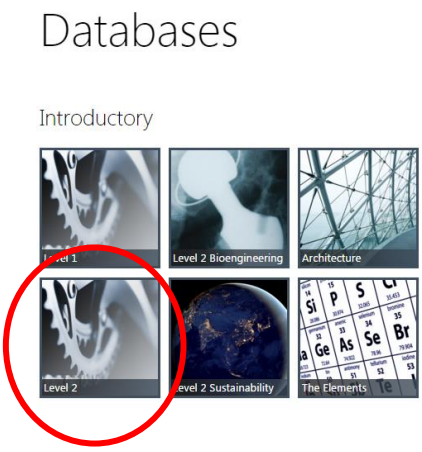
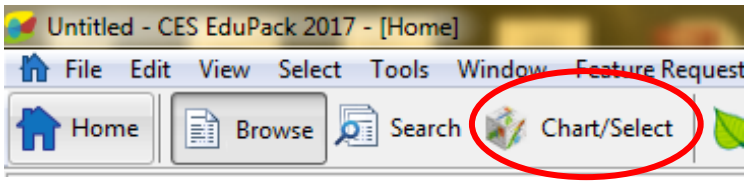
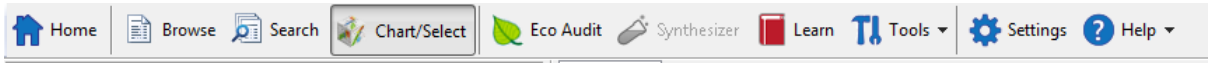
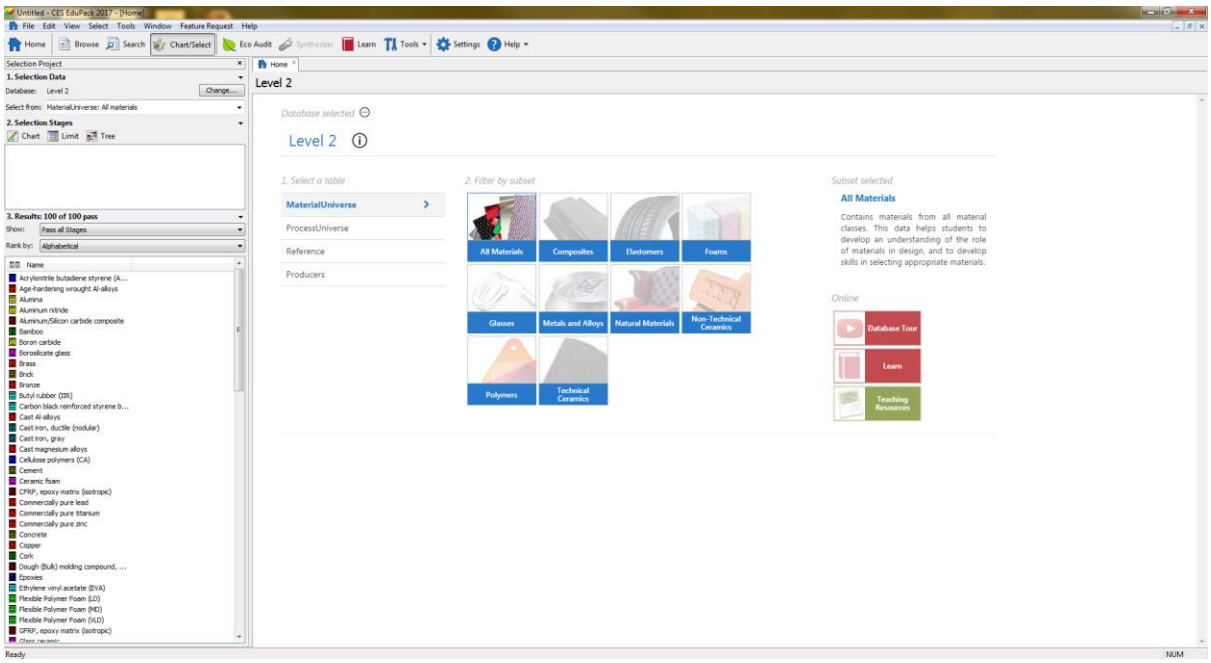
1. Open CES Edupack 2017 and select **Level 2 Materials** (the higher levels have more materials and details in them but can be too much for some applications. Level 2 gives a good detail of different materials without showing too many alterations of similar materials)



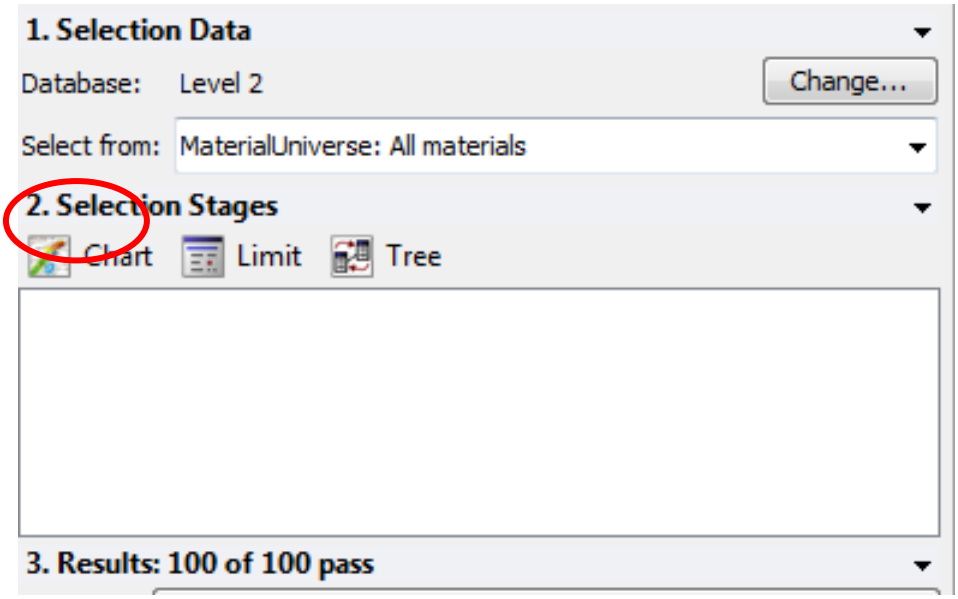
2. Press **Chart/Select** to open a material selection project



