Coin Cell series EIS Test

Purpose

This test is to demonstrate coin cell battery's EIS test. You can use this application note for your battery's EIS test. This application note guides to make this experiment using sequence file to demonstrate how to use sequence file. This complex procedure can be tested with just 6 steps sequence file using "tag" function on constant control parameter. But this procedure is only available with constant step voltage value. If you want to test this kind of test with variable voltage step, please refer to ZIVE application note7.

More simple method for this test is using frequency scanning potentiodynamic PEIS in technique menu. See ZIVE application Note8

This demonstration's test condition is;

- ◆ Start potential: 800mV
- ◆ Final potential: 3V
- ◆ Voltage step: 50mV
- ◆ EIS measurement at each potential step
  - Initial frequency: 10kHz
  - Final frequency: 0.1Hz
  - Amplitude: 1mV
  - Points per decade: 10

Preparation

- ZIVE SP/MP electrochemical workstation
- 3V Li ion Coin cell
- Coin Cell holder

Cell Connection

+ electrode(Green lead & Blue lead)
- electrode(White lead & Red lead)

Procedure

1. Turn the Power switch on the ZIVE SP/MP electrochemical workstation
2. Open the SM software by clicking the SM icon. The following progress box will appear, and will show the progress of checking instrument configuration and communication between ZIVE SP/MP electrochemical workstation and PC.


If the link is successfully connected, Click "OK" button on the box then the progress box will automatically disappear and SM software will appear. If the link failed, The following progress box will display then click the "Retry" button.
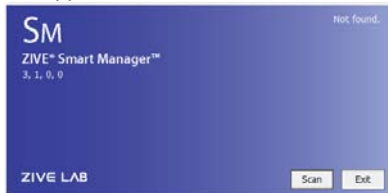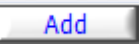
If the link failed again after clicking "Retry" button, you need to check USB cable connection.
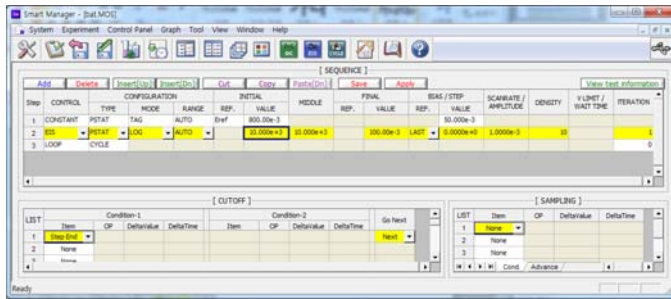
3. Click New Sequence function icon (or select Sequence function-New on Experiment menu)
    Then you can see the following menu
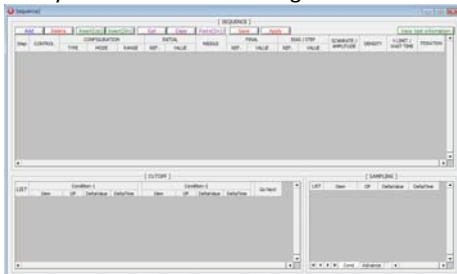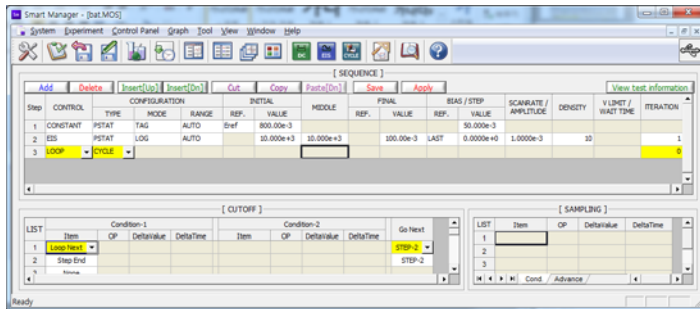

4. Click Add button .
    Input figure for parameter setting as the follows.
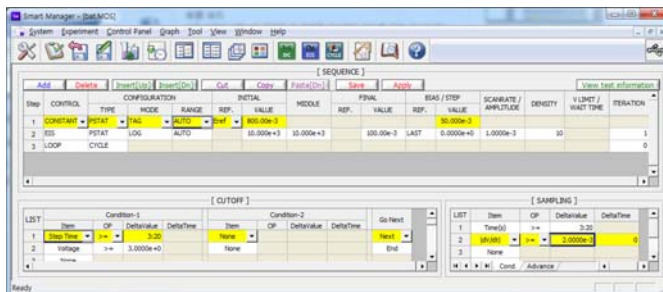
1st step (constant voltage control)

2nd step (EIS measurement)


3rd step (loop)

The above 1st step is for constant voltage applying and add to 50mV step at next loop return.

