"Compliance to Moduli version 3" virtual instrument (VI)

This program has been created by **Manlio Tassieri** and it is based on the analytical procedure introduced by R.M.L. Evans, M. Tassieri, D. Auhl and T.A. Waigh, in "*Direct conversion of rheological compliance measurements into storage and loss moduli*", Physical Review E **80**, 012501 (2009).

Installation

This program has been written in LabVIEW 2010
Two scenarios are now possible:

(I) On your machine LabVIEW 2010 **is installed**.

In this case, you can copy the folder named "Compliance to Moduli version 3" and use directly the executable file having the same name as the folder.

(II) On your machine LabVIEW 2010 **is not installed**.

In this case, you need to copy the folder named "Installer" first. Explore the folder and install supporting software by double clicking the "setup.exe" icon. The installation will allow you to run the executable "Compliance to Moduli version 3" on your PC.

Modus operandi

The first time you run the executable, a dialog box appears asking you to choose the file to read and analyse (i.e. the file containing the compliance data). Note that the file to read must be of type .dat or .txt. It may contain more than two columns; however the executable reads only the first two columns of the file. These must be: {time [s], compliance [Pa^{-1}]}. The file must not contain column headings and the first row of data should not have elements equal to zero.

Once the compliance data file has been chosen and opened, the data are displayed on the top-left graph of the application's front panel (blue symbols in Figure 1).

The same data are then re-displayed in the bottom-left graph of the front panel as "*t/J vs. time*" (turquoise symbols in Figure 1). In this way, it is possible to verify if the compliance measurement has reached the steady state regime at long time. If so, the plot "*t/J vs. time*" should show a plateau region at long time (i.e. the steady state viscosity value). Move the graph cursor (i.e. the centre of the crossed red lines) to the point where the plateau region begins, and the software will provide the steady state viscosity value (η) shown on the right side of the graph (and set it as initial value of the viscosity into the parameter toolbar, top-right).

The program then automatically calculates and displays the following parameters: ω, G', G'' , η^* and phase angle. In particular: G' and G'' are displayed on the top-right graph (white and red symbols, respectively, in Figure 1), whereas the magnitude of

the complex viscosity is displayed on the bottom-right graph together with the phase angle (white line in Figure 1).
Note that, in first instance, the program will calculate the above complex parameters by setting the two parameters (η and J_0) required by the model as follow: $J_0=0$ and η equal to the steady state viscosity value described before. Usually this is a very good assumption because J_0 is for the majority of the materials of the order of 10^{-6} [Pa^{-1}] or smaller.
The range of frequency where the complex parameters are displayed is calculated by using the time window extremes of the compliance measurement. In particular, the longest time interval (t_{max}- t_0) (where $t_0=0$) provides the lowest frequency ω_{min} (i.e. $\omega_{min}=1/\ t_{max}$), whereas the shortest time interval (t_{min}- t_0) provides the highest frequency ω_{max} (i.e. $\omega_{max}=1/\ t_{min}$).

