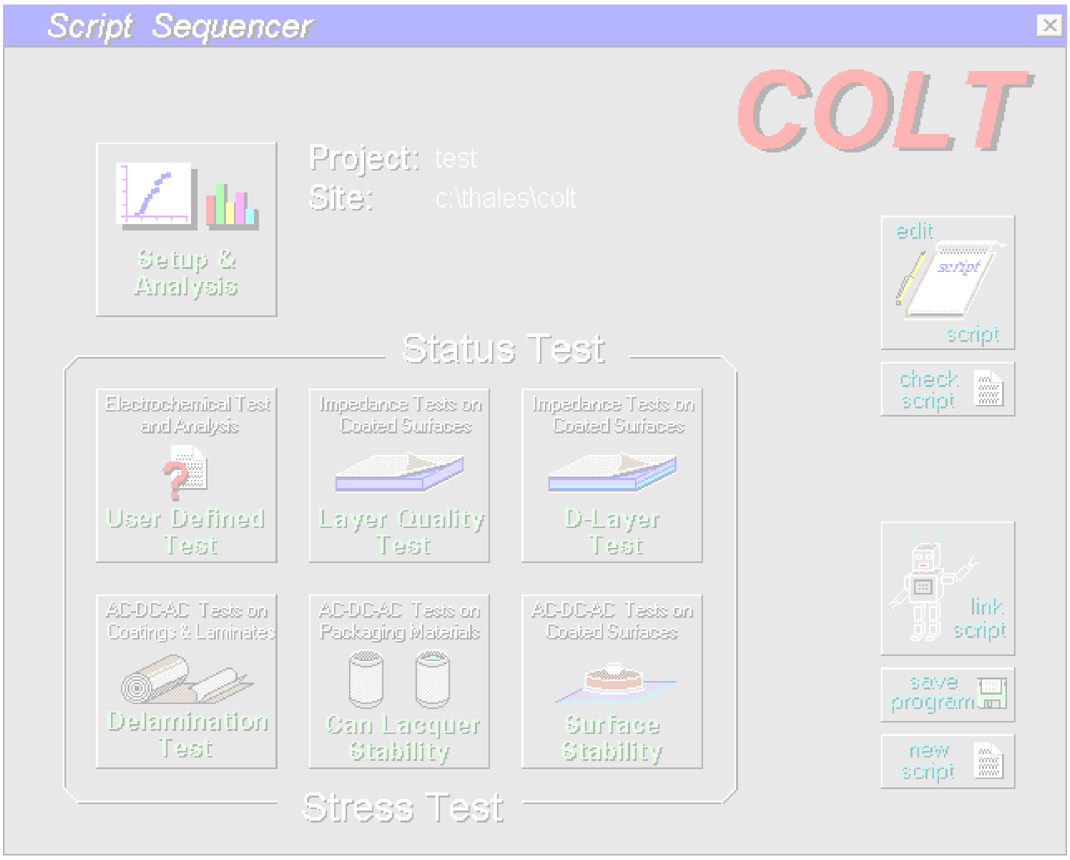
COLT

Coating & Laminate Tester



ZAHNER

05/2022

1 Introduction

Coated metals and metal-compounds possess enormous importance as packaging materials worldwide. The manufacturers of food packaging such as tins, foils etc. bear a great risk: **packaging failure at the customer may quickly result in a recourse exceeding billions of dollars**.

The weak points of foils and coating systems are well-known and often involve the adhesion between metal and coating. Already during the production, processing steps such as stretching, deep drawing, stamping or printing create mechanical stress. The sterilization process and of course the corrosive effects during storage of the products themselves can generate and expand cracks and pores within the protective coating, leading to breakdown of the metal-polymer bond and eventually to the delamination of the coating.

In general, electrochemical methods are suitable for determining the quality of packaging materials. In particular, Electrochemical Impedance Spectroscopy (EIS) is a sensitive tool for the detection of pores or damaged locations as well as for measuring the quality of lacquers and coatings.

Merely determining the quality level is not sufficient to provide a reliable prediction of failure cases. Even when EIS is used, it is only in combination with systematic stress or ageing trials that reliable prediction can be obtained.

Therefore, a successful strategy consists of combining the determination of the actual condition with stress intervals. Thereby, it is possible to trace the changes in the material's general condition triggered by the effects of stress.

An advantageous strategy to simulate realistic stress exposed on the packaging of a prefabricated under presence of the product substance while avoiding expensive, time-consuming ageing tests, is:

Accelerate the natural degradation of the packaging material by electrochemical stress!

Cathodic polarization of the polymer-metal interface accelerates, by orders of magnitude, the natural processes of

- dissolution of metal traces
- alkalization
- hydrogen formation
- delamination.

The advantage of using electrochemical stress, compared to all other methods of accelerated degradation, is that the test object can remain in the same testing equipment for the application of stress as is used to determine the condition of the coating.

The determination of the condition by means of non-destructive EIS (AC method) requires an electrochemical workstation. Its integrated potentiostat also controls the electrochemical stress phase through cathodic polarization (DC method). Determining the condition of the material following controlled stress is carried out once again by means of EIS (AC method). Precise analysis of the changes between the ‘before’ and the ‘after’ state provides the basis for reliable prediction.

This AC-DC-AC sequence provided the name for this testing sequence.

AC-DC-AC was developed over recent years by Dr. Jochen Hollaender at the *Fraunhofer Institut für Verfahrenstechnik und Verpackung* in Freising, Bavaria, and has been perfected by Zahner as a reliable, automatic test method.

The COLT System.

The Zahner Zennium X/Pro/XC Electrochemical Workstation represents the heart of the COLT. It is renowned for its high precision, ease of use and comprehensive software package.

Its revolutionary **Script** software concept allows full automation of the complex processes. The Script COLT controls the execution of the AC measurement, the subsequent DC polarization with recovery phase and finally the AC measurement in strictly reproducible form. The reliable analysis of EIS measurements is not trivial. For this reason, COLT also carries out the comparative impedance analysis, reducing the data to well-defined, meaningful results, recording all the important parameters in a form suitable for statistical analysis, and the documentation of each individual measurement together with a printout or file export.

2 Software Installation & Start

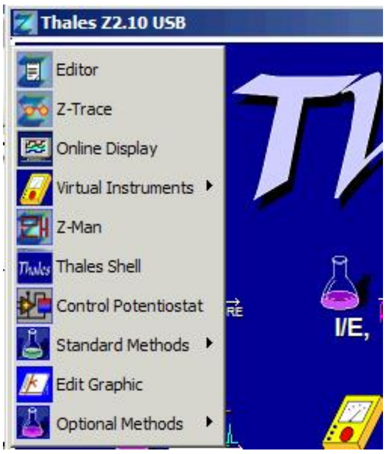
The COLT software is content of the standard delivery package of the THALES software package and available after its installation. For COLT, no further installation procedure is necessary.