The 2nd step is for EIS measurement.

The 3rd step is to mark cycle for 1st step to 2nd step. This cycle mark will be used to separate each EIS data when you analyze EIS data using Zman software. If you do not insert Loop(cycle) step after EIS measurement, You must separate each EIS data by manually.

5. Click "Save" button to save the technique file which contains the above parameter and setting file name.
6. You can assign this technique file to channel(s) which you want by click "APPLY" button or select schedule file using file selection on "Single channel control/monitor" or "multi channel control/monitor"
   If you click "apply" button on technique menu, You can see the following channel selection menu.
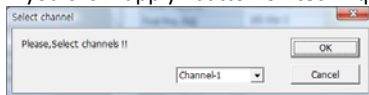
   Select channel and click OK then this technique file will be assigned on the channel.
   Click "Close" button or minimize technique window.
7. If you want control ZIVE SP/MP electrochemical workstation using "Single channel control/monitor", you can see following windows.


To start experiment, click Start button

If you want control ZIVE SP/MP multichannel, you can see the following window

To start experiment for specific channel, click Start button on the channel. If you want to start experiment for multiple channel, click on Group column which you want to start and click Start button **at bottom side.**

8. After click start button, you can see the following box.
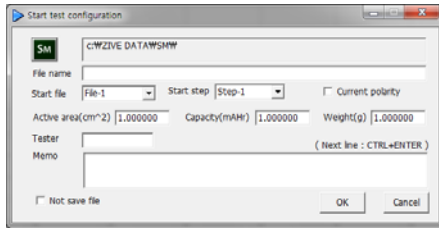
The data file name is automatically determined as default value but if you want to change data file folder then click icon

You can make new folder which you want to save.

◆ If you want use your file name, input your file name on "File name"

◆ If you did not make file name manually, new data folder which named as sequence file name or technique file name under data folder and it's subfolder will be created with name as date. The data file will be saved in this folder. The data file name will be determined automatically as string with sequence file name or technique file name and hour and minute and second, finally channel number will be added.

example) If you used sequence file for test and its file name is testabc.zsc and channel number is 1 and test date is 2000 year January 1st time is 15:30: 1 then the data file will be saved as

C:\Zive data\sm\data**testabc.zsc\2000010115\3001_01**.sdo (If data file have DC data only)

Or

C:\Zive data\sm\data**testabc.zsc\2000010115\3001_01**.sde (If data file have DC data and EIS data)

Or

C:\Zive data\sm\data**testabc.zsc\2000010115\3001_01**.seo (If data file have EIS data only)

e.g.) schedule file name with extension\yearmonthdayhour\minutesecond_channel number

If you input file name as "tommy" then

C:\Zive data\sm\data**testabc.zsc\2000010115\tommy3001_01**.sdo (sde,seo)

① Start Step: If your sequence file has several steps, you can select starting step.

② Start file: If batch file is loaded, select file number

③ Current polarity: If you want reverse polarity for measured current, check on this box.

④ Active area: For calculation of current density

⑤ Capacity: For C-rate value calculation

⑥ Weight: For specific capacity calculation

⑦ Tester: Operator name

⑧ Memo: Text information for test (For line change, use CTRL+ENTER)

➢ No Save file: If you click this check box, the data will NOT be saved.

If you are ready to test, click OK button then experiment will be started.

You can see real time plot as the following.

Real time EIS graph shows sub window at right upper side. This window display sine wave or E vs. I graph to check data quality. Default display is sine wave.
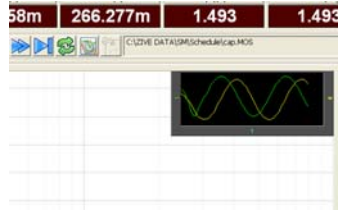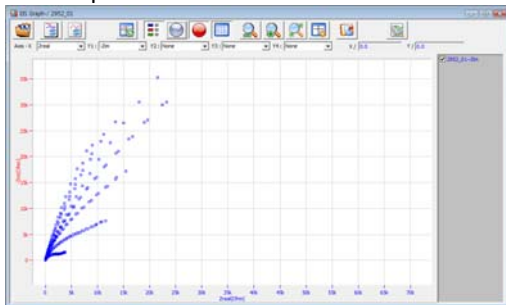

This shows two sine wave graphs. One is for current (green line) and the other is for voltage (Yellow line).