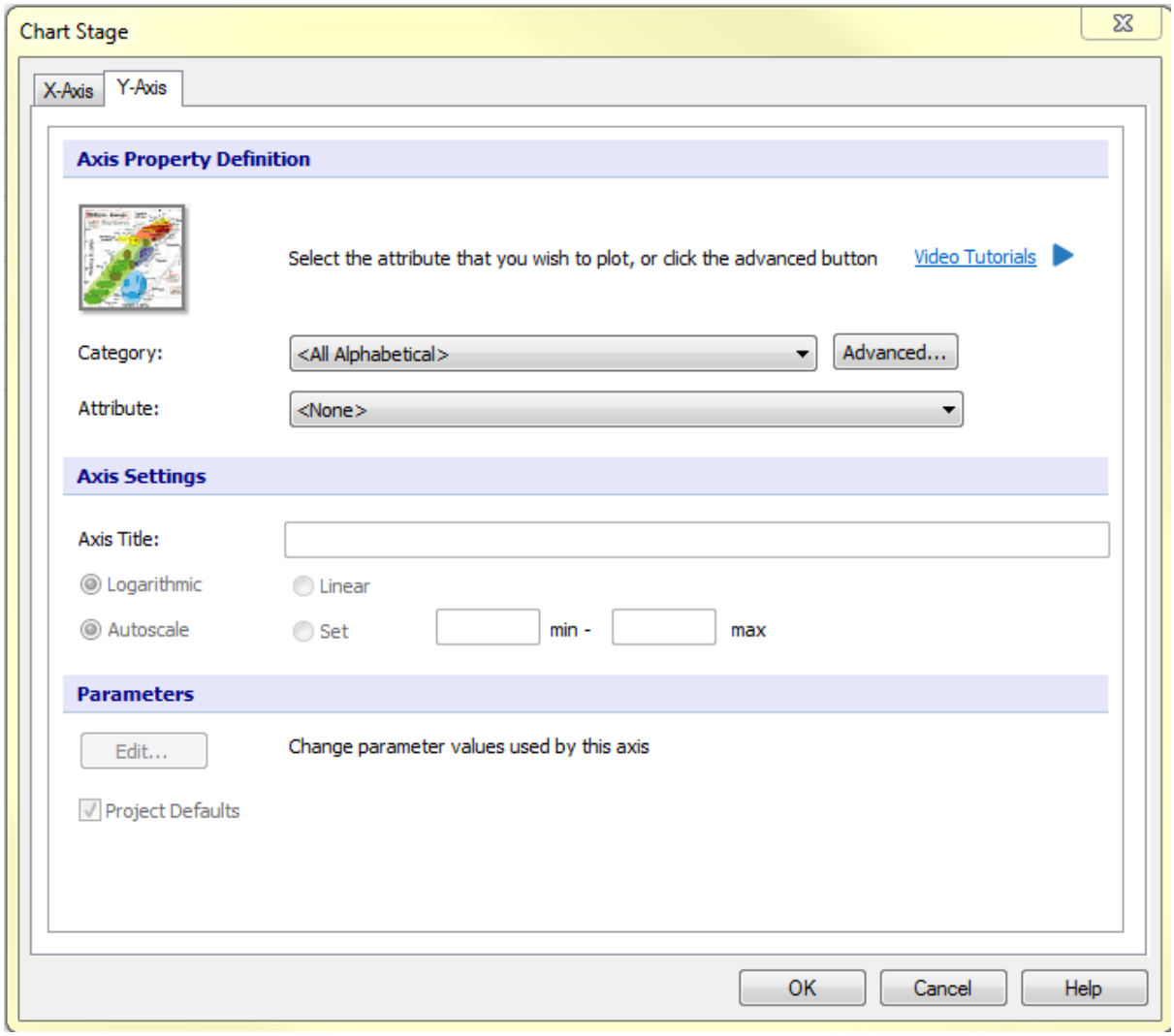




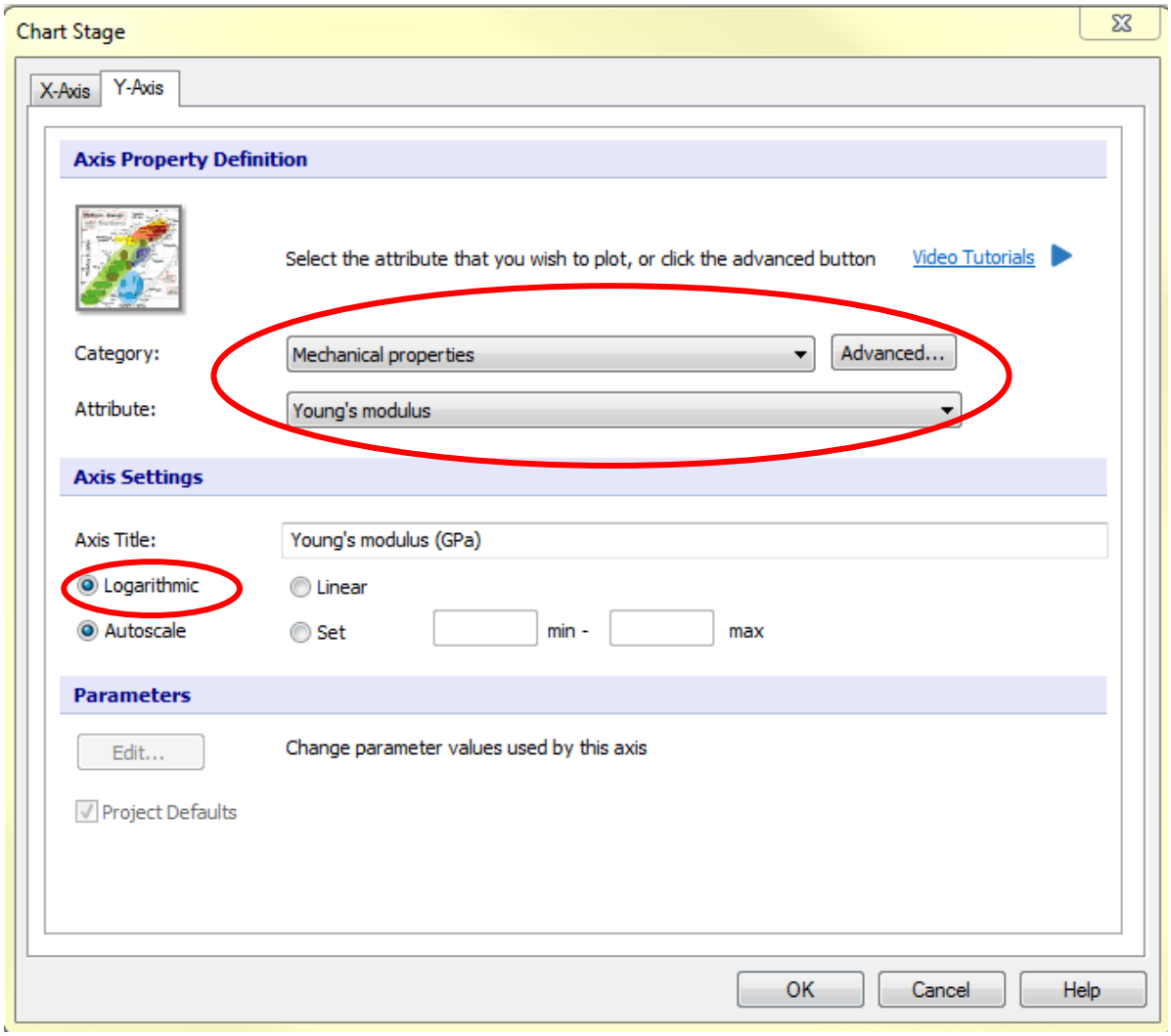
3. Press **Chart** to start a new chart



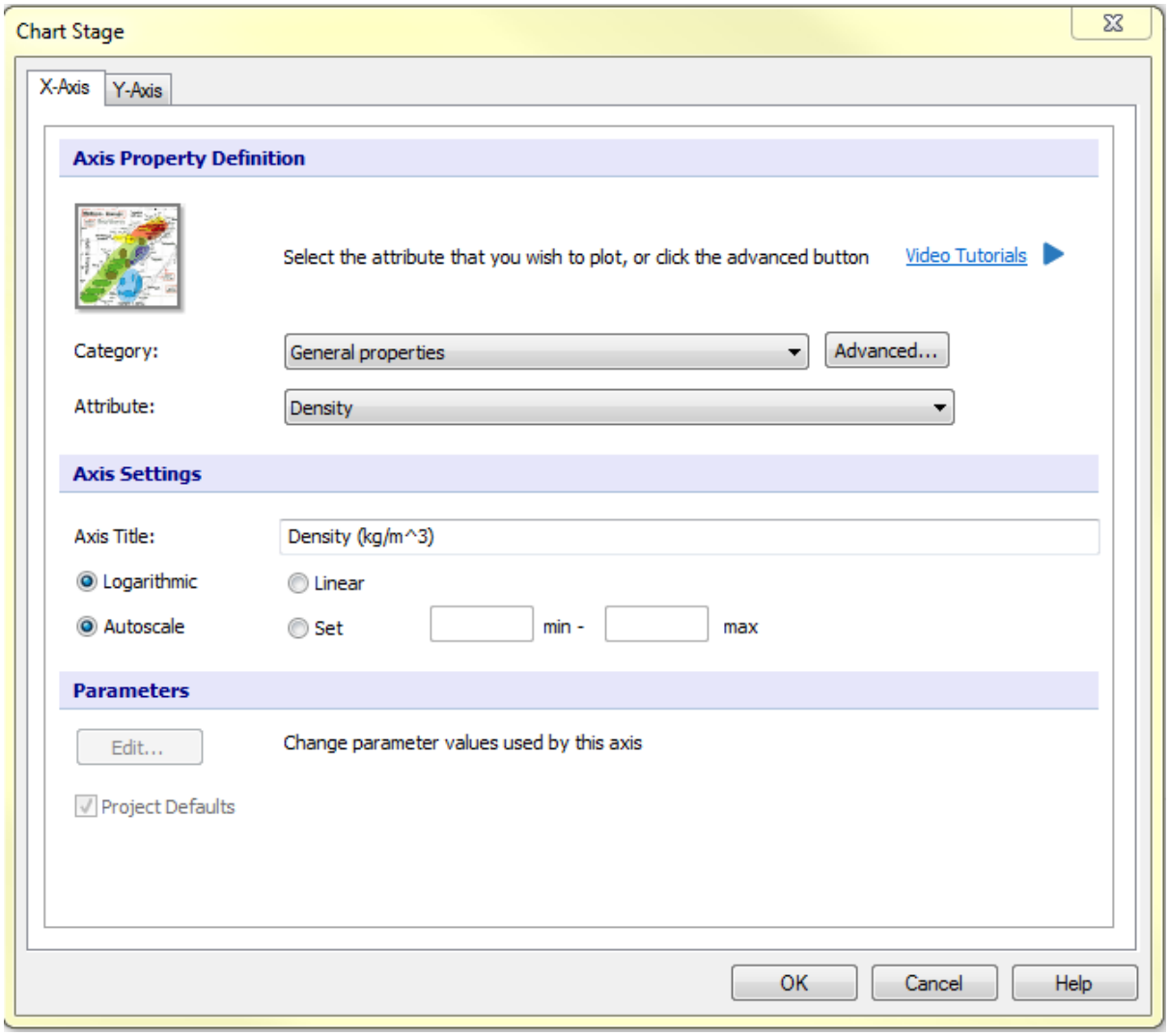
4. A window to choose Y and X axis attribute opens