Enter the COLT software through the pull-down menu navigator as follows:

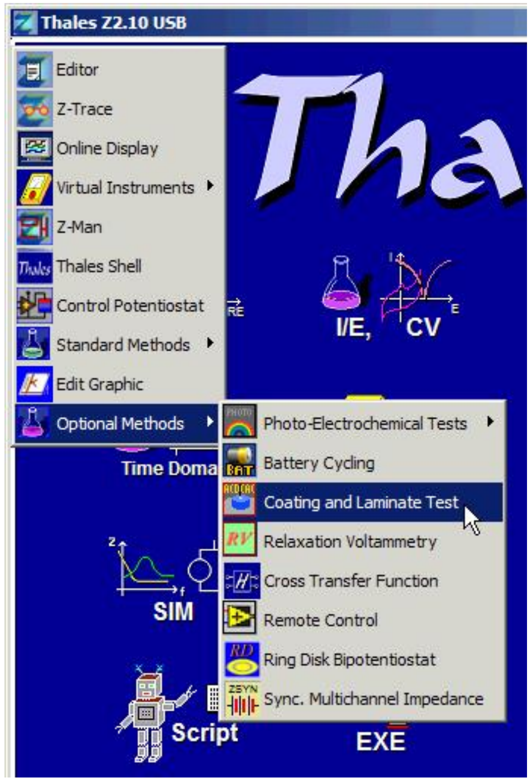
1. Position the mouse cursor on the THALES “Z” icon on the leftmost edge of the THALES window taskbar.

2. Confirming with the left mouse key will open the pull-down menu navigator.

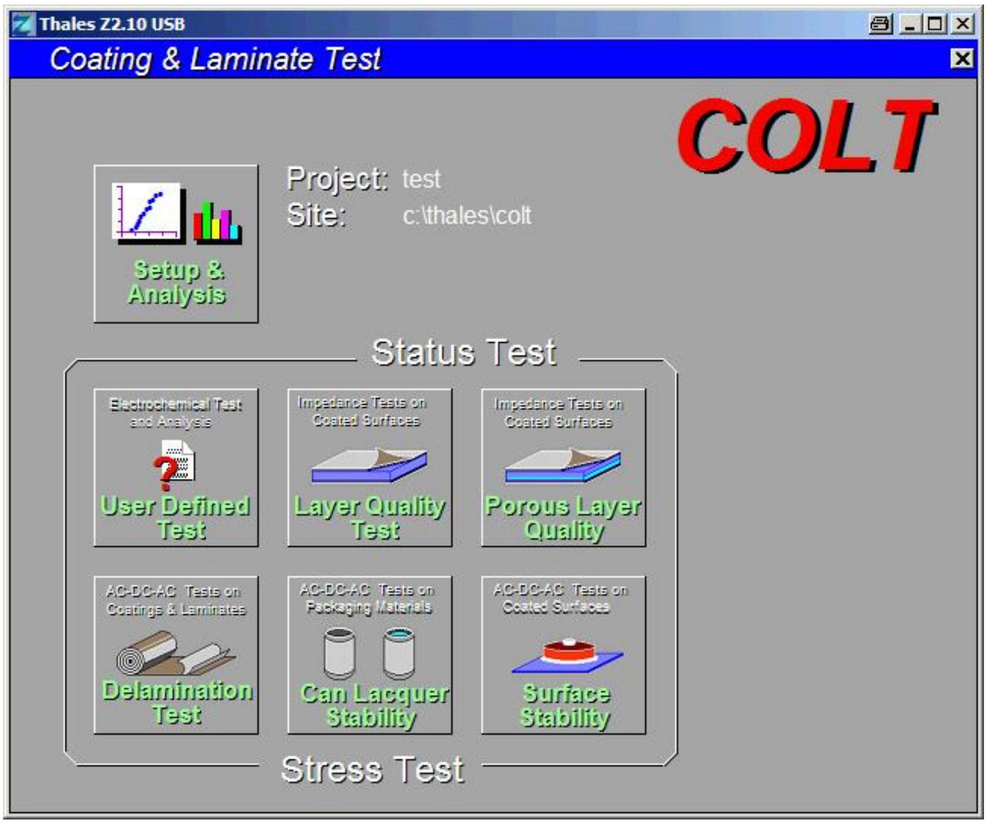
Choose *Optional Methods*.



3. The next level of the pull-down menu navigator will pop up. Choose *Coating and Laminate Test* and confirm.



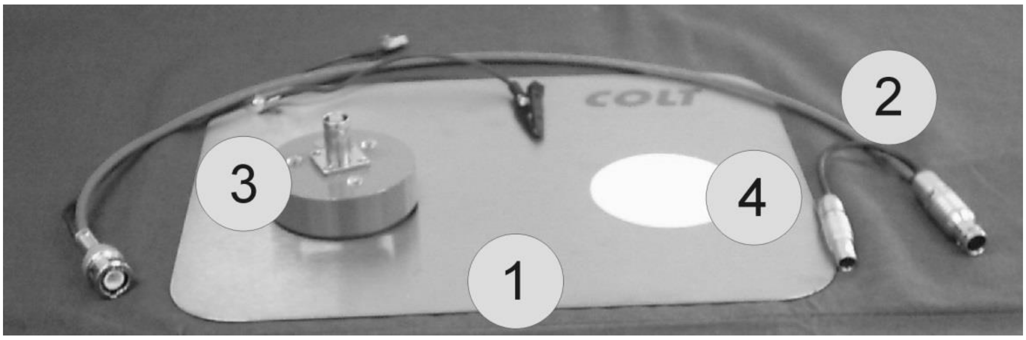
The COLT panel opens up as follows:



Within the THALES package, COLT was written as so called *Script*. The source code for COLT is accessible to the user, which allows for further modifying or extending COLT by individual routines. COLT provides a button *User Defined Test* as a short-cut for integrating user-defined routines. Please consider that COLT is a highly complex application. It is therefore not recommended for inexperienced users to modify the application, except for manipulating the so-called description files, which is explained later. Please refer to the *SCRIPT* manual for further details.

3 COLT Hardware

3.1 Bipolar Block-Cell / Coating Stability Test



1. High-grade steel base plate with grounding connector and test electrode connector
2. Connection cable with 2 Lemo-, 1 BNC- and 1 ground connector
3. Cu counter electrode with integrated shielding
4. Electrolyte carrier
5. Buffer solution pH ≈ 7 (aqueous Hydrogen-/Di-hydrogen phosphate)