If you switch this graph to I vs E, double click on the graph then graph format will be changed.
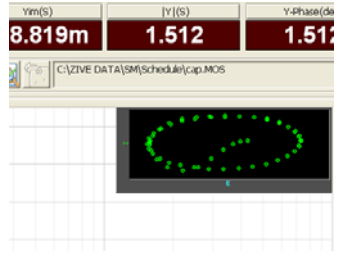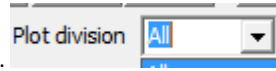

9. You can display graphic by clicking button on tool bar

Click "Open data file" icon and select data file which you run the experiment.

You can select Bode plot by clicking icon or Nyquist plot by clicking icon.
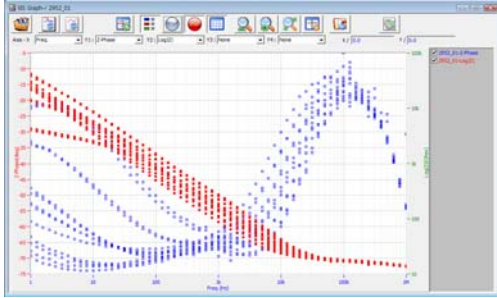
SM can split each EIS graph by selecting "step" in "division".

You can split data by file, cycle or step. Splitted data set's color was changed and graph line will be broken

ZMAN will split each EIS data automatically if you insert "cycle" mark.

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For user defined graphic, you can select X axis and Max 4 Y axis parameter as you wanted.
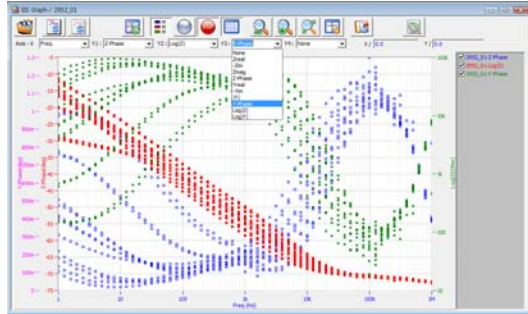
Data Analysis

1. Open "ZMAN" by clicking ZMAN icon. ZMAN program is located c:\program files\zivelab\zman2.2 folder.
2. You can see the following window.
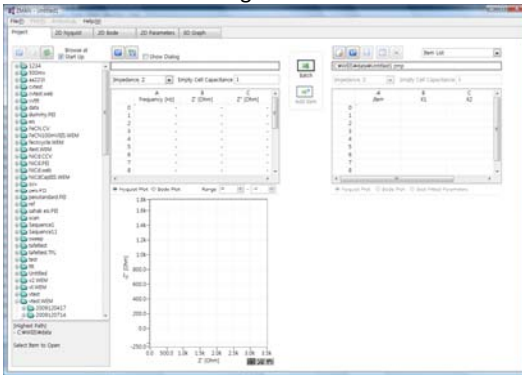
3. Click Right button of mouse
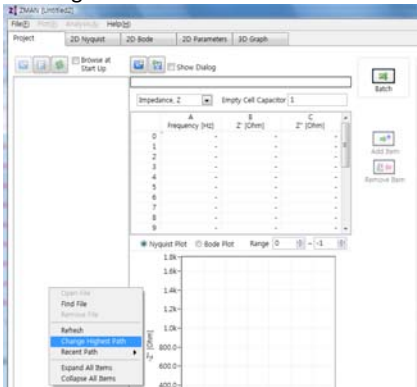
   Select Change Highest Path and select the folder which contain SM data.
4. Select data file by double clicking
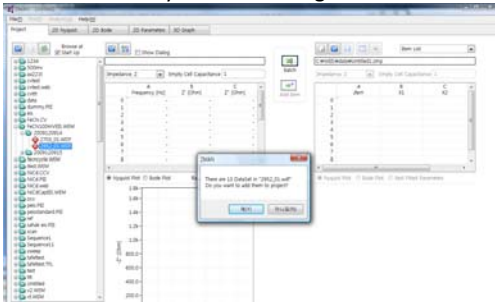
   If you inserted Cycle market as we used the above sequence file, above box will appear. Click "Yes" then multiple EIS data will be splitted automatically.
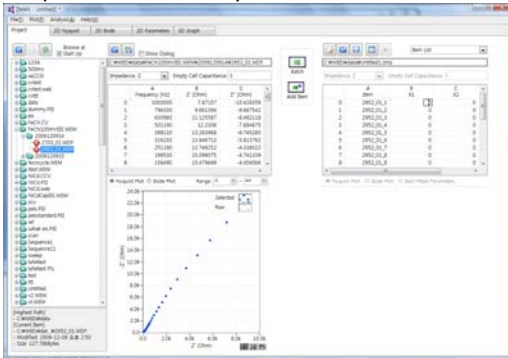
If you do not want to use all EIS data set, Click "No" then you can see select box.
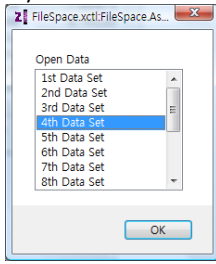
You can select one EIS data for analysis.