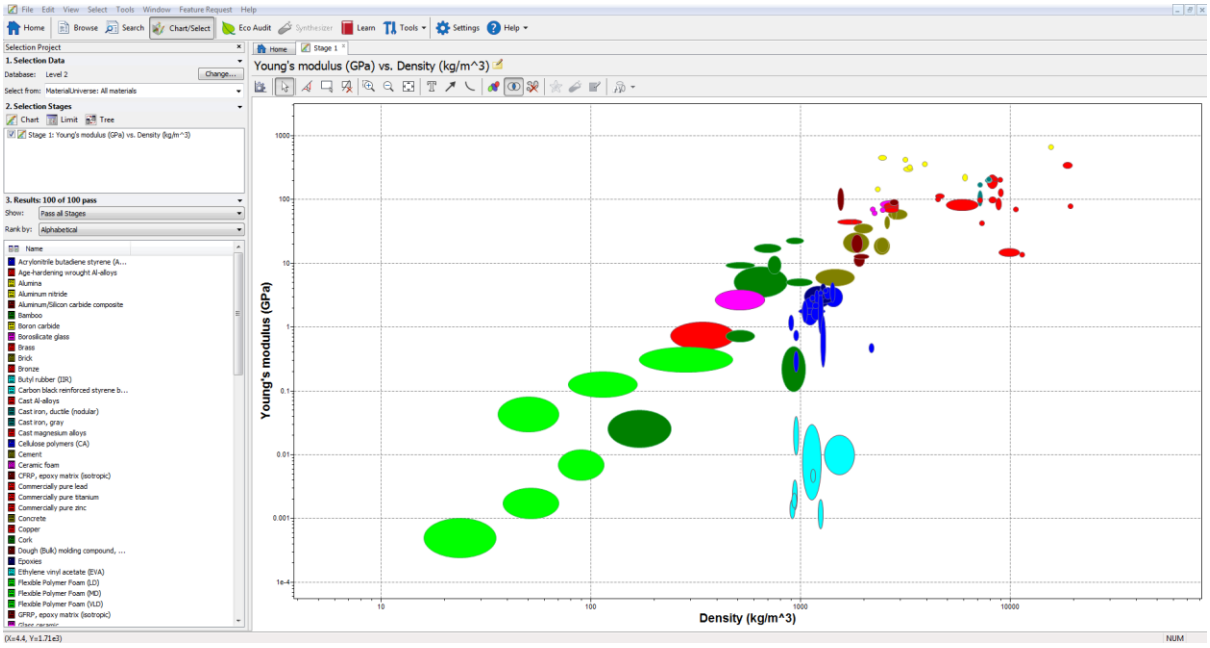
5. On Y-Axis, select **Category: Mechanical properties**, **Attribute: Young's modulus**. Ensure the Axis is in Logarithmic scale.