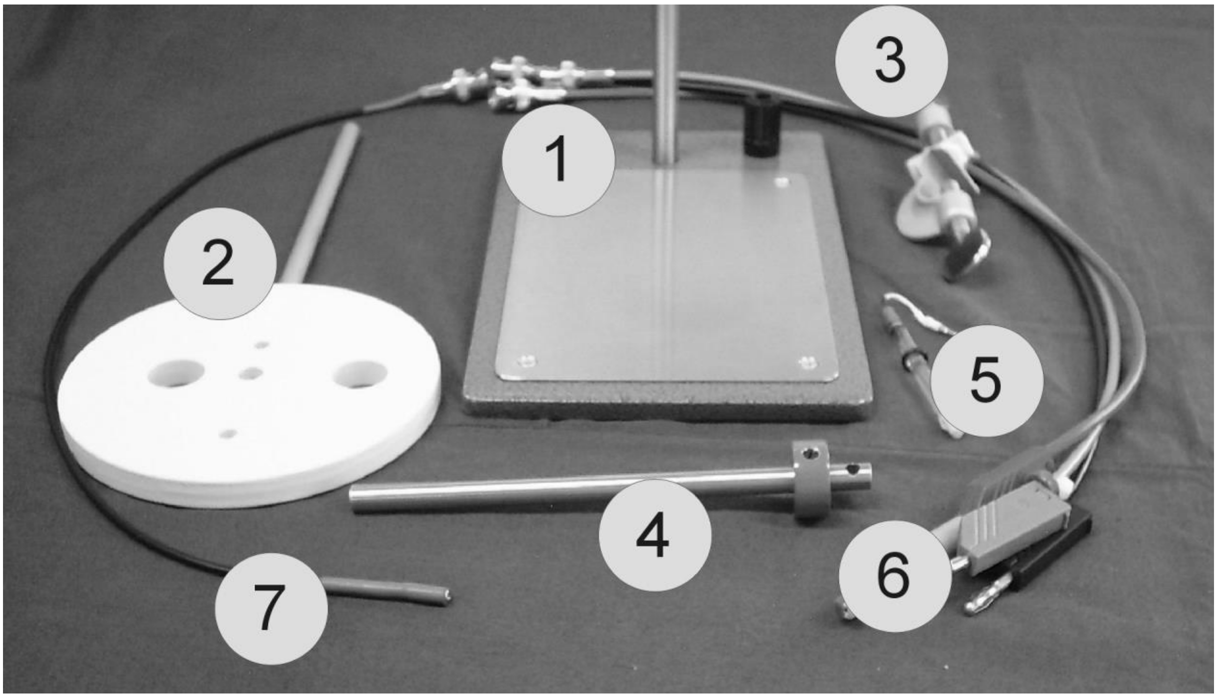
Set-up

1. Connect the IM-system to the 'Bipolar block-cell' using the cable (2). The LEMO plugs are meant for the Zennium side.
2. Connect the BNC plug of the cable (2) to the BNC-outlet of the Cu counter electrode (3). Connect the grounding plug to the base plate connector.
3. Position the foil sample to be investigated in the middle of the base plate.
4. Contact the foil sample with the alligator clip.
5. Moisten one electrolyte carrier (4) with buffer solution and position it on your foil sample.
6. Position the Cu counter electrode on the electrolyte carrier so that it is covered best.
7. Start the measurement.

Maintenance

1. Avoid damaging the shielding of the Cu counter electrode (e.g. by a harsh handling).
2. Do not turn the Cu counter electrode upside down directly at the end of the experiment, but first wipe off the buffer solution sticking to the electrode with a clean cloth. With this you can avoid a contamination of the sealing rings inside the electrode with salt.
3. After longer use of the Cu counter electrode the copper may show a dark coat. This does not affect the measurement.

3.2 In-Situ Can Test



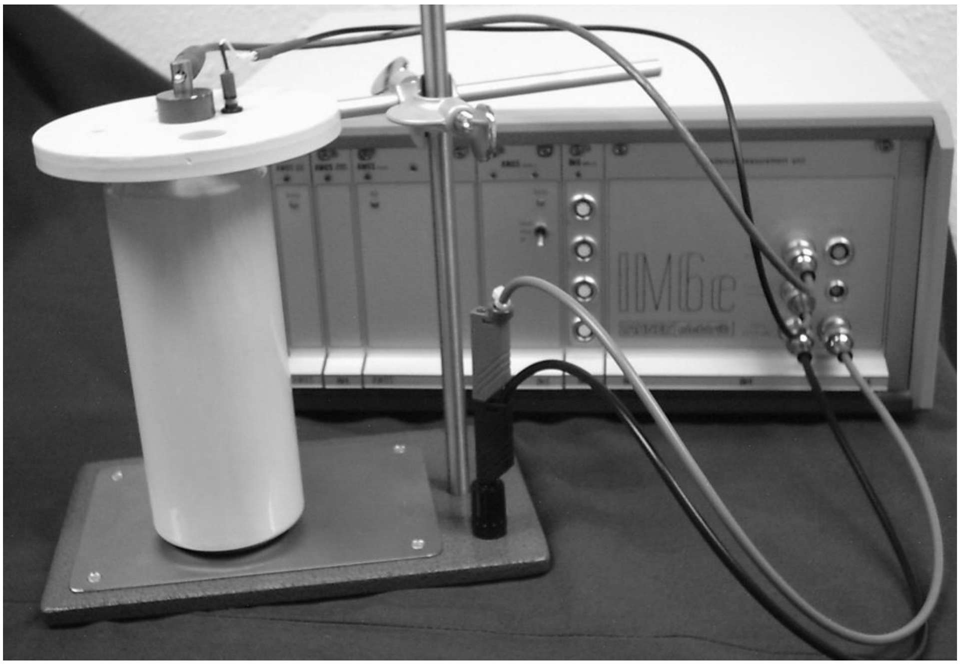
1. Grounded stand with integrated, planar high-grade steel test electrode contact
2. Top with openings in different distances for reference electrode, centered opening for counter electrode and clamps for fastening it to the stand rod.
3. Stand clamps
4. Adjustable high-grade steel counter electrode
5. Ag/AgCl reference electrode with O-ring (see 4. Cut Edge Delamination Test)
6. 3 standard cables BNC to 4 mm banana plugs (red = counter electrode, black = test electrode, blue = test electrode sense)
7. 1 cable BNC to 2-mm-outlet (green ends: reference electrode)

Set-up

1. Position the can which is to be investigated on the plate of the stand (1). The bottom or the lower edge of the can must be in electrical contact with the plate.
2. Fill the can with electrolyte or buffer solution.
3. Fix the top (2) to the stand using the stand clamp (3). The top should be at about the same height as the upper edge of the can.
4. Adjust the height of the high-grade steel reference electrode (4) so that a majority part is covered by the liquid. The electrode must not touch the bottom of the can nor must it touch the surface.

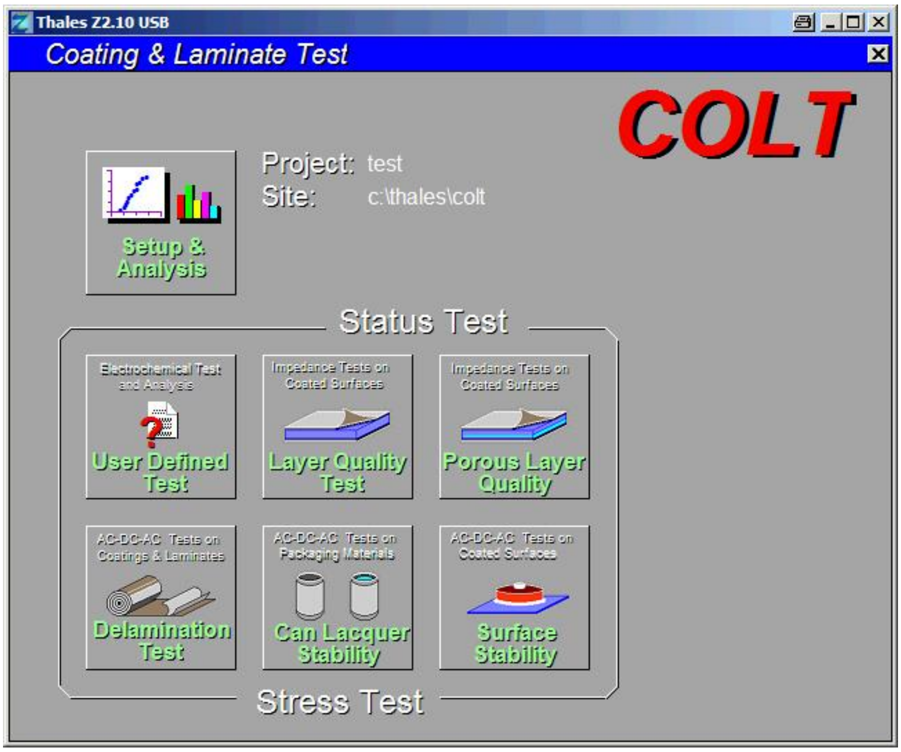
5. Put the reference electrode (5) into one of the fitting openings of the top after you put on the O-ring to the electrode. Note: the two wider openings in the top (2) are for future extension, and are not used presently.
6. Set up the electrical contact between the electrodes and the Zennium workstation as follows:
   a. Put the test electrode cable (black) and test electrode sense cable (blue) together into the black outlet of the stand (1).
   b. Put the counter electrode cable (red) into the appropriate opening of the high-grade steel counter electrode (4).
   c. Connect the reference electrode cable (green) to the 2-mm-outlet with the plug of the reference electrode (5).
7. Now you can start the measurement.