5. Parameter for voltage name can be changed from X1 to Voltage for example by clicking "edit item" button
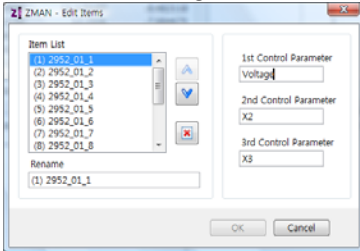
6. You can input each voltage value for each EIS data using X1 colum.
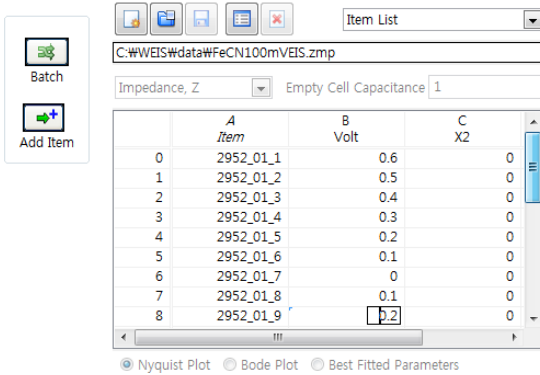
Or if the voltage distance is equal, you can use formula function.

7. You can see Impedance,Admittance,Modulus,Dielectric Constant by selecting as the following
   a) Select data set
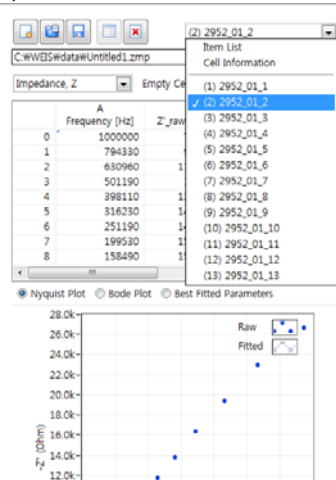
b) Seelect Impedance,Z in polar,Admittance,Y in Polar, Modulus, M in polar, Dielectric Constant, E in polar. (in polar = in Polar Coordinate)
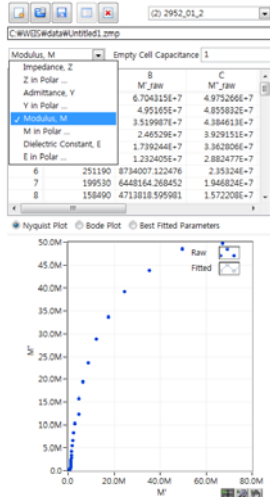