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

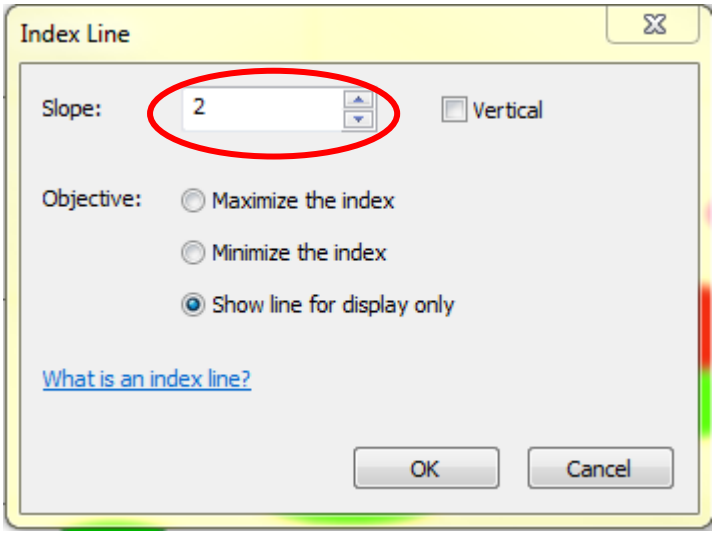


7. A plot of Young's Modulus with Density of all the materials available in the Level 2 Library is shown. Can you guess the different materials and groups? You can click on them to reveal which material it is.

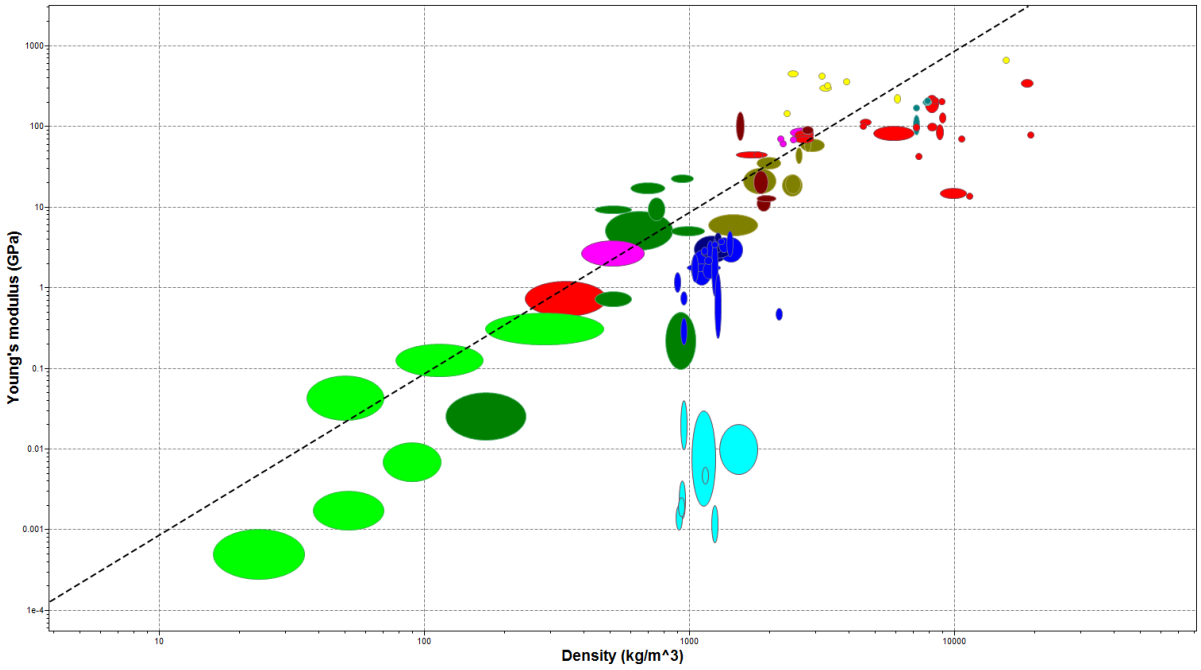


8. Select Index and display lines

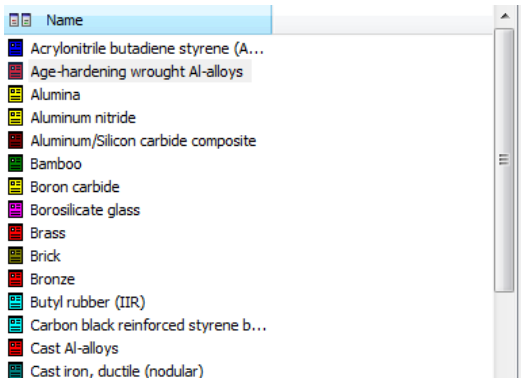
9. A window opens, give Slope: 2 and Objective as Show line for display only.

