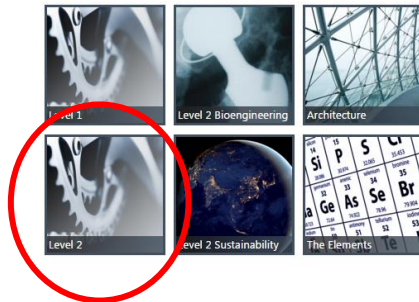


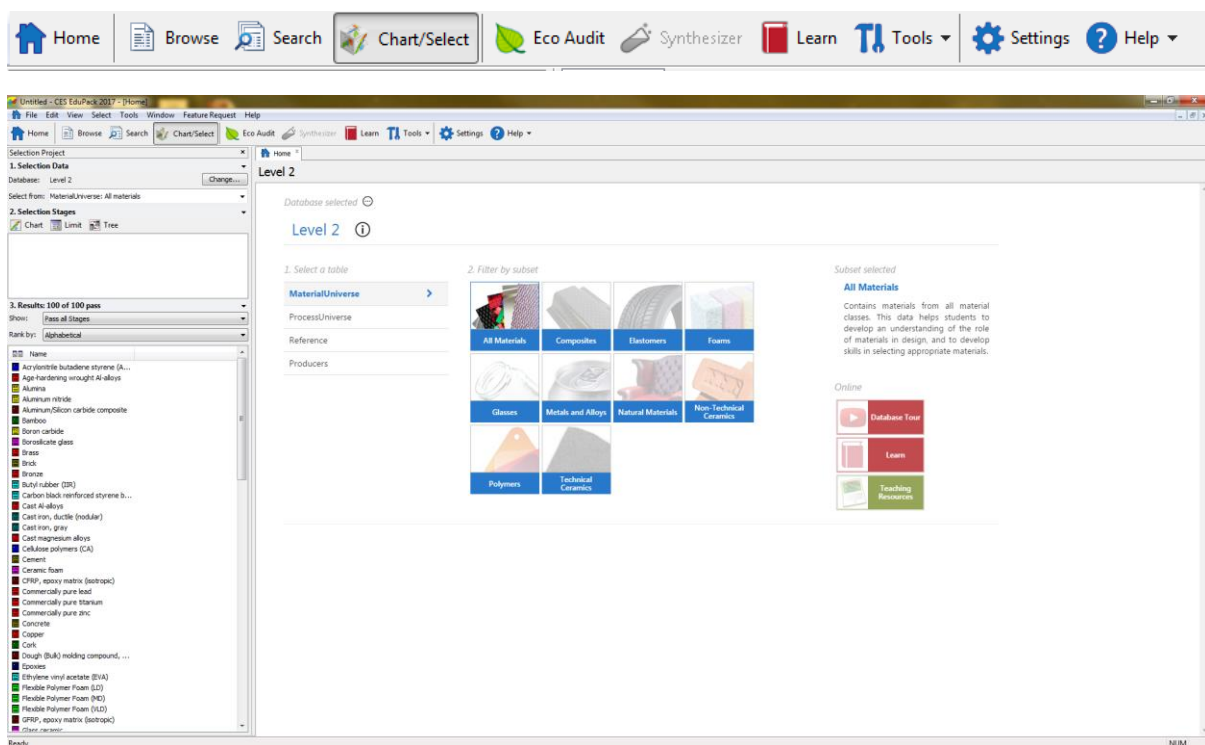
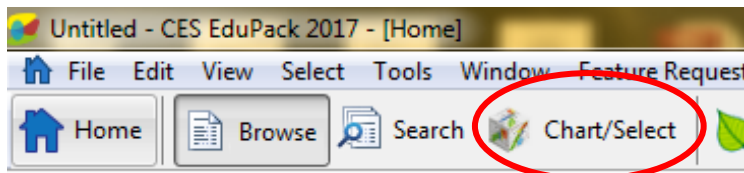
1. Open CES EduPack 2017 and select **Level 2 Materials** (the higher levels have more materials and details in them but can be too much for some applications. Level 2 gives a good detail of different materials without showing too many alterations of similar materials)

Databases

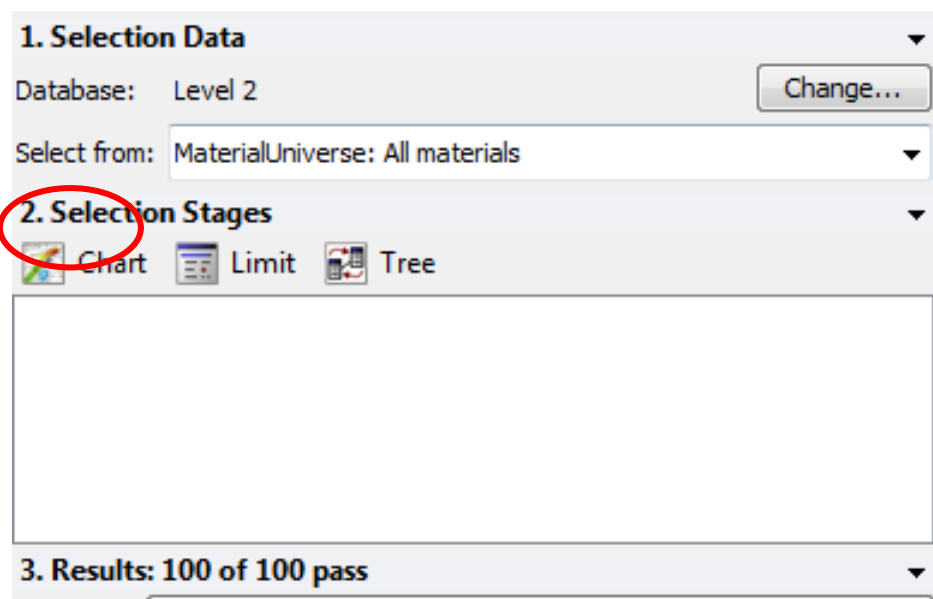
Introductory



2. Press **Chart/Select** to open a material selection project



3. Press **Chart** to start a new chart






1. Selection Data

Database: Level 2 Change...