8. Click 2D nyquist plot
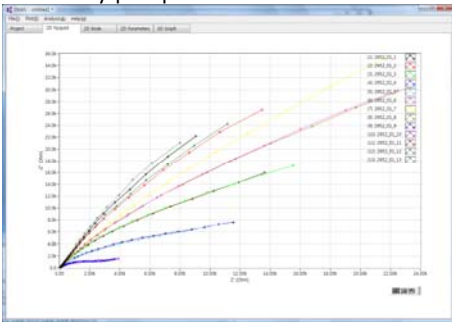
You can see "Echem style" by clicking right button of mouse and select "Echem style"
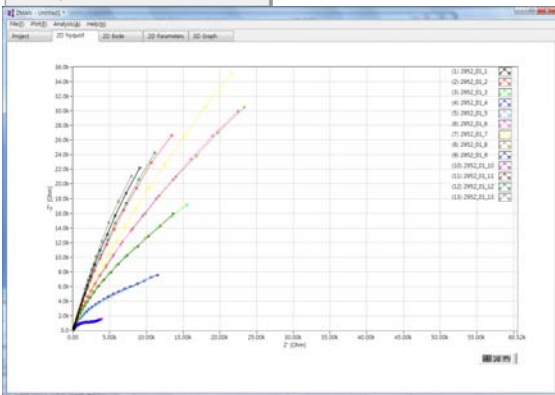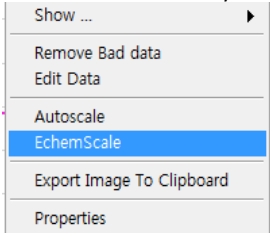
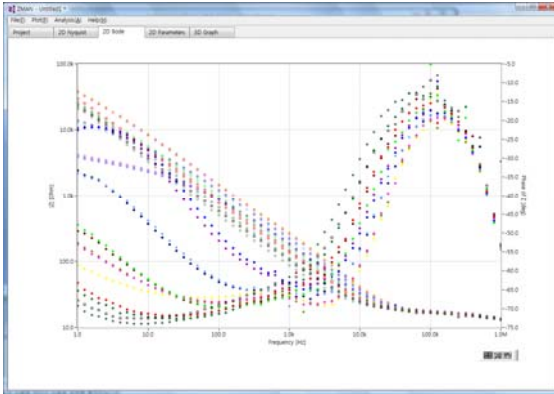Echem style is X axis scale and Y axis scale on graph is same.
You can check each data value by selecting "cursor" with clicking right button of mouse .
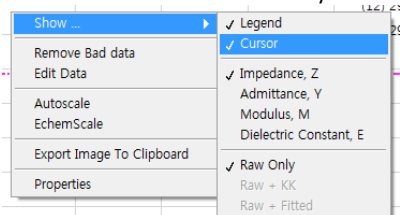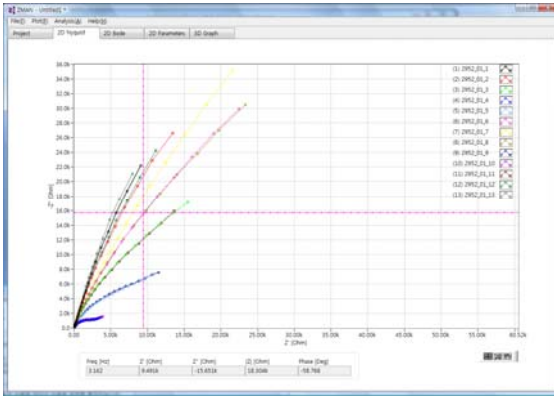
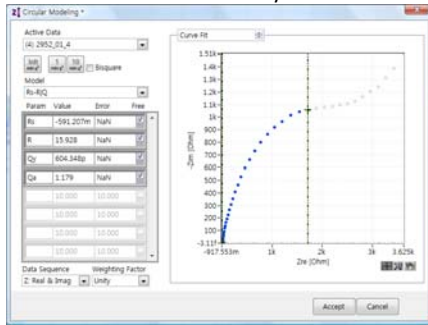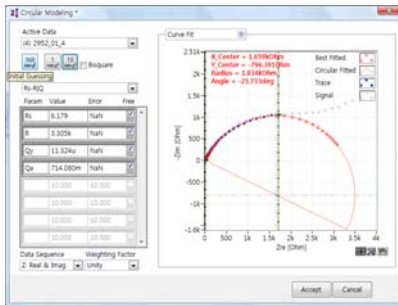You can move the point by dragging the mouse after check cursor icon .