The figure below shows an example of a correct measurement set-up.



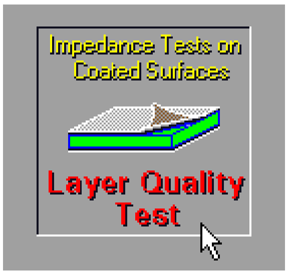
4 COLT Methods

From the main menu of the COLT software, the user may call one of five different methods. An additional button is reserved for a user-defined method.



The provided COLT methods can be divided into two classes: the *status tests* and the *stress tests*. Further on, the methods differ into 'electrochemical hardware' and the equivalent circuit models used.

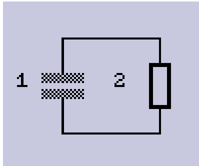
4.1 Layer Quality Test – LQT[1]



Parameters:

Rest potential (open circuit potential)	OCP
Layer capacity (1)	C
Exponent (1)	EXP
Polarization resistance (2)	RP

Equivalent circuit[2]:



- Electrochemical hardware: 'Bipolar block-cell'
- Measuring arrangement: 2-electrodes
- Parameter files: **c:\thales\colt\layer.ism** (impedance)
  c:\thales\colt\layer.isf (model)

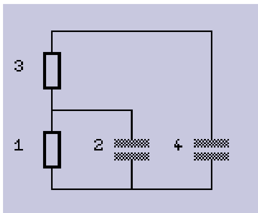
With the LQT method, the sample quality is measured by means of an impedance measurement at rest potential. The measurement parameters are defined in the file *layer.ism*. When the measurement is finished, the impedance curve is fitted using the model defined in the file *layer.isf* (see scheme above). From the fitted data, the parameters layer capacity, loss angle and polarization resistance are taken and stored along with the measured rest potential.

4.2 Test Porous Layer Quality - TLQ

Parameters:

Rest potential (open circuit potential)	OCP
Loss capacity 1 (2)	C1
Exponent 1 (2)	EXP1
Resistance 1 (1)	R1
Loss capacity 2 (4)	C2
Exponent 2 (4)	EXP2
Resistance 2 (3)	R2

Equivalent circuit[2]:



- Electrochemical hardware: 'Bipolar block-cell'
- Measuring arrangement: 2-electrodes
- Parameter files: **c:\thales\colt\bilayer.ism** (impedance)
  c:\thales\colt\bilayer.isf (model)

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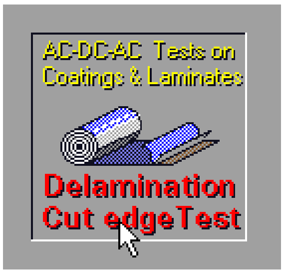
[1] The three characters marked in blue in the method title line are used as folder names for the corresponding storage site of experimental data.

[2] An electrolyte resistance is considered during the fitting procedure, which is not displayed here.

In analogy to LQT, the TLQ method is used to investigates the sample quality by means of an impedance measurement at the rest potential. The measurement parameters are defined in the file *bilayer.ism*. When the measurement is finished, the impedance curve is fitted using the model defined in the file *bilayer.isf*. From the fitted data, the parameters of the loss capacities C1, EXP1, C2, EXP2 and the resistances R1 and R2 are evaluated and stored together with the measured rest potential.

4.3 Delamination Cut Edge Test – CET (Stress Method)



Parameters:

Rest potential before stress	OCP1
Polarization current at the beginning of stress	I0
Polarization current after 1 minute	I60
Polarization current at the end of stress	I120
Rest potential after stress	OCP2
Layer capacity before stress	C1
Layer capacity after stress	C2
Delamination depth	Del.Depth

- Electrochemical hardware: ring electrode arrangement
- Measuring arrangement: 3-electrodes with reference electrode
- Parameter files: **c:\thales\colt\cutedge.ism** (impedance)
  c:\thales\colt\cutedge.isf (model)
  c:\thales\colt\cutedge.isw (polarization)

The CET method is used for investigations of foils. It is an AC-DC-AC type method where the sample is measured first at the rest potential. The measurement parameters are defined in the file *cutedge.ism*. The first impedance measurement is followed by a polarization phase. In the first two minutes of that phase the electrical stress (P_{pol}= -2V) is applied and then the new rest potential is measured for one minute. After that, a second impedance measurement at the new rest potential is performed.

For analysis, the measurement values at 100 Hz (before and after stress) are taken to calculate the capacities from their imaginary parts. From the change of that capacity, the delamination depth *D* can be calculated according to the following formula:

$$D = \frac{C2 - C1}{43nF} \cdot \frac{1000}{K}$$

K: cut edge length [K] = mm

D: Delamination depth [D] = µm

C2: Capacity value from second spectrum

C1: Capacity value from first spectrum

(43 nF: capacity of the double layer of Al concerning the dimension of the electrode)

4.4 Can Lacquer Stability Test – CLT (Stress Method)

Parameter:

Rest potential before stress	OCP1
Polarization current at beginning of stress	I0
Polarization current after 1minute	I60
Polarization current at end of stress	I120
Rest potential after stress	OCP2
Layer capacity before stress	C1
Layer capacity after stress	C2
Layer resistance before stress	R1
Layer resistance after stress	R2

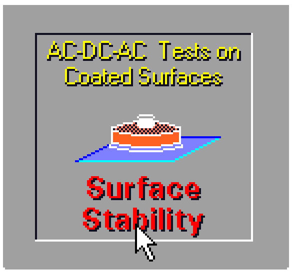
- Electrochemical hardware: Rod-electrode set
- Measuring arrangement: 3-electrodes with reference electrode
- Parameter files: **c:\thales\colt\canstab.ism** (impedance)
  c:\thales\colt\canstab.isf (model)
  c:\thales\colt\canstab.isw (polarization)

The CLT method is a further variation of the AC-DC-AC method, which is used for investigating cans. In the first step, an impedance measurement at rest potential is performed. The measurement parameters are defined in the file *canstab.ism*. In the first two minutes of the consequent polarization phase, an electrical stress (P_{pol}= -2V) is applied, after which the new rest potential is measured for one minute. Finally, a second impedance measurement at the new rest potential is performed.

For analysis, the measurement values at 10 Hz and 10 kHz (before and after stress) are taken to calculate the layer resistances *R* and layer capacities *C* from their real parts.

$$R_n = real(Z(10\,Hz)) \qquad\qquad C_n = \frac{1}{2 \cdot \pi \cdot \omega \cdot imag(Z(10\,kHz))}$$

4.5 Surface Stability Test – SST (Stress Method)



Parameter:

Rest potential before stress	OCP1
Polarization current at beginning of stress	I0
Polarization current after 1 minute	I60
Polarization current at end of stress	I120
Rest potential after stress	OCP2
Layer capacity before stress	C1
Layer capacity after stress	C2
Layer resistance before stress	R1
Layer resistance after stress	R2

- Electrochemical hardware: Bipolar block-cell
- Measuring arrangement: 2-electrodes
- Parameter files: **c:\thales\colt\surfstab.ism** (impedance)
  c:\thales\colt\surfstab.isf (model)
  c:\thales\colt\surfstab.isw (polarization)

The SST method is used for the investigation of flat samples (metal sheets, foils, etc.) and is also based on the AC-DC-AC method.