Select from: MaterialUniverse: All materials

2. Selection Stages

 Chart  Limit  Tree

3. Results: 100 of 100 pass

4. A window to choose Y and X axis attribute opens

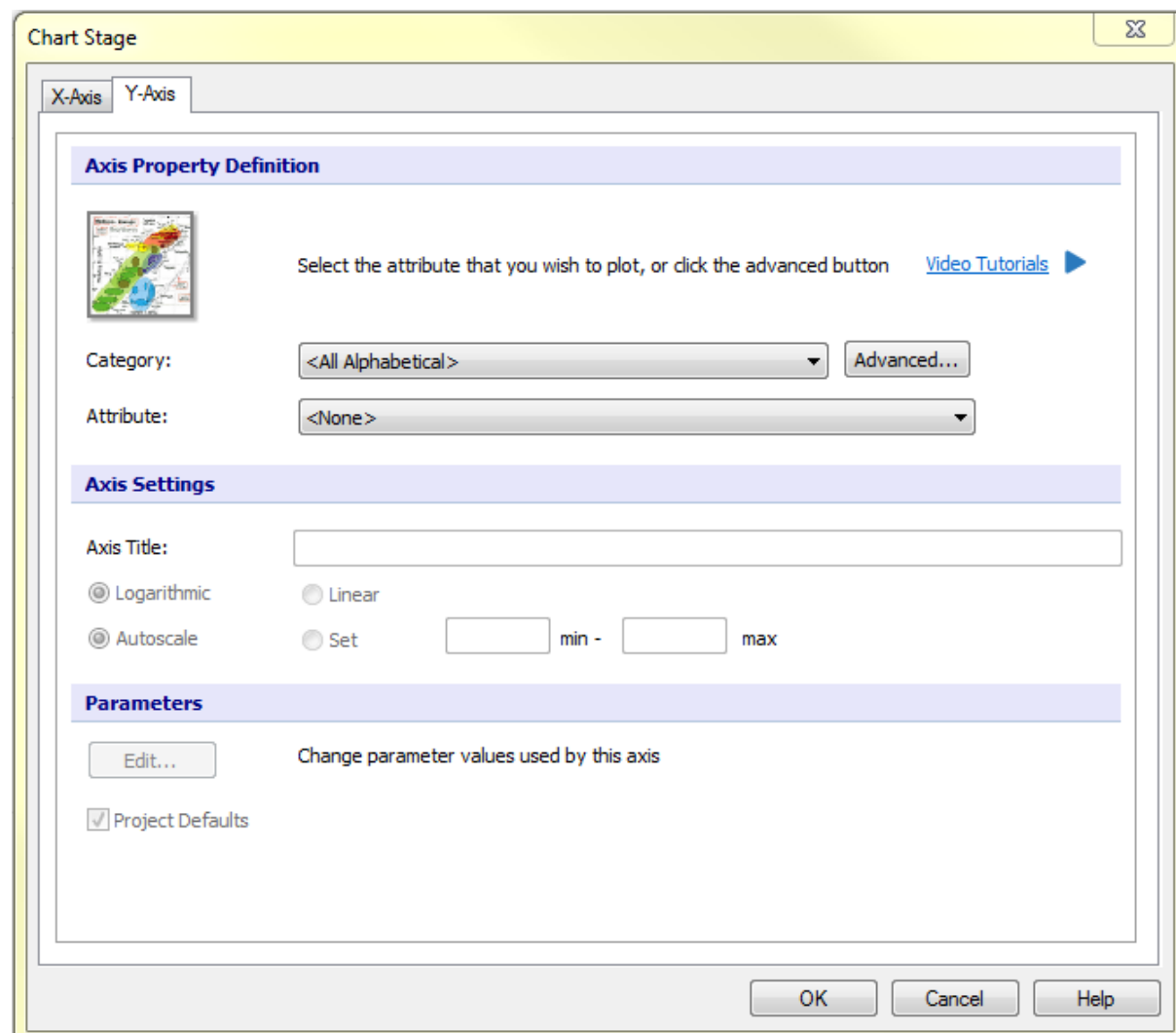



Chart Stage

X-Axis Y-Axis

Axis Property Definition

 Select the attribute that you wish to plot, or click the advanced button [Video Tutorials](#)

Category: <All Alphabetical> Advanced...

Attribute: <None>

Axis Settings

Axis Title:

☒ Logarithmic ☐ Linear

☒ Autoscale ☐ Set min - max

Parameters

Edit... Change parameter values used by this axis

☒ Project Defaults

OK Cancel Help

5. On Y-Axis, select **Category: Mechanical properties, Attribute: Young's modulus**. Ensure the Axis is in Logarithmic scale.

Chart Stage

X-Axis Y-Axis

Axis Property Definition

Select the attribute that you wish to plot, or click the advanced button [Video Tutorials](#)

Category: Mechanical properties Advanced...

Attribute: Young's modulus

Axis Settings

Axis Title: Young's modulus (GPa)

☒ Logarithmic ☐ Linear

☒ Autoscale ☐ Set min - max

Parameters

Edit... Change parameter values used by this axis

☒ Project Defaults

OK Cancel Help

6. On X-Axis, select **Category: General properties, Attribute: Density**. Ensure the Axis is in Logarithmic scale.

The screenshot shows the 'Chart Stage' dialog box with the 'X-Axis' tab selected. The 'Axis Property Definition' section includes a small map icon and a text prompt: 'Select the attribute that you wish to plot, or click the advanced button [Video Tutorials](#)'. Below this, the 'Category' dropdown is set to 'General properties' and the 'Attribute' dropdown is set to 'Density'. An 'Advanced...' button is located to the right of the Category dropdown. The 'Axis Settings' section shows the 'Axis Title' as 'Density (kg/m^3)'. Under the scale options, 'Logarithmic' is selected with a radio button, while 'Linear', 'Autoscale', and 'Set' are unselected. The 'Set' option has empty input fields for 'min' and 'max'. The 'Parameters' section at the bottom has an 'Edit...' button and a checked checkbox for 'Project Defaults'. At the very bottom of the dialog are 'OK', 'Cancel', and 'Help' buttons.

Chart Stage

X-Axis Y-Axis

Axis Property Definition

Select the attribute that you wish to plot, or click the advanced button [Video Tutorials](#)

Category: General properties Advanced...