9. Click 2D Bode

Anaysis

1. You can select fitting method by your purpose Circular fit or Modeling & fitting

   - Circular fit
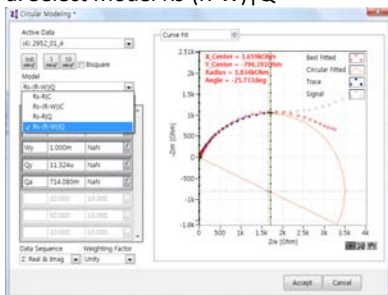   a. Select circular fit on Analysis

   b. Move right cursor into circle region as the above and click Initial guessing icon
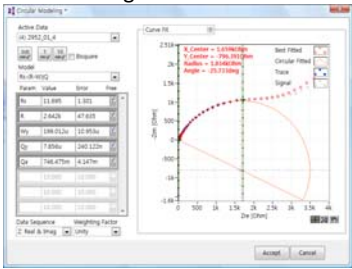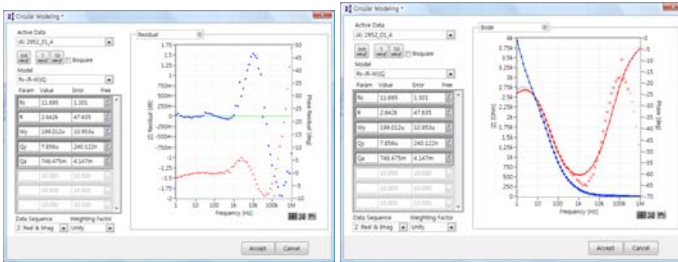

   c. Click fitting icon 1time or 10 time fitting
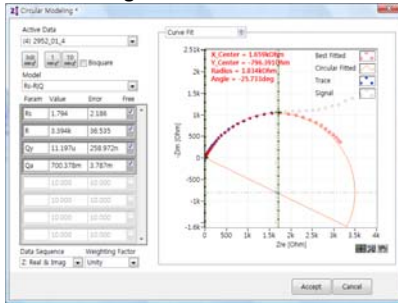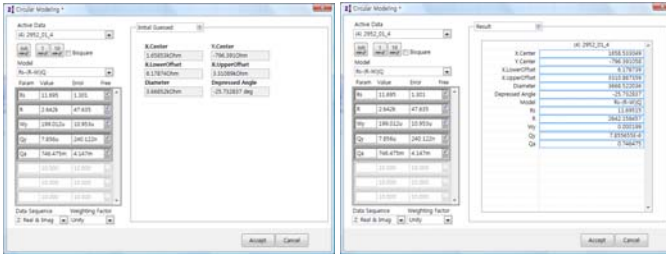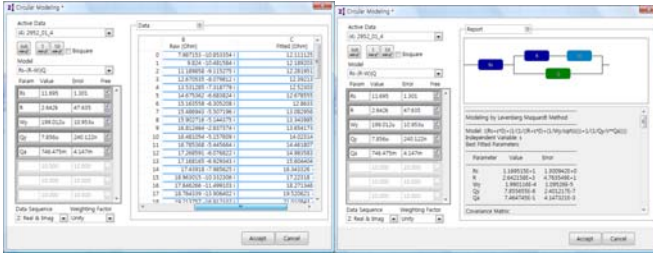

   d. Select Model Rs-(R-W)|Q

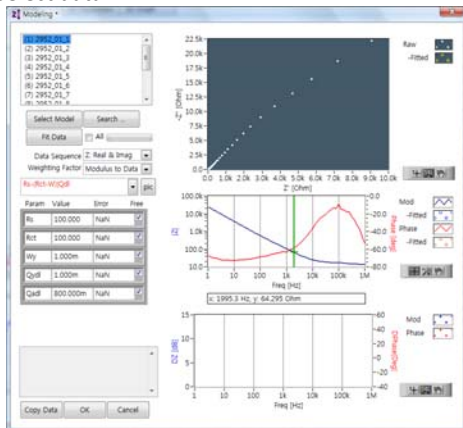e. Click fitting icon 1time or 10 time fitting

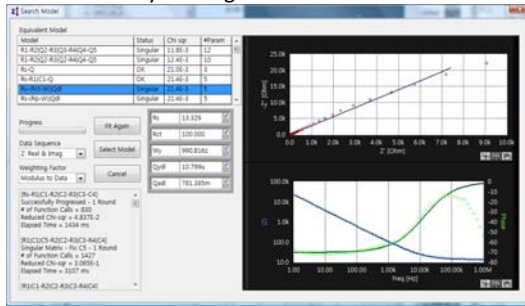F. You can see data list , Report, Initial Guess information, Result, Residual, Bode as the follows.