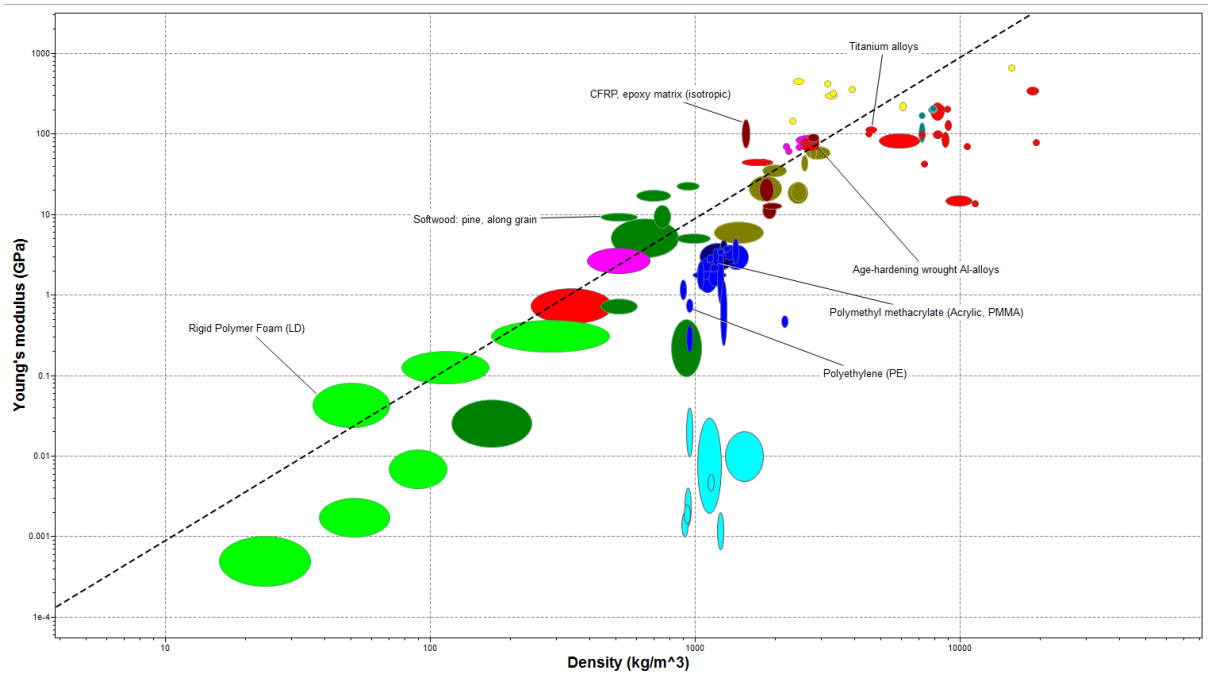


10. Click on the plot to display the index line. The display line can be moved up and down to understand the performance of material for this particular index.

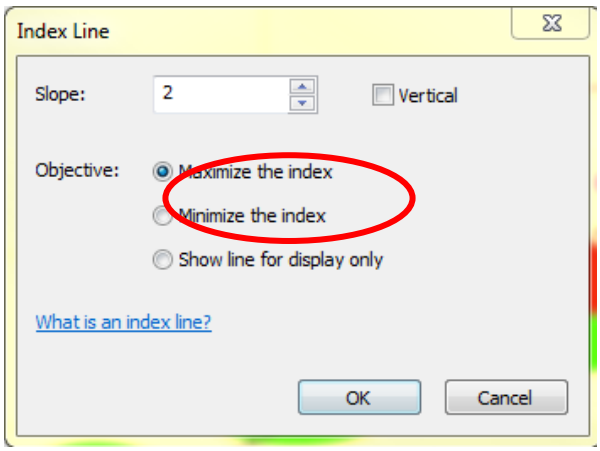


11. Label the material by right clicking on the names of the material on the right side. Insert labels as shown in the plot for Polyethylene, Aluminium alloys, Polymethyl methyl acrylate etc.