Attribute: Density

Axis Settings

Axis Title: Density (kg/m³)

☒ Logarithmic ☐ Linear

☒ Autoscale ☐ Set min - max

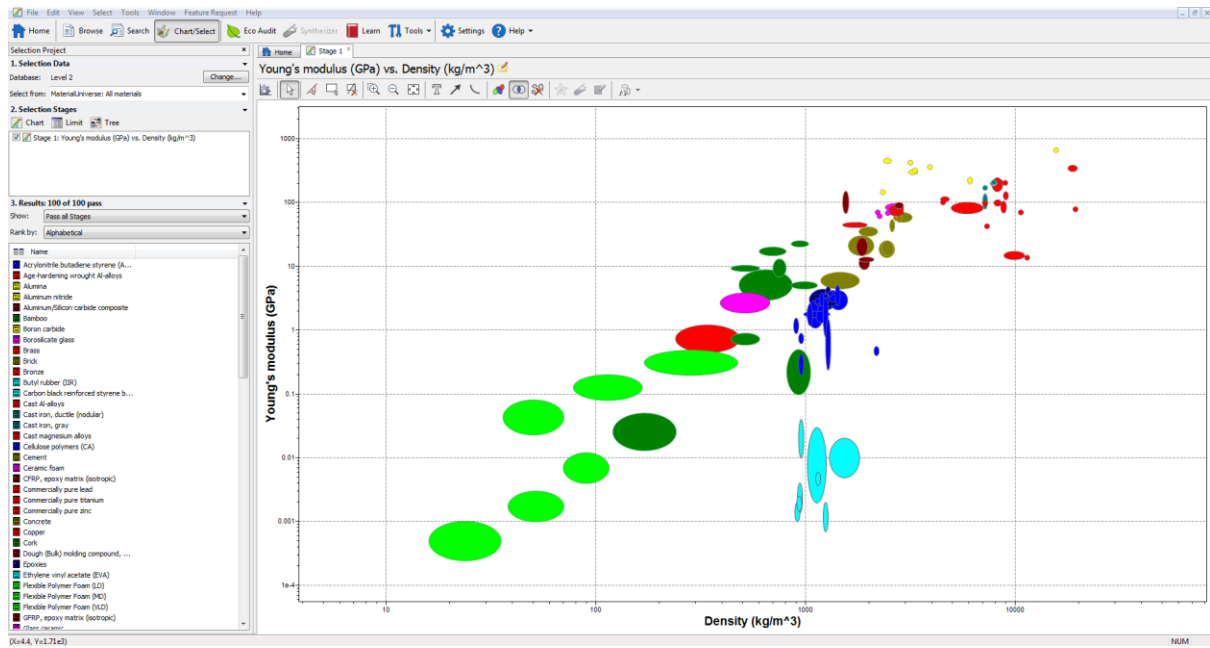
Parameters

Edit... Change parameter values used by this axis

☒ Project Defaults

OK Cancel Help

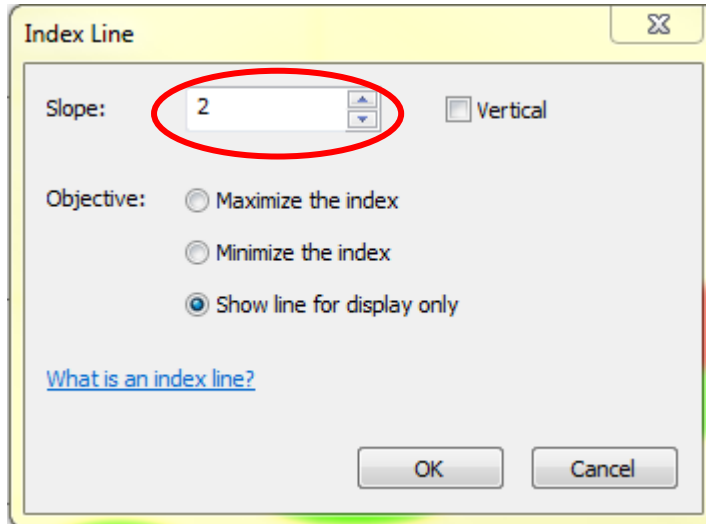
7. A plot of Young's Modulus with Density of all the materials available in the Level 2 Library is shown. Can you guess the different materials and groups? You can click on them to reveal which material it is.