Click accept button if you want use this parameters
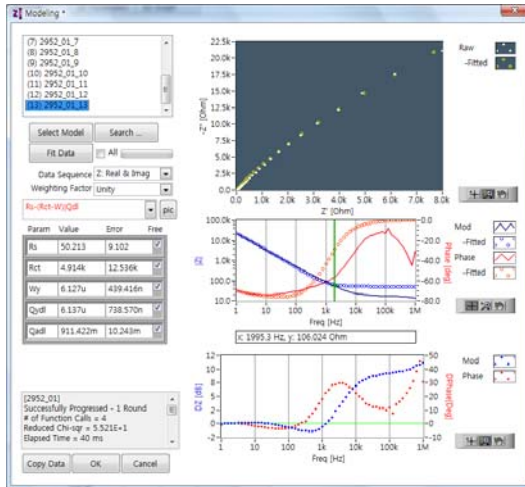
- Select Modeling on Analysis

a. Select data

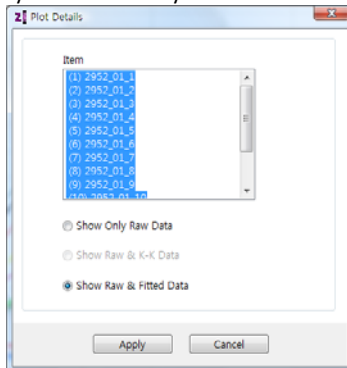b. Search Model by clicking "search" button and Click on Rs-(Rct-W)|Qdl model

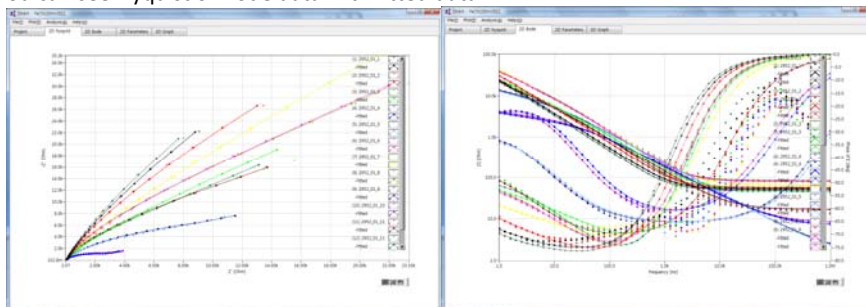   Click Select Model button

c. Check "all" and Click Fit data

    Click OK button
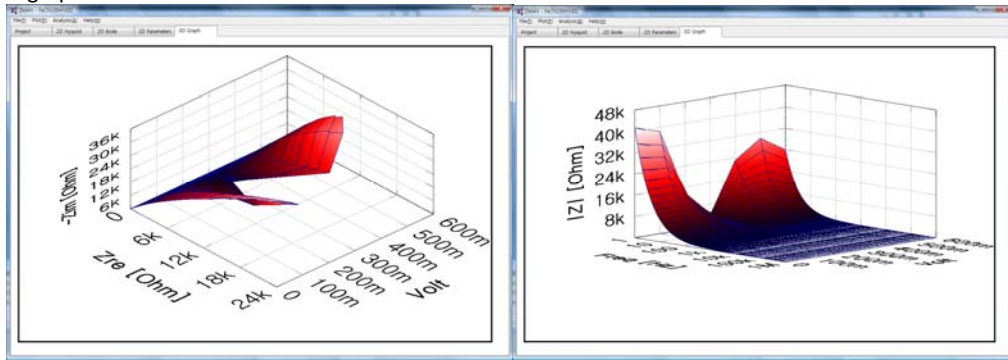
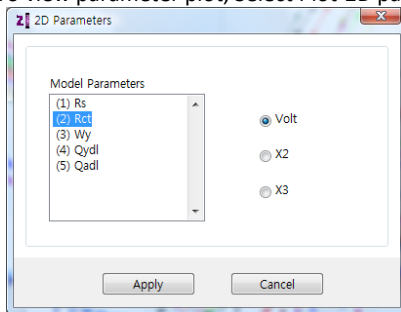d. If you want overlay raw data and fitted data, Plot detail in Plot menu

e. You can see Nyquist or Bode data with fitted data

f. 3D graph

g. To view parameter plot, Select Plot-2D parameter

Select parameter(s) and click apply button