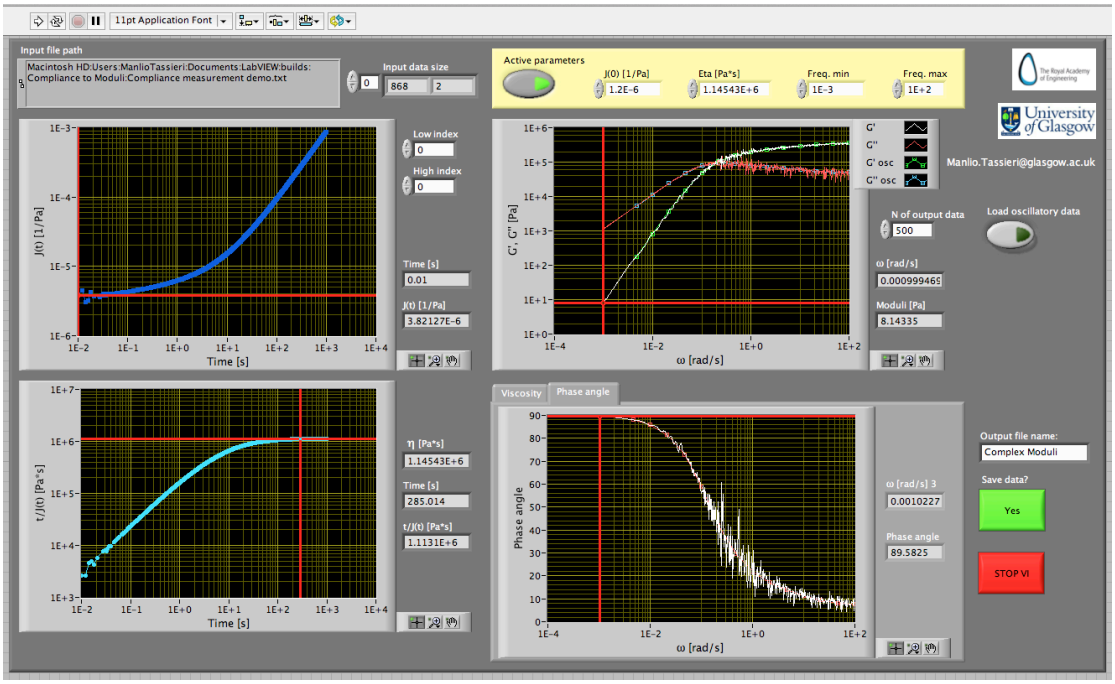

Figure 1. Front panel of the executable "Compliance to Moduli version 3".

However, it is possible to change both the parameters (i.e. η and J_0) and the frequency range (i.e. ω_{min} and ω_{max}) by editing the corresponding values in the parameter toolbar above the complex moduli graph (top-right in Figure 1), after first activating the toolbar by pushing the button.
A further push of the activation button reinitializes all the above parameters.

The viscoelastic moduli obtained from the creep conversion can be directly compared with those obtained from an oscillatory measurement, just by pressing the "Load oscillatory data" button on the right side of the viscoelastic moduli graph. Note that the file to read must be of type .dat or .txt. It may contain more than two columns; however the executable reads only the first three columns of the file. These must be: {frequency [rad/s], G' [Pa], G'' [Pa]}. Moreover, within a single run it is possible to change the oscillatory data just by pressing again the "Load oscillatory data" button; however, it is not possible to overlay more than one oscillatory measurement at one time.

The displayed parameters and moduli can be saved into a text file by pressing the "save data?" button, which also terminates the program after saving. The output file is saved in the same folder as the compliance input file. The output file name is composed of the input file name plus what is written in the "Output file name box" (eg. Input file name = Compliance; Output file name box = Complex Moduli; Output file name = Compliance_ Complex Moduli.txt).

The effective number of output data points (i.e. number of rows in the output file) for the specific range of frequency can be chosen by changing the numeric value in the "Number of output data" box (the default value is 500 points, equally spaced on a Log scale).

During execution, the program can be stopped at any time by pressing either the "Stop VI" button (centre-right in Figure 1) or the little red button on the top toolbar (top-left in Figure 1).

The program can be re-started by pressing the white arrow button on the top toolbar (top-left in Figure 1).

Tips

Together with the program examples of compliance and related oscillatory measurements are provided. The files are named "Compliance measurement demo" and "Oscillatory", respectively.

With regard to the possibility of changing the initial values of the parameters introduced above, note that, while changing ω_{min} towards lower values might result in a physically meaningful extrapolation, it is always pointless to increase ω_{max}.

All the parameters and the number of output data values can be changed while the program is running. It will adjust the results as fast as your machine will allow (usually a few ms!).

Remember that the possible noise in the calculated complex parameters (i.e. G', G'' and η^*) has its origin in the genuine noise of the experimental data (i.e. compliance measurement). In order to eliminate the noise in the final results, a fitting function of the experimental data could be used instead.

Both the "Low index" and the "High index" values can be used to cut from the bottom and the top, respectively, the range of compliance data that are going to be transformed. So that, for instance, the undesired presence of creep oscillations at short times can be removed.

For further information or questions, please do not hesitate to contact me:
Manlio.Tassieri@glasgow.ac.uk