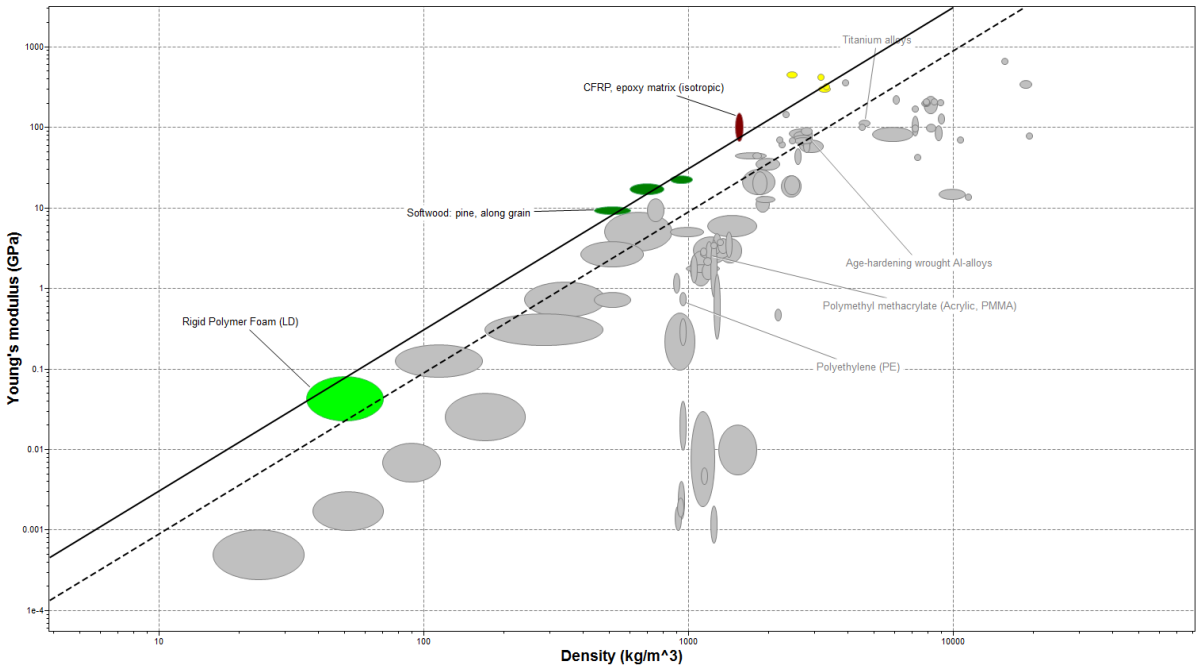




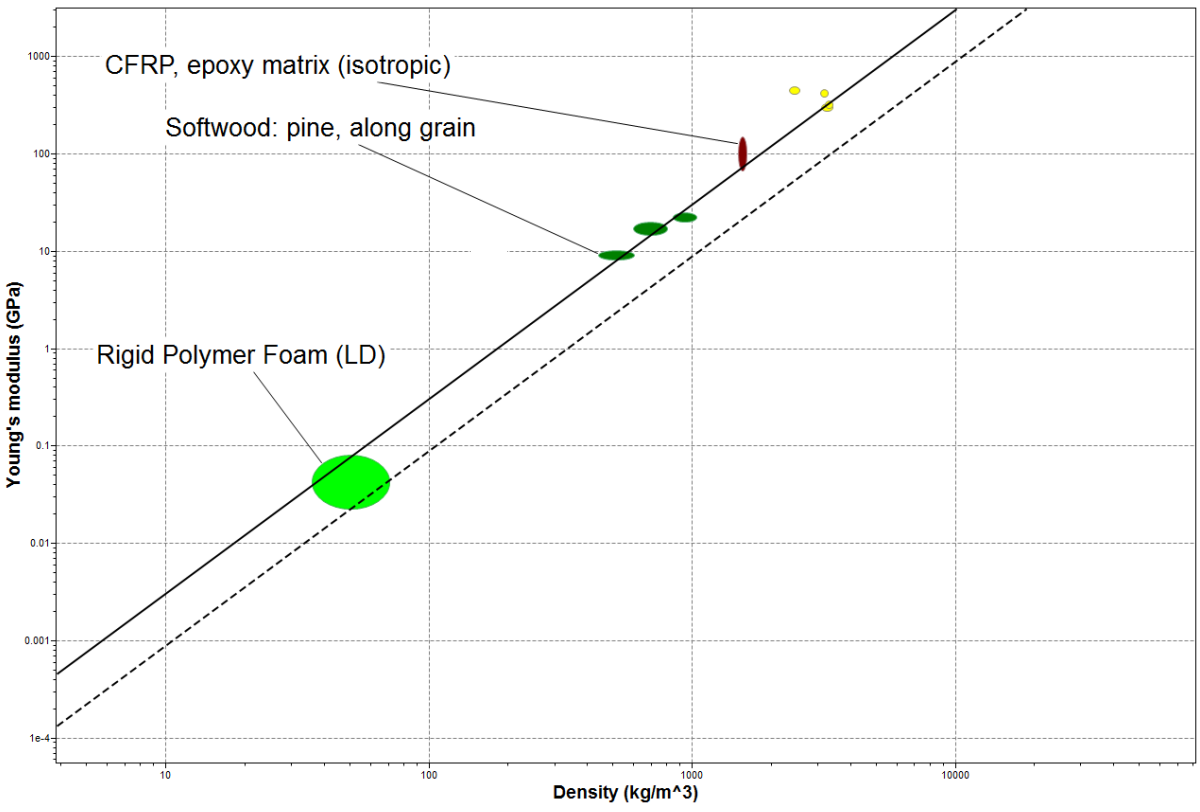
12. Draw another index line but this time set the objective as Maximise the index.