In a first step, an impedance measurement at rest potential is performed. The measurement parameters are defined in the file *surfstab.ism*. In the first two minutes of the subsequent polarization phase, an electrical stress (P_{pol}= -2V) is applied. Then, the new rest potential is measured for one minute. After that, a second impedance measurement at the new rest potential is performed.

For analysis, the measurement values at 10 Hz and 10 kHz (before and after stress) are taken to calculate the layer resistances *R* and layer capacities *C* from their real parts.

$$R_n = real(Z(10\,Hz)) \qquad\qquad C_n = \frac{1}{2 \cdot \pi \cdot \omega \cdot imag(Z(10\,kHz))}$$

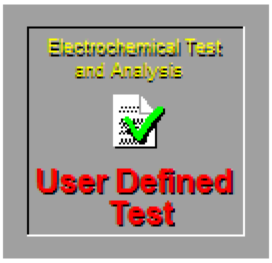
4.6 Modification of AC and DC parameters

To modify the parameters of impedance measurement and polarization phase, load the corresponding data file into the EIS-program respectively into the polarization program. Setup the potentiostat and define the recording parameters such as frequency range, amplitude, resolution, etc. Then start the measurement and check if it will run correctly. The changed parameter file will finally be generated by overwriting the old one.

- **Note:** modification of model files (*.isf) is critical, if the parameter sequence of the used impedance elements is changed.

- **Note:** to extend the potential range up to 10V, use the buffer and select the corresponding connection scheme. That connection scheme will be stored within the parameter list of the corresponding impedance parameter file *.ism.

4.7 User Defined Test - UDT



Parameters:

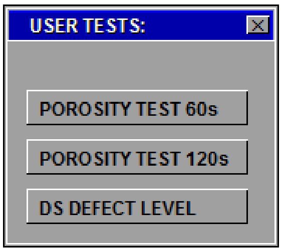
Advanced user can define own test procedures in the COLT script:

C:\Thales\script\colt\colt_src.is_

The *SCRIPT1* section is reserved for this user defined test procedures. An example is given in the COLT script.

For more information about user defined test procedures refer to the SCRIPT manual.

Example:

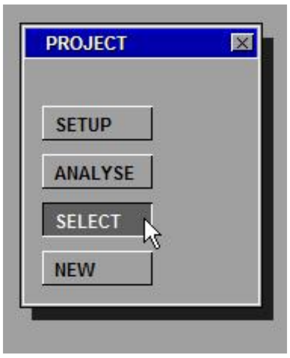


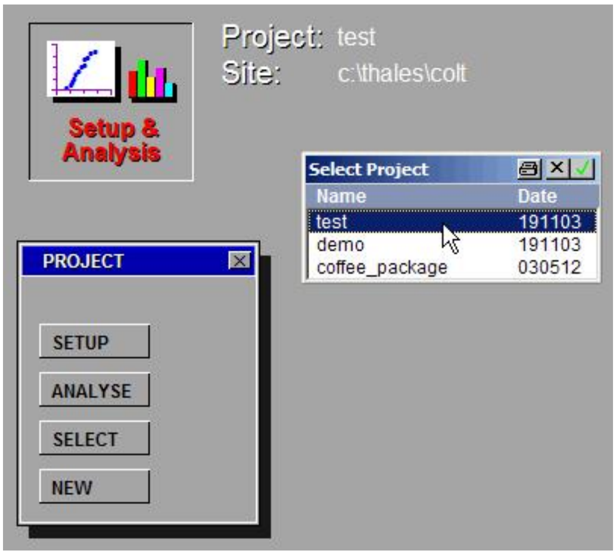

```
SCRIPT1
'-----------------------------------------------------------------------
'section for user defined tests
'for example three test are defined
'selectable from a menu
MENU(0)
MENU$("USER TESTS:")
MENU$("POROSITY TEST 60s")
MENU$("POROSITY TEST 120s")
MENU$("DS DEFECT LEVEL")

    ...

'end of user defined test section
'-----------------------------------------------------------------------
SCRIPT_END
```

5 Project Management

The project management is handled in the sub-menu '**Setup & Analysis**'. Here you may change the current project and create new projects.

5.1 SELECT: Change between projects





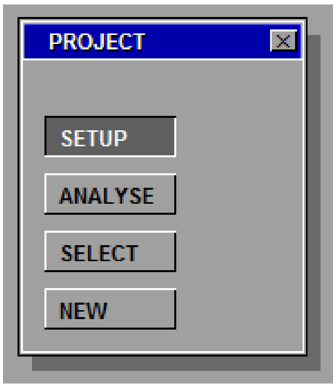
5.2 NEW: Create a new project

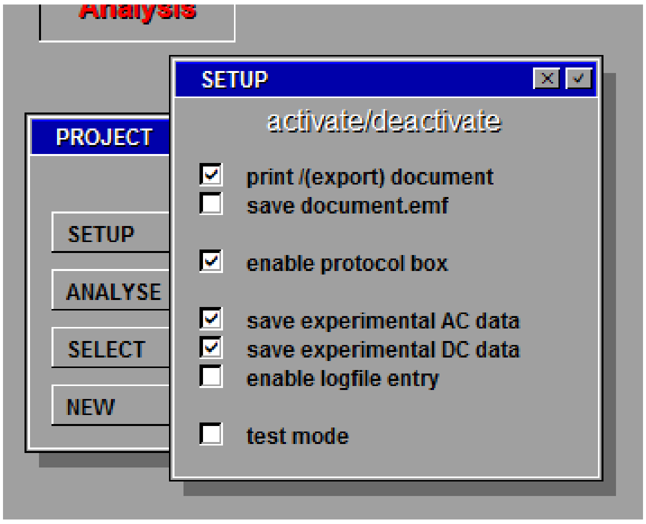
When creating a new project, please check carefully the project name. It is used also as a data path name and must not include characters which are not allowed in file names. In that case, an error message will occur, like in the case that the project name is in use already.

6 SETUP: Data output control

The measurement data are stored in the folder C:\THALES\colt as projects. For each project, a new (sub-)folder is created. For instance, if you define a project called *myname*, a folder C:\THALES\colt\myname is created. Within a project, for each COLT method an individual (sub-)folder is created. The measurement data are stored in that folder. For example, the experimental data of the cut edge test within the project *myname* are stored in the folder C:\THALES\colt\myname\cet.

The submenu '**Setup & Analysis**' allows to set the program parameters in detail.





6.1 Print / export documents

Assigned to each method, an individual protocol document is created during a measurement. This setting allows you to print or export the protocol after the measurement automatically.