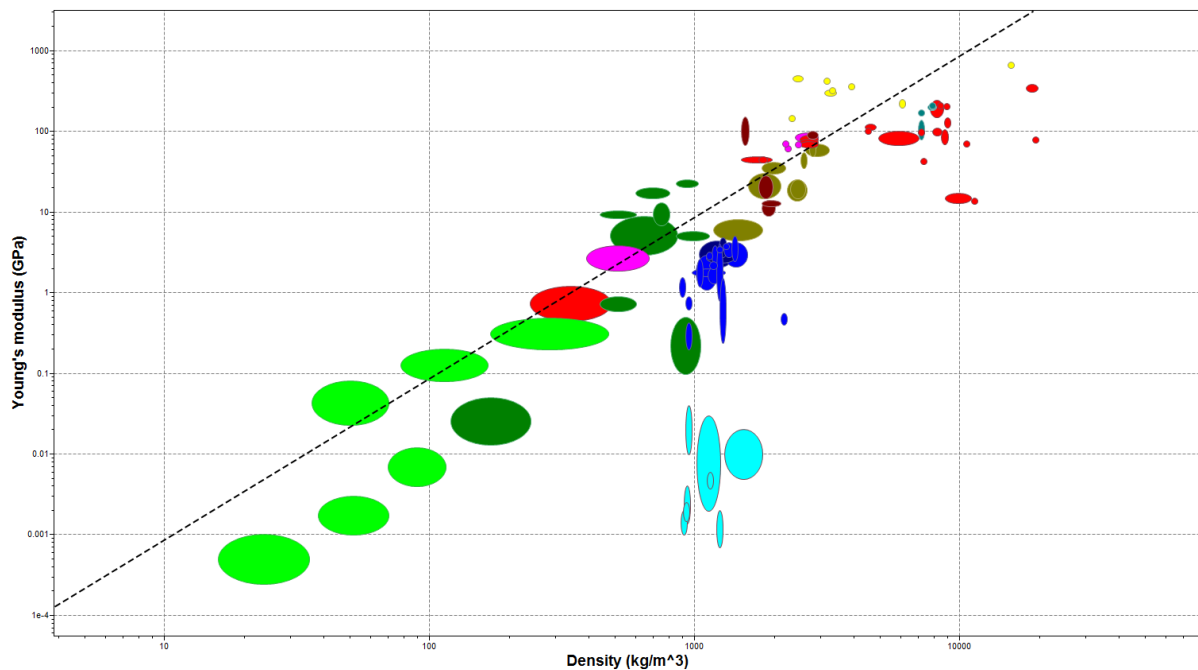
8. Select Index and display lines



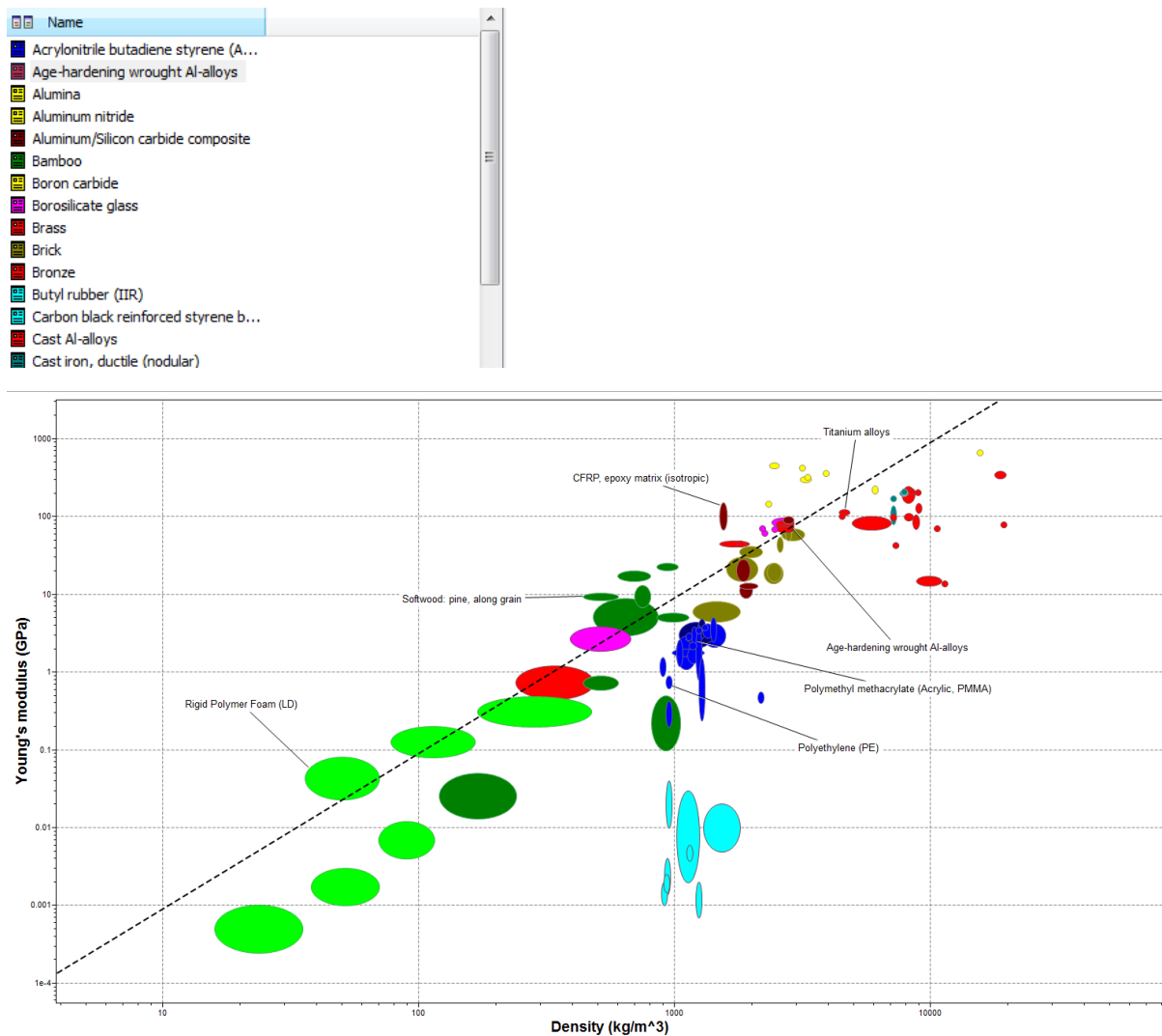
9. A window opens, give Slope: 2 and Objective as Show line for display only.



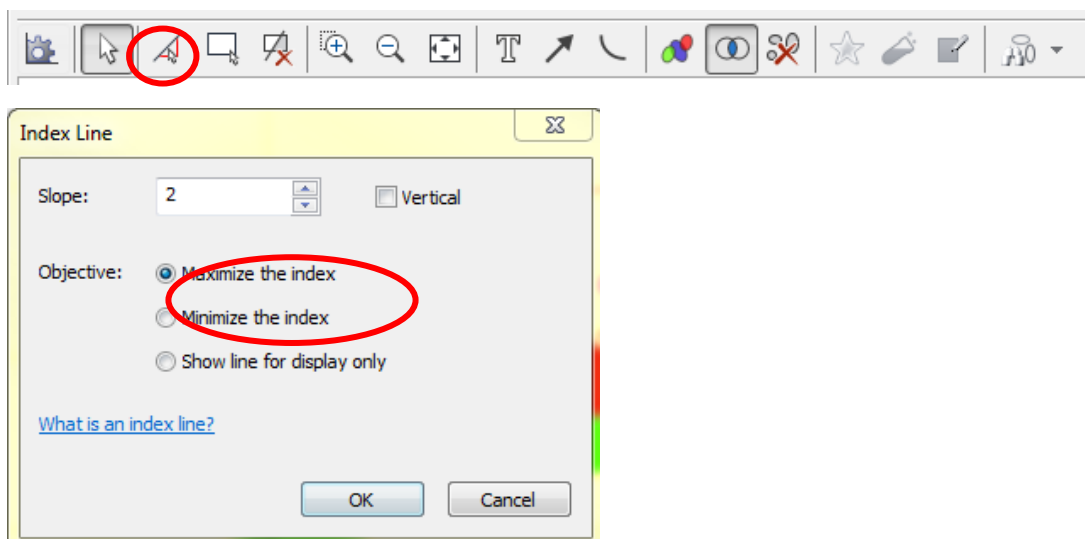
10. Click on the plot to display the index line. The display line can be moved up and down to understand the performance of material for this particular index.



