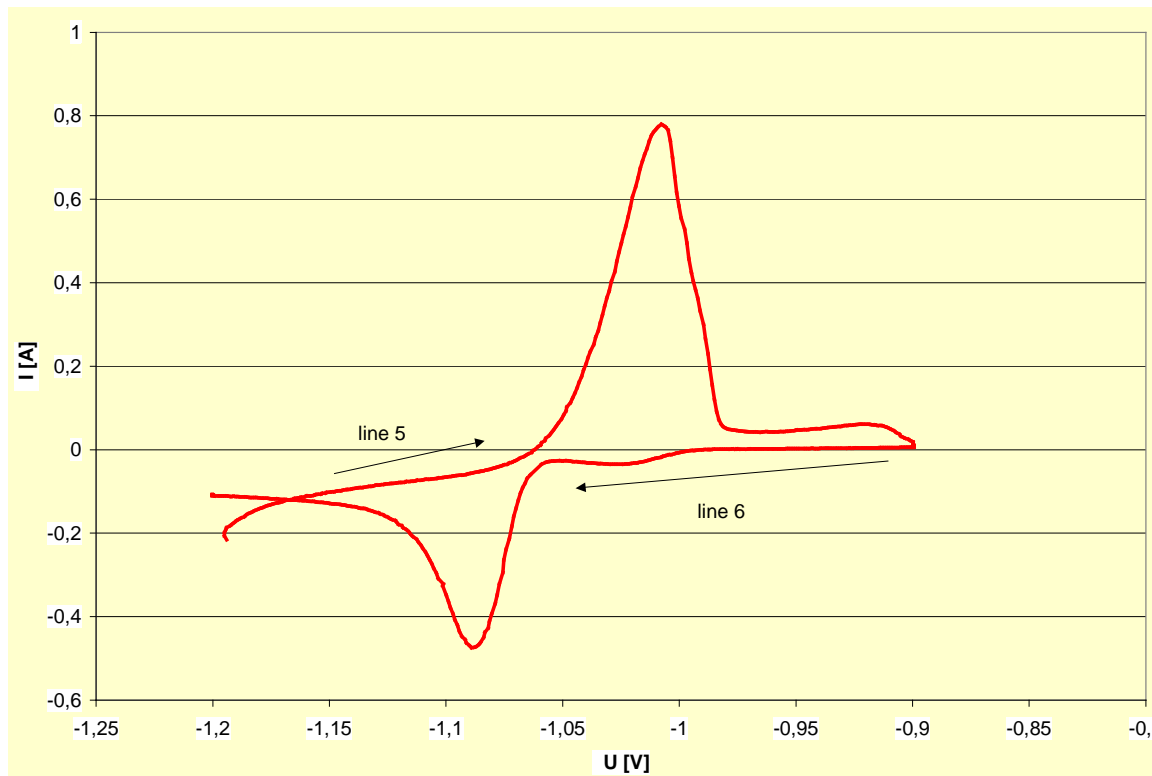


Figure 2: CV measurement result

Tips and Tricks

The following should be taken into account for CV measurement:

- To get a high accuracy the test system should be operated in the pulse (basytec) modus. In case of the standard/Beate modus the accuracy is reduced.
- Do not change the polarity of the sense lines. The polarity of the sense line must be in that way that an increased current leads in an increased sense voltage. Otherwise the control system will not work correct.
- Take the measurement resolution and accuracy into account. A test channel should be used in the range of 1% to 100 % of the rated parameters.
- Within the graphical analysing screen it is very simple to change the sign of the values. Double click the curve and then edit the SQL command. You will find a command like this:

```
select D.'U[V]' as X, D.'I[A]' as Y, D.'Line'  
from .....
```

change this to:

```
select -D.'U[V]' as X, -D.'I[A]' as Y, D.'Line'  
from .....
```

This will change the signs of the X and Y values. This was done within figure 3.