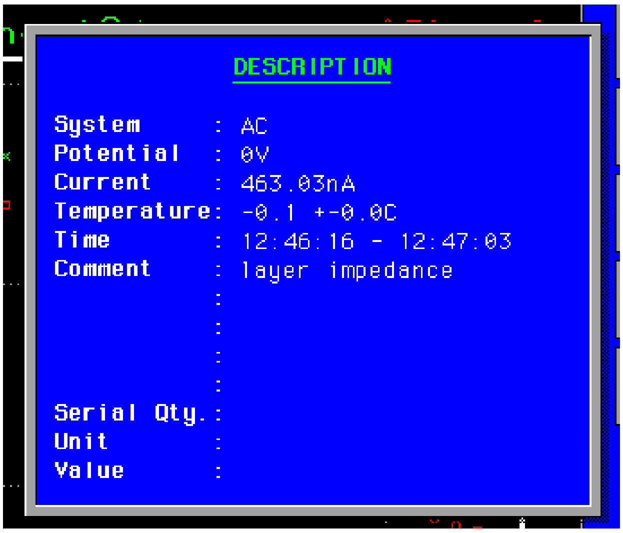
6.2 Save document.emf

If this setting is activated, the protocol document described above is saved in the method folder of the project, using the current form sheet (and printed optionally). The format used is Windows®-EMF graphics, which can be opened or imported by most programs like Word® or Powerpoint®. The file name is created using the date and the time of the measurement, e.g. *cet211103152904.emf.*

Note: if both *print* as well as *export document* are disabled, the document created is automatically copied to the Windows® clipboard. It can then be pasted directly into another program by *Control + V* or by means of the mouse context menu.

6.3 Enable protocol box

Activate this setting, if you wish to insert individual parameters (sample name and description, comments, etc.) into the measurement protocol. The program stops at that point expecting the inputs. When deactivated, the input window is skipped and the program continues.



6.4 Save experimental AC/DC data

During each measurement, the AC impedance spectra and the polarization data are saved temporarily in the folder C:\THALES\colt. They are overwritten by the next measurement. If you like to save these data permanently, you have to activate one or both of these settings.

If the above settings are activated, COLT creates a new sub-folder for the current day in the corresponding method folder of the project (e.g. *040315* for March 15, 2004) and copies the files into this folder. To create a significant file name, the starting time of the measurement is used.

Example:

During a CET measurement the following files are created in C:\THALES\colt:

cutedge1.ism	AC impedance file before stress
cutedge1.isw	DC polarization data
cutedge2.ism	AC impedance file after stress

If the save file settings are activated, the following files are created additionally as a permanent copy in the path of the project:

... **Dataroot**\cet\031121\113305_1.ism (= **Dataroot**\cet\cutedge1.ism)
... **Dataroot**\cet\031121\113305_1.isw (= **Dataroot**\cet\cutedge1.isw)
... **Dataroot**\cet\031121\113305_2.ism (= **Dataroot**\cet\cutedge2.ism)

6.5 Enable logfile entry

For each method of a project, a sub-folder is created when a method is used for the first time (method folder). In this folder, a file is created (e.g. *cet.log*) that contains a text table. This table contains the output parameters defined for this individual method as data columns, together with date and time of their origin and the system name, given in the first line of the comment protocol. After each measurement, the calculated significant parameters are appended to the table listing, provided the 'enable log file entry setting' is enabled. The tables are ready for import into any table calculation program, but are also used by COLT in order to analyze this data (e.g., for drawing the time course of the measured parameters).

Date	Time	System	OCP0/V	I0/A	I60/A	I120/A	OCP1/V	C1	....
40803	80155	coffee0413	-0.817	-5.5e-06	-1.8e-05	-4.9e-05	-0.846	5.19e-08	....
40803	80608	coffee0413	-0.807	-6.9e-06	-1.9e-05	-4.7e-05	-0.855	5.17e-08	....
40803	81137	coffee0413	-0.787	-6.6e-06	-2.0e-05	-5.0e-05	-0.795	5.11e-08	....
40803	81629	coffee0413	-0.787	-6.5e-06	-1.9e-05	-3.9e-05	-0.823	4.76e-08	....
40803	82138	coffee0413	-0.814	-6.7e-06	-1.8e-05	-4.6e-05	-0.839	4.31e-08	....
40803	82521	coffee0413	-0.771	-6.9e-06	-1.8e-05	-4.9e-05	-0.794	4.94e-08	....
.....	......	....	.....	....	....	....	......	....	....
.....	......	....	.....	....	....	....	......	....	....
90803	104548	coffee0413	-0.793	-6.8e-06	-1.7e-05	-4.9e-05	-0.823	4.96e-08	....
90803	104929	coffee0413	-0.800	-4.9e-06	-1.6e-05	-4.4e-05	-0.818	5.00e-08	....
90803	105420	coffee0413	-0.811	-6.9e-06	-1.7e-05	-3.8e-05	-0.836	4.60e-08	....
90803	110028	coffee0413	-0.789	-6.1e-06	-1.7e-05	-4.5e-05	-0.810	4.66e-08	....
Next	*run*	*to*	*come*						

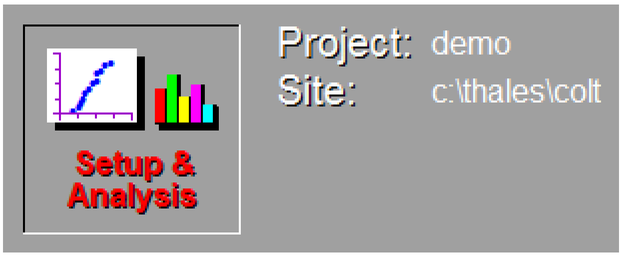
6.6 Test mode

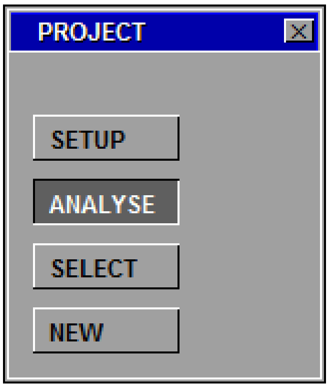
The test mode is implemented to save time when programming/modifying the COLT procedures using the SCRIPT technique. When activated, the (sometimes time-consuming) measurements are skipped. Thus, only the analysis and the saving/printing routines are executed.

After the programming/adjustment is finished, this setting should be disabled.

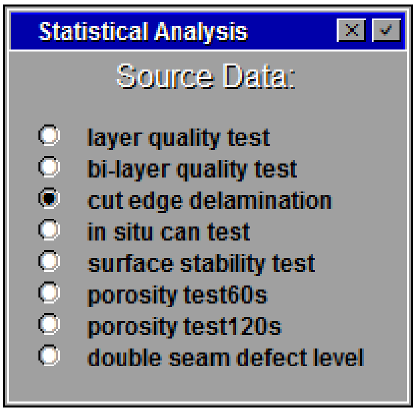
7 ANALYZE: Statistical data analysis support

The evaluation of the COLT data is activated by the sub-menu *Setup & Analysis*. Here you will find a couple of basic statistical functions, allowing for a first rough analysis of the measured data.



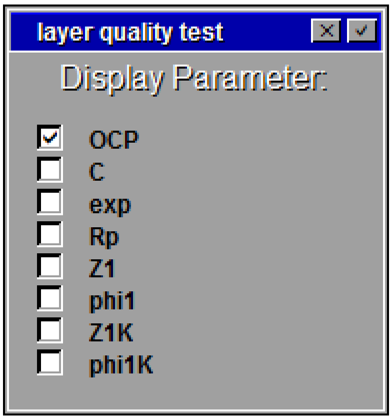


7.1 Source Data: Select data from a specific method



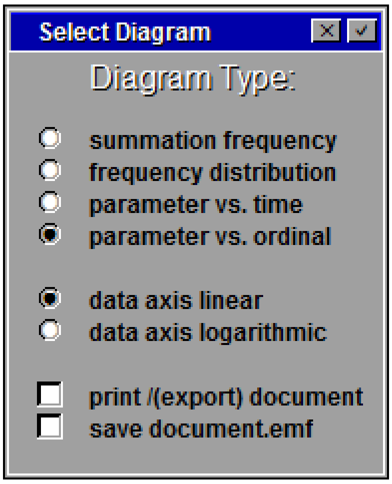
Select the data you want to analyze.