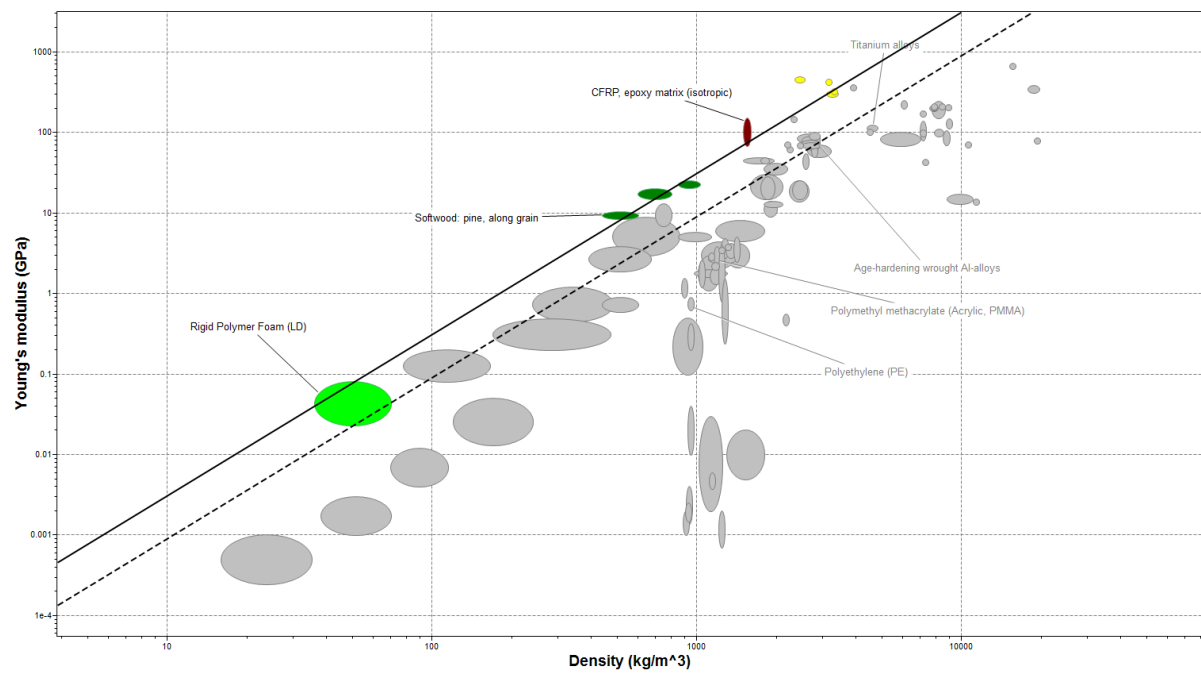
11. Label the material by right clicking on the names of the material on the right side. Insert labels as shown in the plot for Polyethylene, Aluminium alloys, Polymethyl methyl acrylate etc.



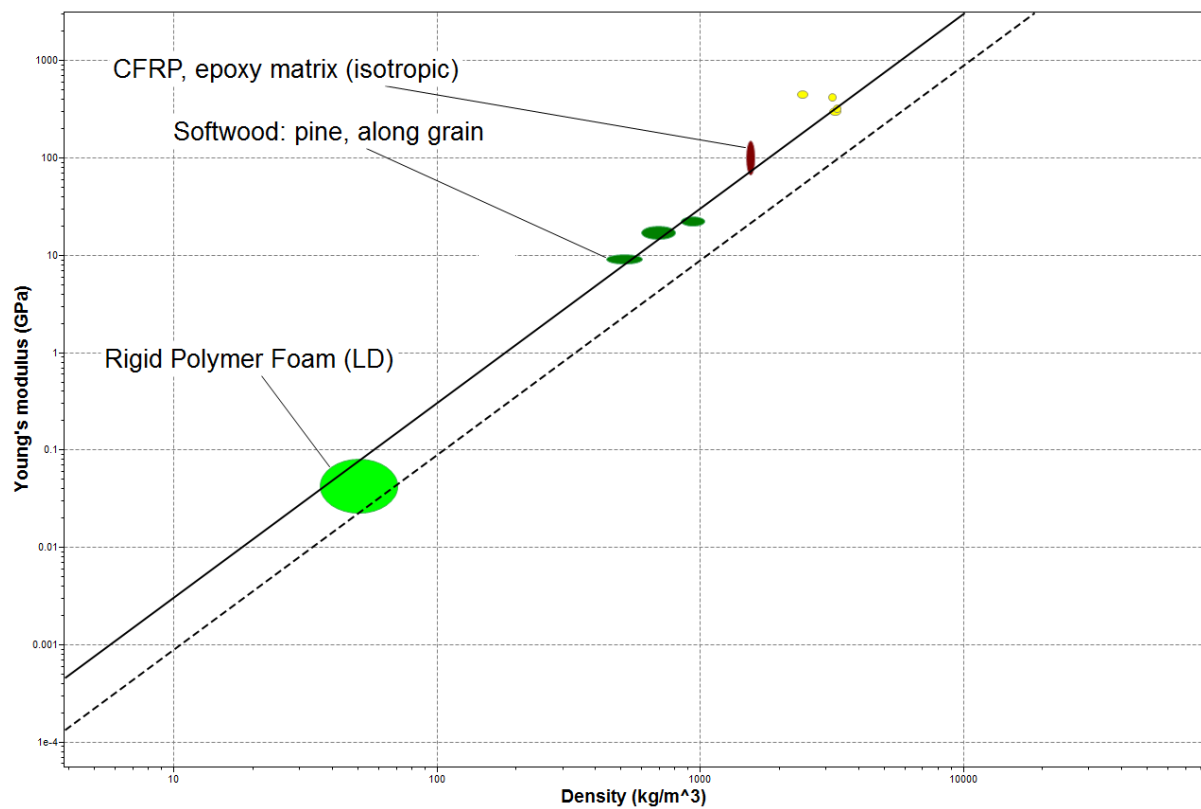
12. Draw another index line but this time set the objective as Maximise the index.



13. Move the selection line in-order to select the top materials for the current index



14. Click Hide failed records



15. This plot suggests Wood, Rigid Polymer Foams, CFRP and 3 different ceramics as possible selection. But certain materials have the advantage of being shaped into structurally stiffer shapes like I-sections and tubes. In order to take this into account we will introduce the concept of shape factors and represent them graphically.

16. Click on the Tools options to define the material by accounting for the shape.

The screenshot shows the 'User Defined Record' dialog box. The top toolbar includes icons for Home, Browse, Search, Chart/Select, Eco Audit, Synthesizer, Learn, Tools (circled in red), Settings, and Help. The dialog box is titled 'User Defined Record' and contains the following sections:

- Record Details**: Includes a 'Name' field (with a red border), a 'Color' dropdown menu set to 'Orange', and a 'Notes' text area. A message below the name field states 'Name cannot be empty'.
- Selection Attributes**: A list of expandable categories with dropdown arrows:
 - General properties
 - Mechanical properties
 - Thermal properties
 - Electrical properties
 - Optical properties
 - Critical Materials Risk
 - Processability
 - Durability: water and aqueous solutions
 - Durability: acids
 - Durability: alkalis

At the bottom of the dialog box are 'OK' and 'Cancel' buttons. A note at the bottom left of the dialog box states: '* Records are not added to the database, but saved with the project file.'