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

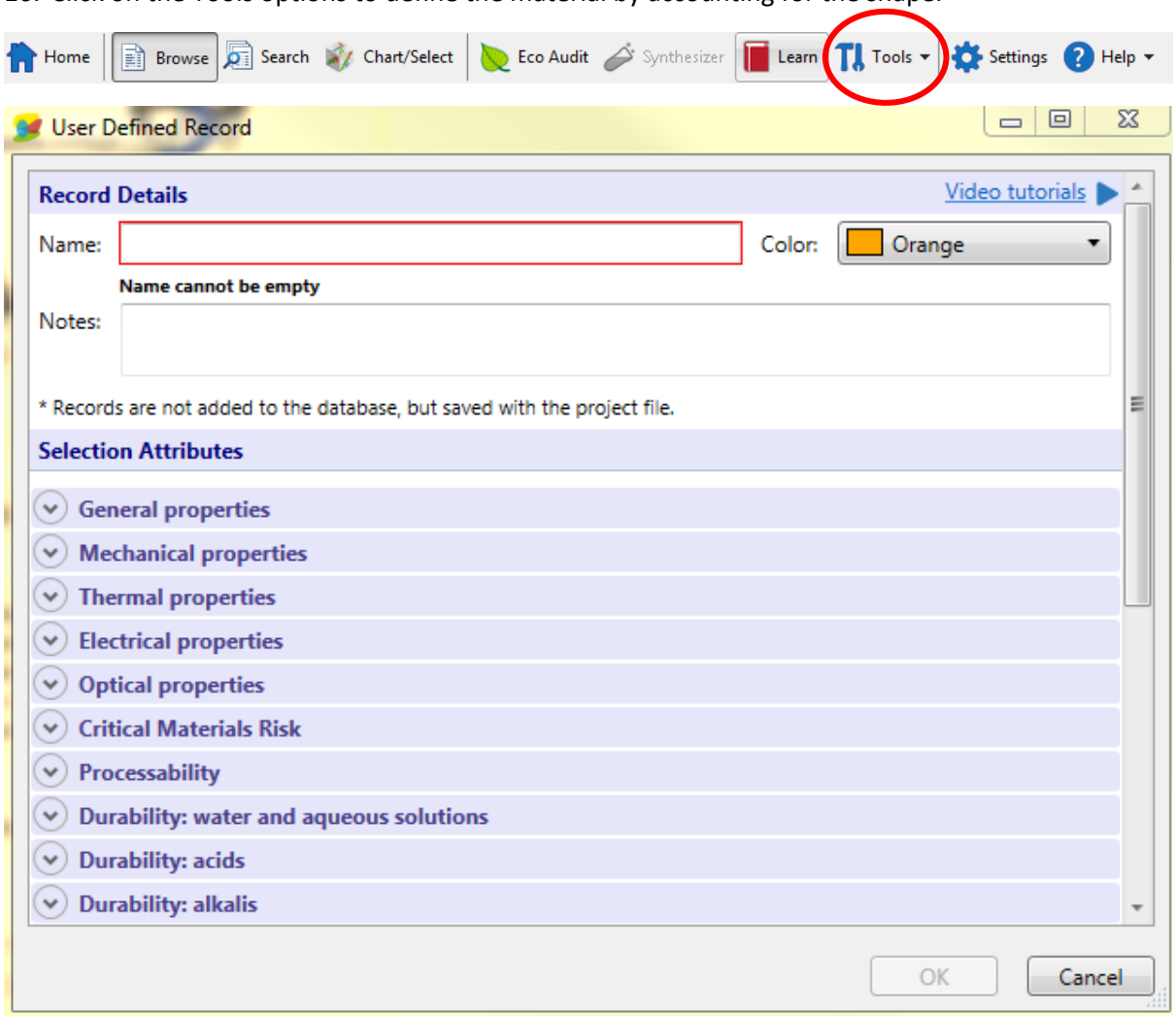


14. Click Hide failed records

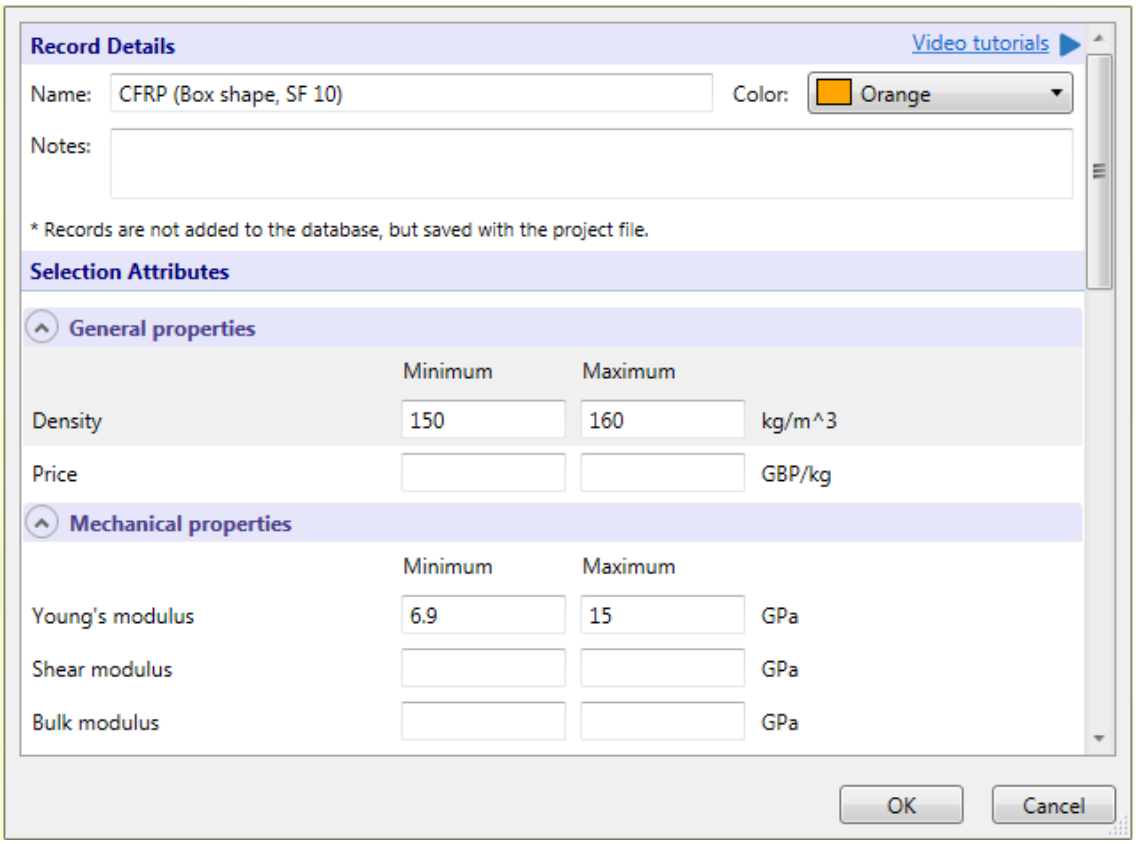


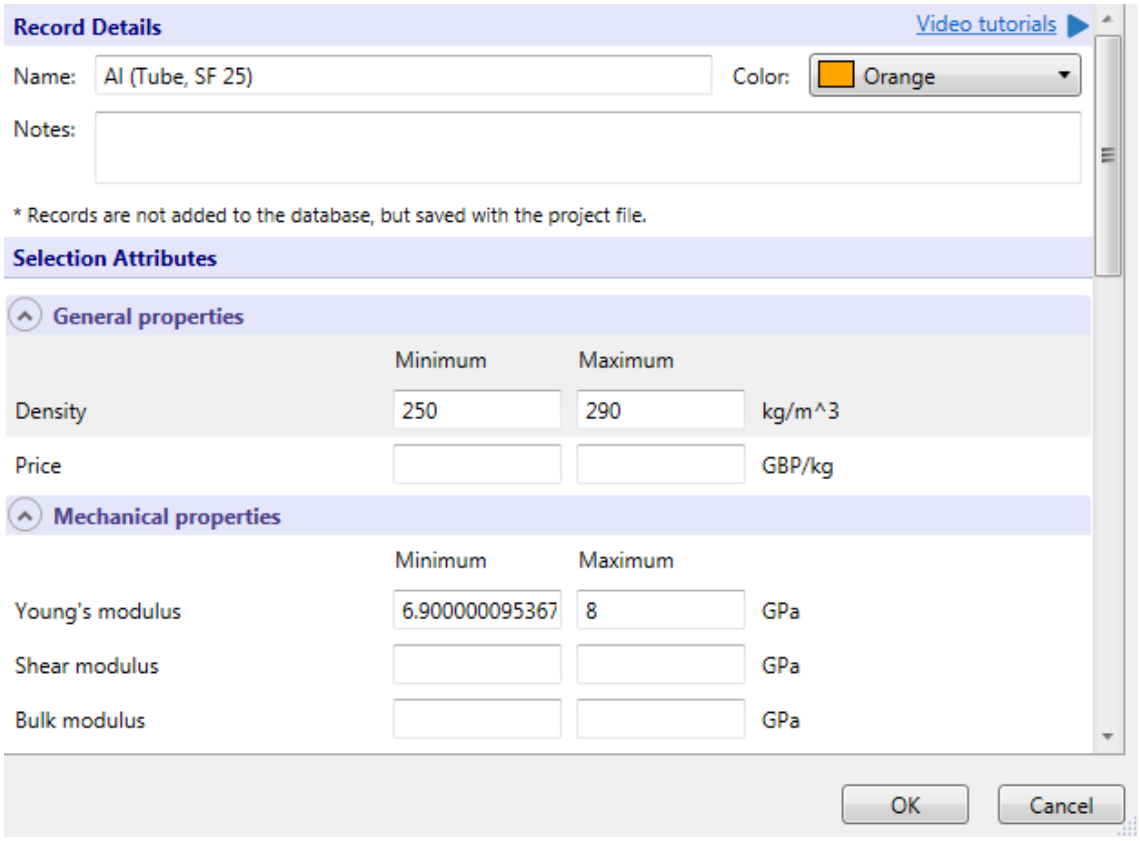
15. This plot suggests Wood, Rigid Polymer Foams, CFRP and 3 different ceramics as possible selection. But certain materials have the advantage of being shaped into structurally stiffer shapes like I-sections and tubes. Inorder to take this into account we will introduce the concept of shape factors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