7.2 Display Parameter: Select parameters



Activate the parameters to be displayed and/or shown.

7.3 Diagram Type: Select output mode



Select one of the analysis methods:

- summation frequency
- frequency distribution
- parameter vs. time
- parameter vs. ordinal

Now, select the scaling of the y-axis:

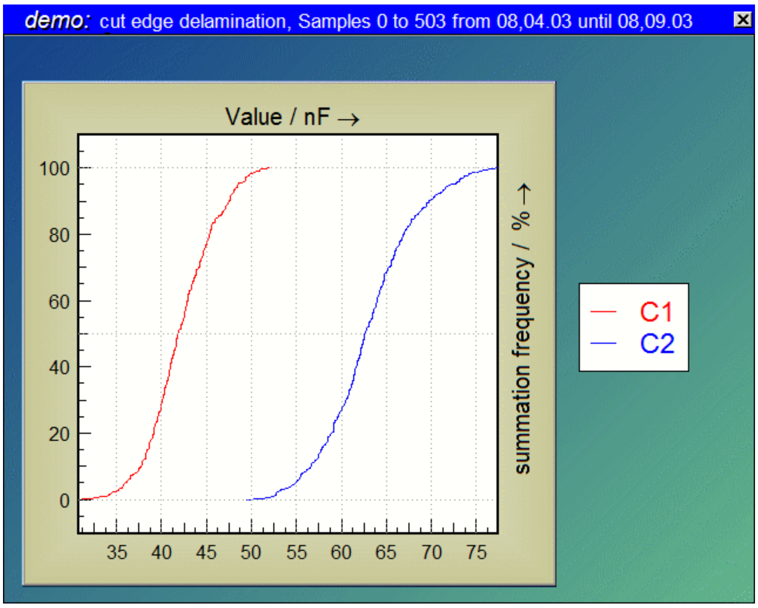
- linear
- logarithmic

Finally, you can select to print or save the diagram. If nothing is selected, the diagram is copied to the clipboard:

- print diagram and plot on screen
- export diagram as EMF graphic file and plot on screen

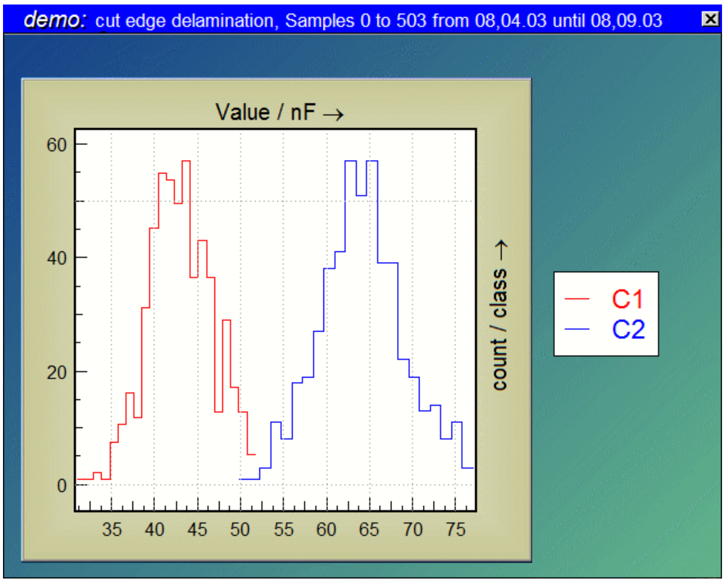
When *export/plot diagram* is selected, the diagram will be implemented into the according document form *anaform* and will be copied into the CAD environment. For editing purposes, use Thales CAD.

7.3.1 Summation frequency



In the *summation frequency* diagram, the integral of the frequency distribution is evaluated and displayed, normalized to 100%.

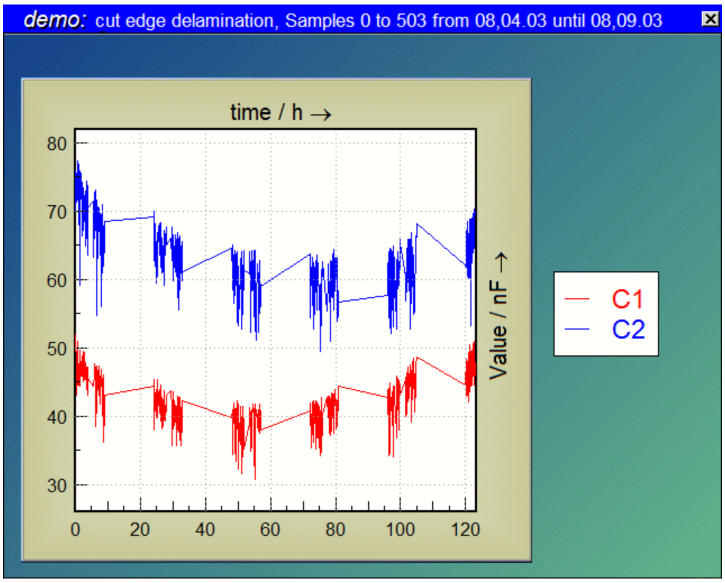
7.3.2 Frequency distribution



In the *frequency distribution* diagram, the measurement parameters are classified. The number of classes is calculated from the number of measurement points.

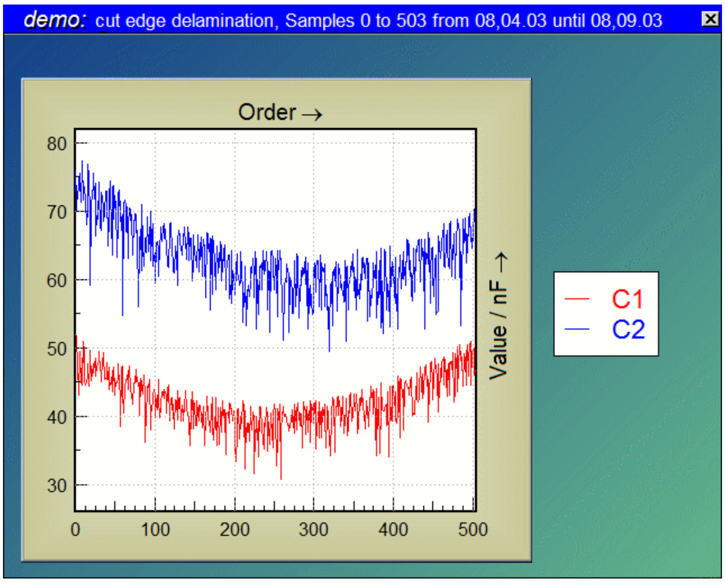
$$N_{Classes} = 2 * \sqrt{\text{number of datapoints}}$$

7.3.3 Parameter vs. time



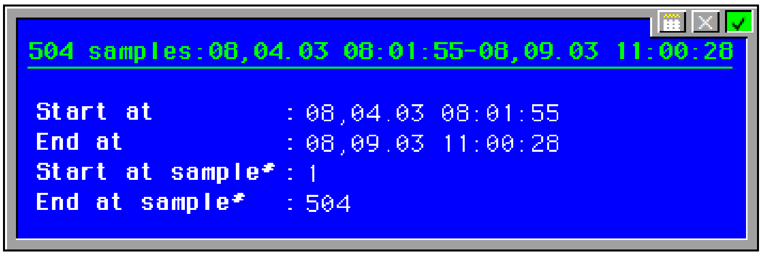
The selected parameters are displayed vs. the measurement time.