17. Define a CFRP box section (shape factor of 10) and Aluminium tube (shape factor of 25). Input the properties as shown in figures

Record Details

[Video tutorials](#)

Name:
Color: Orange

Notes:

* Records are not added to the database, but saved with the project file.

Selection Attributes

General properties

	Minimum	Maximum	
Density	<input type="text" value="150"/>	<input type="text" value="160"/>	kg/m ³
Price	<input type="text"/>	<input type="text"/>	GBP/kg

Mechanical properties

	Minimum	Maximum	
Young's modulus	<input type="text" value="6.9"/>	<input type="text" value="15"/>	GPa
Shear modulus	<input type="text"/>	<input type="text"/>	GPa
Bulk modulus	<input type="text"/>	<input type="text"/>	GPa

OK

Cancel

Record Details

[Video tutorials](#)

Name:
Color: Orange

Notes:

* Records are not added to the database, but saved with the project file.

Selection Attributes

General properties

	Minimum	Maximum	
Density	<input type="text" value="250"/>	<input type="text" value="290"/>	kg/m ³
Price	<input type="text"/>	<input type="text"/>	GBP/kg

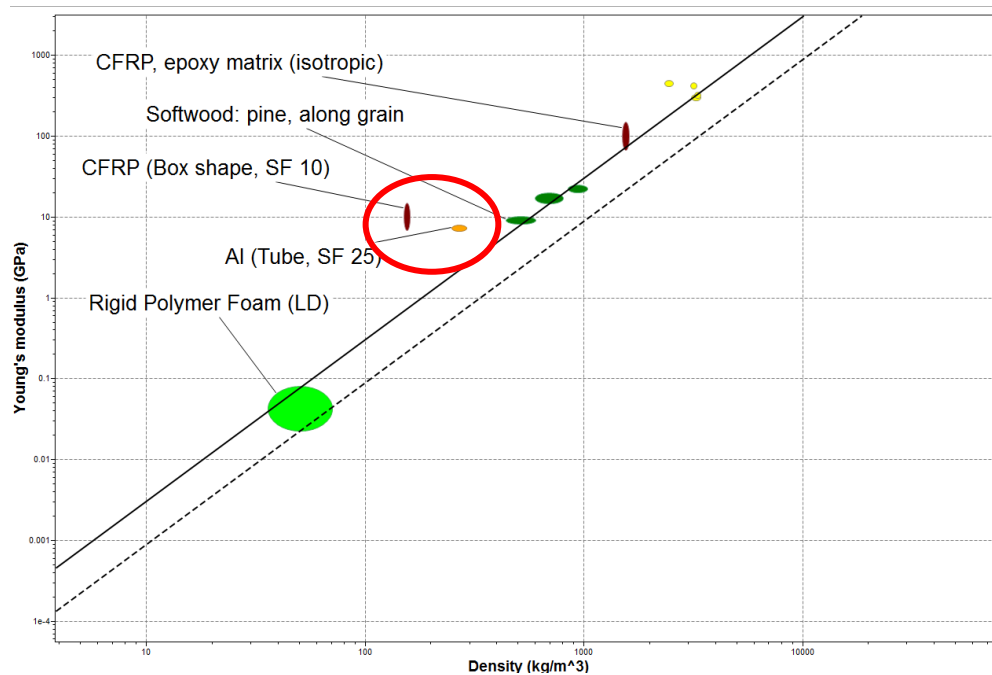
Mechanical properties

	Minimum	Maximum	
Young's modulus	<input type="text" value="6.900000095367"/>	<input type="text" value="8"/>	GPa
Shear modulus	<input type="text"/>	<input type="text"/>	GPa
Bulk modulus	<input type="text"/>	<input type="text"/>	GPa

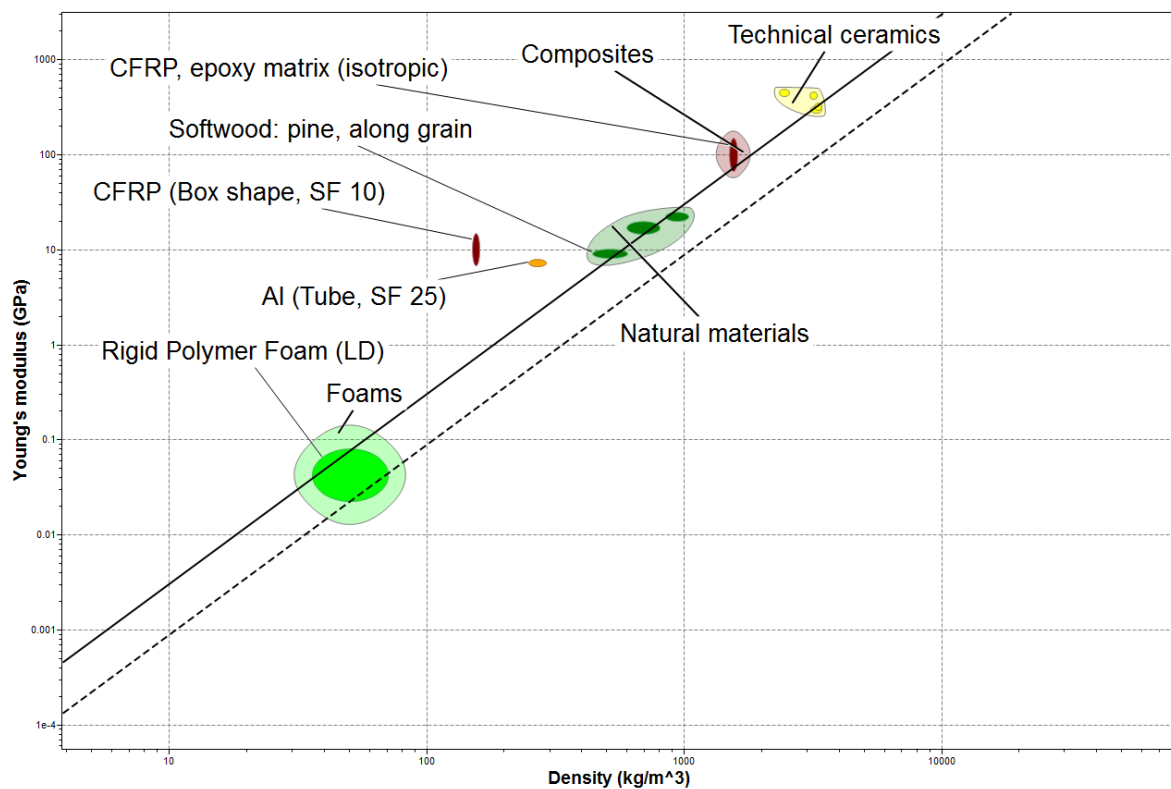
OK

Cancel

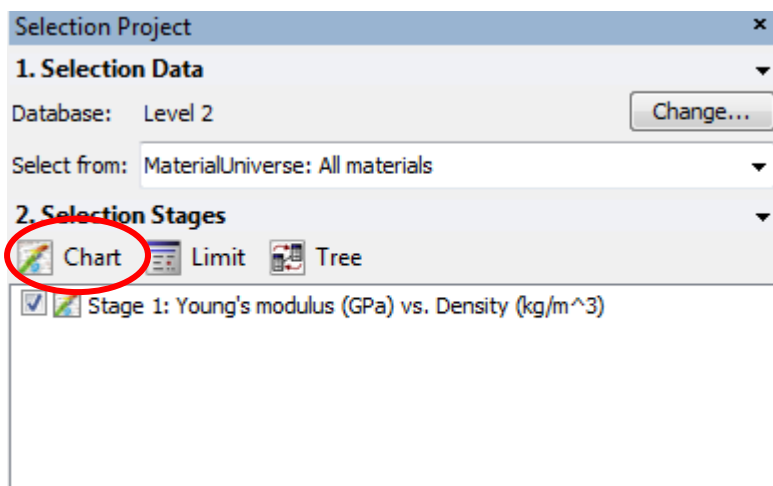
18. These materials will now show up on the plot and is shown to be potential choices for the application.



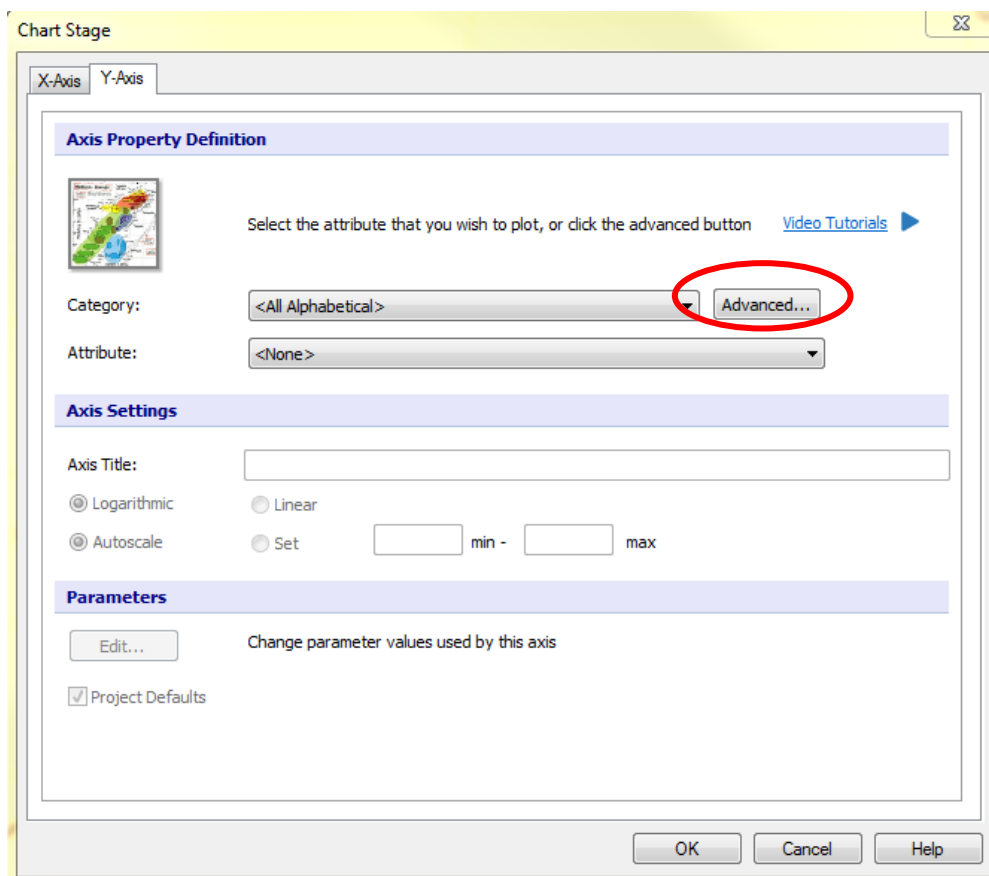
19. Click on show family envelopes to understand more about the potential materials.



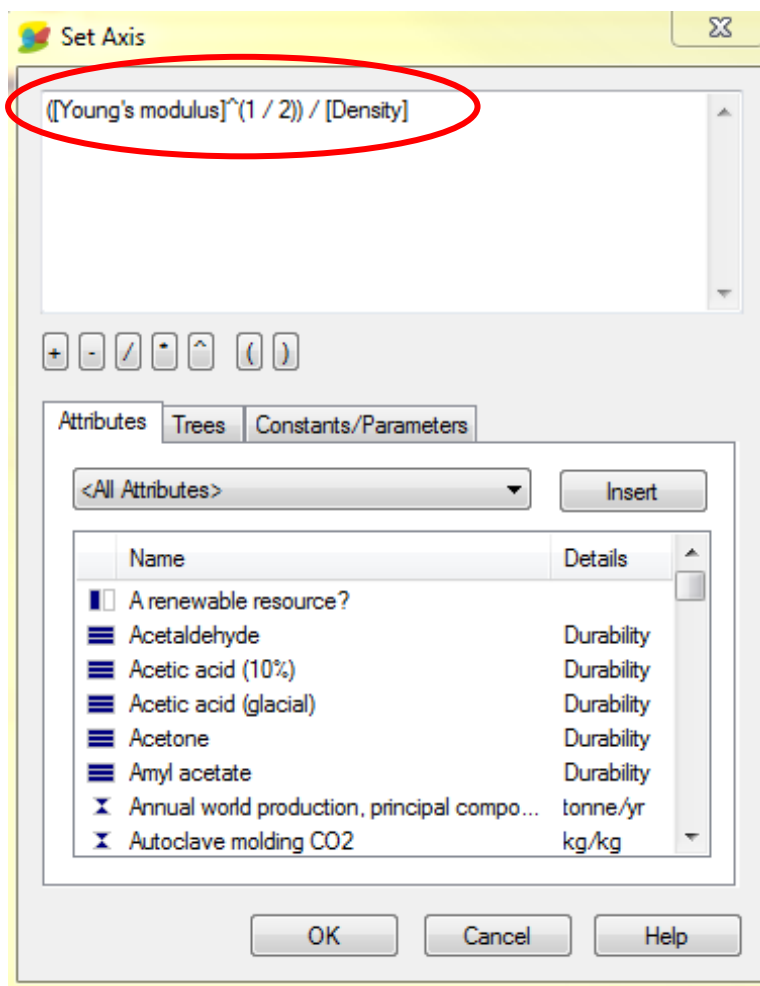
20. In order to rank these materials, another chart is required. Click the Chart option.