7.3.4 Parameter vs. ordinal



The selected parameters are displayed in their order of creation/measurement.

7.3.5 Define display range



The display range of the x-axis can be defined in either of two different ways:

- by selecting a time window
- by selecting an numeric interval of sample points

The range is then set to a minimum which is yet completely displaying both intervals.

7.3.6 Data axis linear/logarithmic

The y-axis may be scaled

- linearly
- logarithmically

8 Appendix

In detail, the folder C:\THALES\colt contains the following files:

8.1.1 Script System Files

Filename	Contents	Type
scr_m	Main menu	Graphics
scr_ce	Help file	Graphics
scr_pe	Help file	Graphics
scr_ed	Active button <edit script>	Graphics
scr_ck	Active button <check script>	Graphics
scr_ed	Active button <link script>	Graphics
scr_ck	Active button <save programs>	Graphics

8.1.2 COLT System Files

Filename	Contents	Type
scr_logo	Logo & passive view buttons	Graphics
scr_b1	Active button for Script1	Graphics, reserved for user script
scr_b2	Active button for Script2	Graphics
scr_b3	Active button for Script3	Graphics
scr_b4	Active button for Script4	Graphics
scr_b5	Active button for Script5	Graphics
scr_b6	Active button for Script6	Graphics
scr_b7	Active button for Script7	Graphics
scr_b8	Active button for Script8	Graphics, reserved
bilayer.ism	Impedance measurement	Parameter file for EIS
canstab.ism	Impedance measurement	Parameter file for EIS
cutedge.ism	Impedance measurement	Parameter file for EIS
layer.ism	Impedance measurement	Parameter file for EIS
surfstab.ism	Impedance measurement	Parameter file for EIS
canstab.isw	Polarization measurement	Parameter file for POL
cutedge.isw	Polarization measurement	Parameter file for POL
surfstab.isw	Polarization measurement	Parameter file for POL
bilayer.isf	Model file	Parameter file for Fit
layer.isf	Model file	Parameter file for Fit
bilayer	Form sheet	Graphics image file
canstab	Form sheet	Graphics image file
cutedge	Form sheet	Graphics image file
layer	Form sheet	Graphics image file
surfstab	Form sheet	Graphics image file
anaform	Form sheet	Graphics image file
flags	Parameter	Setup file

8.2 Summary of data file handling

All COLT data files are located in C:\THALES\colt on the hard drive of the computer (=Dataroot). For each experiment, an individual data-folder sub structure is created by the software automatically as described in the following.

8.2.1 Formal handling of experimental data

As noted above, the measurement data are stored in the Dataroot as *projects*. For each project, a new (sub-)folder is created. E.g., if a project called *demo* is defined, a folder Dataroot\demo is created (i.e., C:\THALES\colt\demo). Within a project, for each COLT method an individual (sub-)folder is created. The measurement data are stored in that folder (if this option is enabled). For example, the experimental data of the cut edge test within the project *demo* are stored in the folder Dataroot\demo\cet (i.e., C:\THALES\colt\demo\cet).

The results time course obtained by the corresponding COLT method within a project is documented (if enabled) in the file *method.log*, the so-called log-file. For example, the resulting data of a cut edge test (method CET) within the project *demo* is stored in the file Dataroot\demo\cet\cet.log (i.e., C:\THALES\colt\demo\cet\ cet.log). **Note**: all consecutive time course data obtained by this method (i. e. CET) of this project (i. e., *demo*) are appended to this text file.

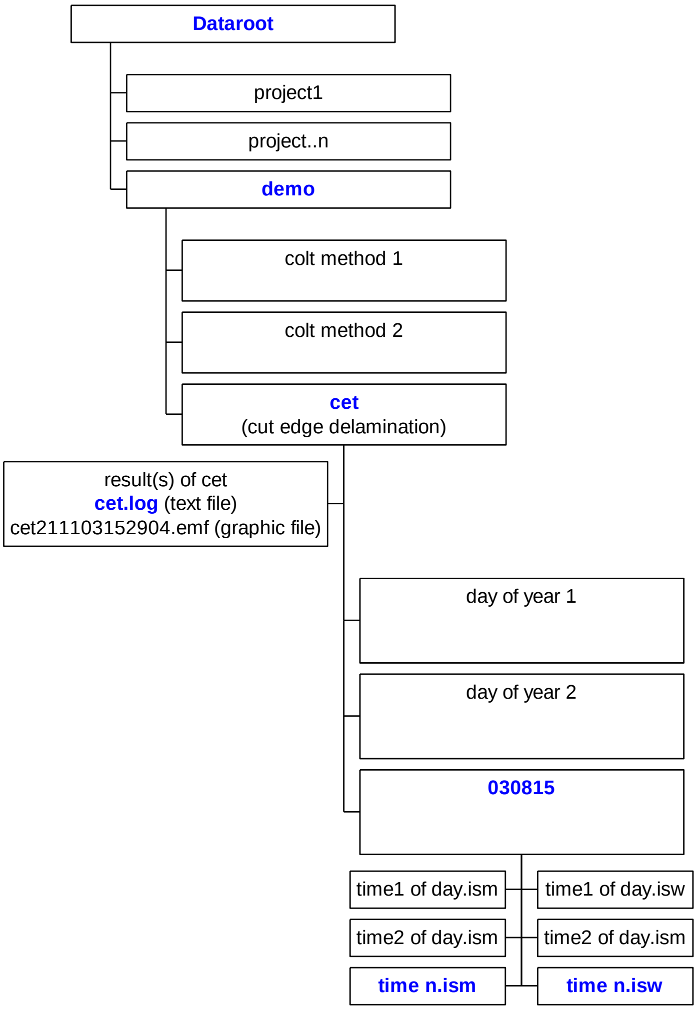
An exemplary table of a *method.log* file can be found in chapter 6.5 (i.e., a log-file, obtained from the COLT cut edge delamination method). Next to the result file (*method.log*) it is also possible to save and document each individual measurement which is performed within the COLT method.

In the course of each COLT measurement, the currently performed AC impedance spectra as well as the polarization data are saved temporarily and are accessible in the Dataroot, under a fixed file name, as long as no successive measurement overwrites them. By activating the corresponding flags, these data are saved separately as copies. In this case, COLT creates a new (sub-)folder relative to the folder of the selected method, based on the actual day. Proceeding on the example given above, the currently performed polarization as well as the impedance measurements are saved in Dataroot\demo\cet\030815 (i.e., C:\THALES\colt\demo\ cet\030815), assuming that the measurements were performed on August, 15th 2003.

Clearly, each measurement itself requires the automatic generation of an individual (and unique!) filename. Therefore, the filename of a distinct measurement is derived from the time when the measurement was started. For instance, an impedance measurement performed at 01:47:11 PM is saved as '134711.ism' (i.e. 'c:\thales\colt\demo\cet\030815\134711.ism', consider the 24-hour notation !).

Note: Polarization measurements possess the extension 'isw'.

For clarity, the following diagram shows the formal handling of a COLT project considering the example outlined in this chapter.



IMPORTANT NOTES

1. The entry in the corresponding log files as well as the saving of the individual measurement data can be en-/disabled independently.

2. All projects are registered in the text file Dataroot\colt.ini (i.e., C:\THALES\colt\colt.ini). You may edit this file, e.g., for disabling older projects by removing the corresponding lines. Please take care when manipulating this file: the project management will run into problems if this file is corrupt. **It is strongly recommended to save a copy before performing any changes.**