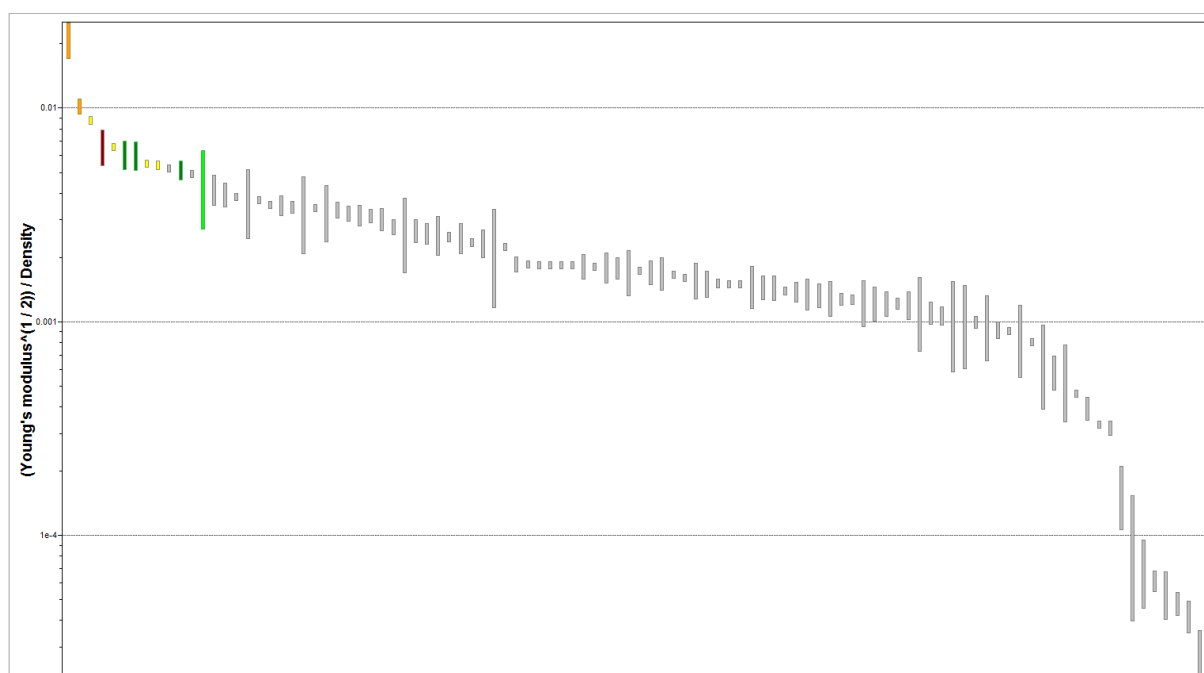
21. Define the Y-Axis by clicking on Advanced option.



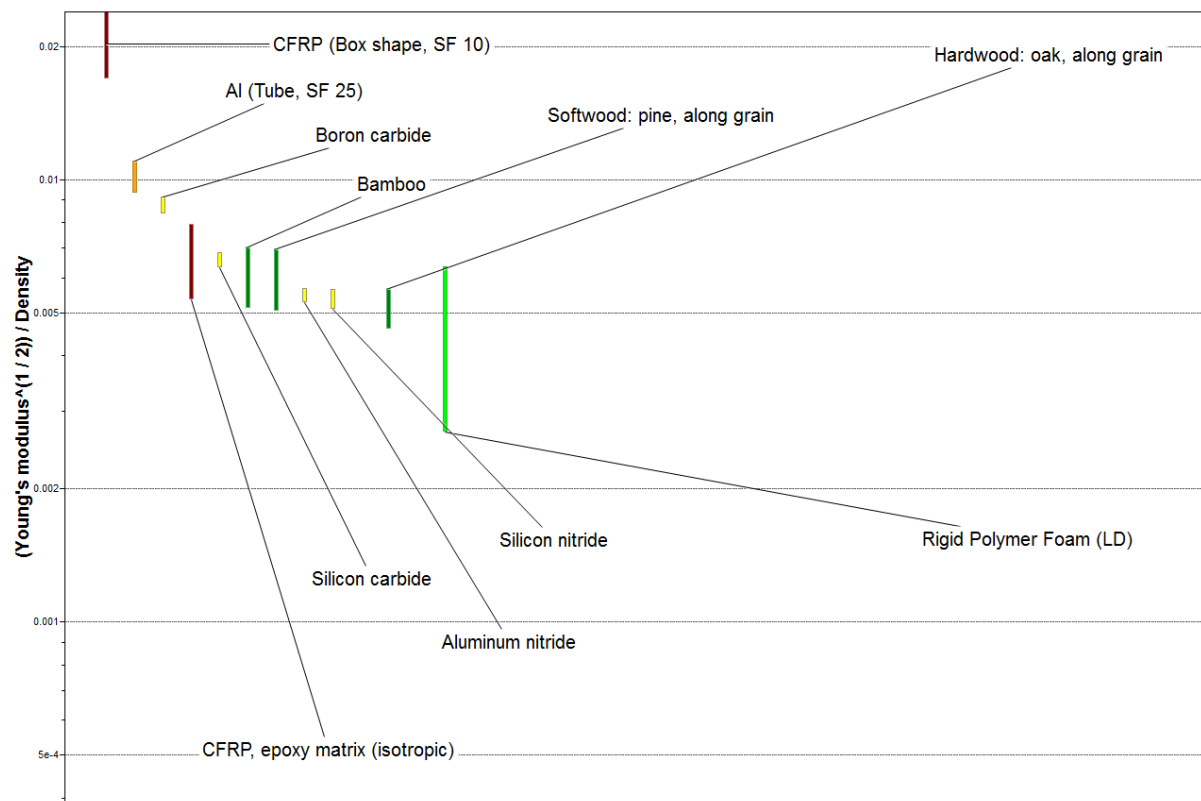
22. Use the equation developer to form the Material Performance Index as shown.



23. Click ok and plot the Material Performance Index according to the rank



24. Remove the failed choices and label the materials



25. Use the File → Print → Save as PDF to export the results