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

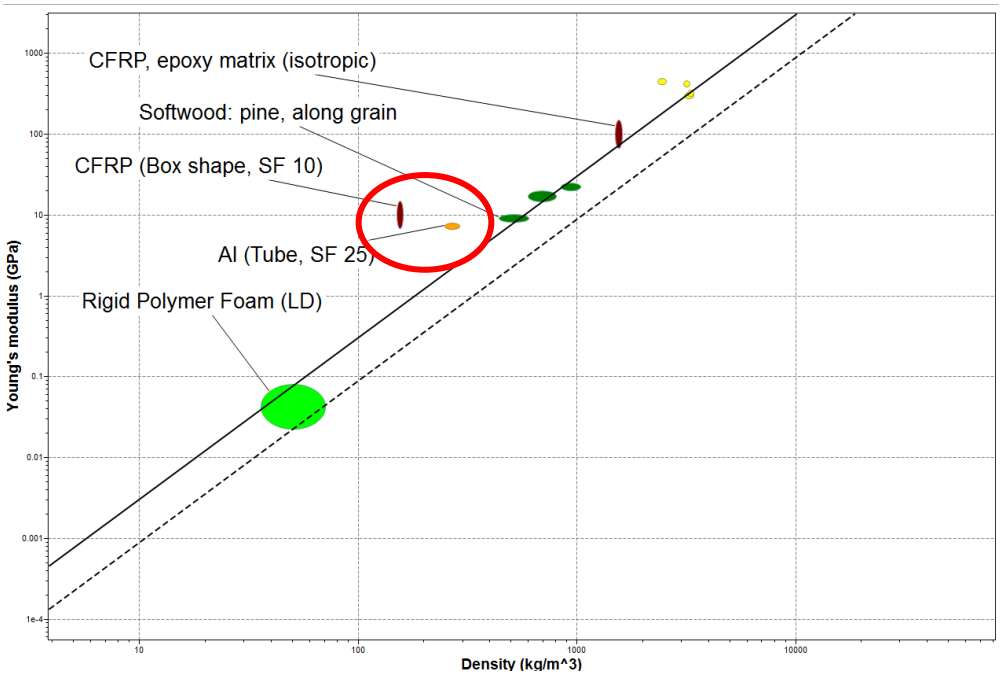


17. Define a CFRP box section (shape factor of 10) and Aluminium tube (shape factor of 25). Input the properties as shown in figures

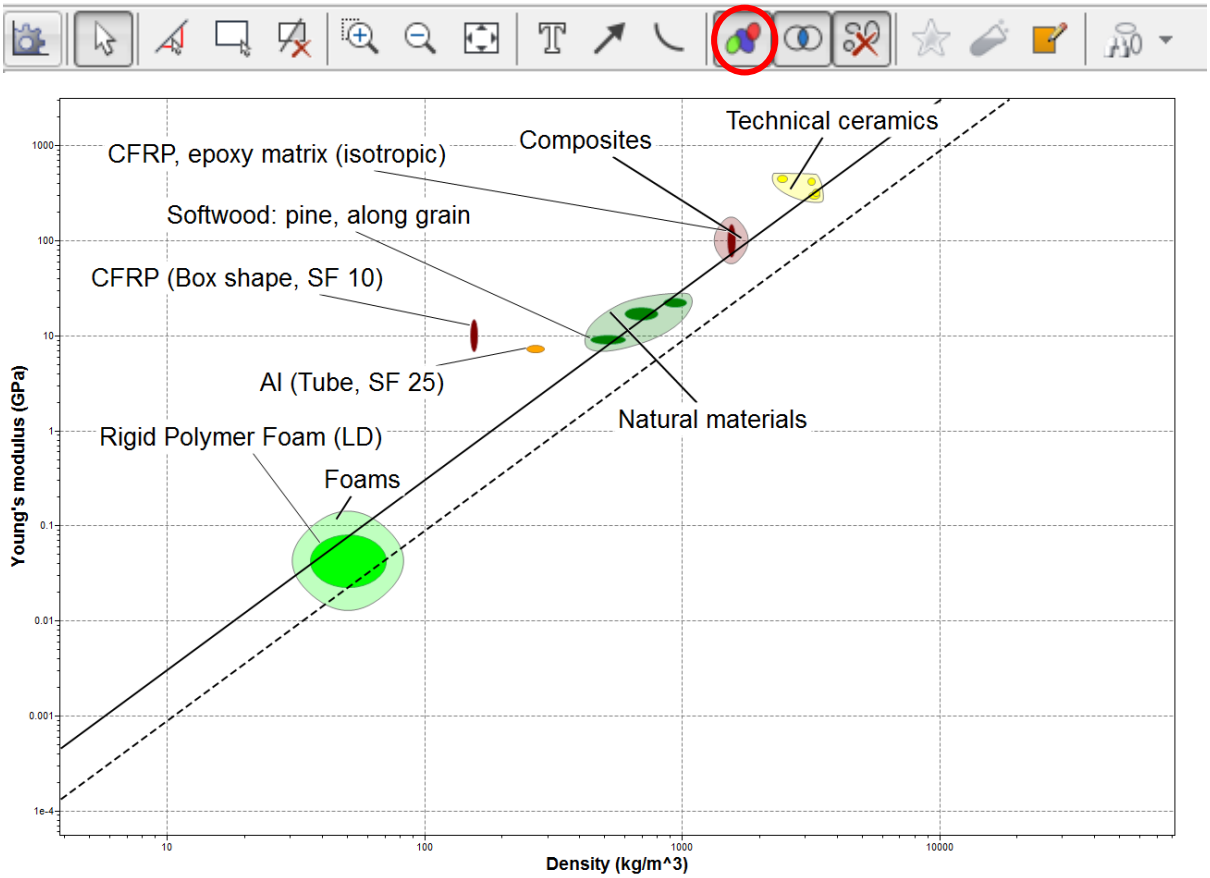

Record Details
Video tutorials
Name: CFRP (Box shape, SF 10)
Color: Orange
Notes:
* Records are not added to the database, but saved with the project file.
Selection Attributes
General properties
Minimum
Maximum
Density
150
160
kg/m^3
Price
GBP/kg
Mechanical properties
Minimum
Maximum
Young's modulus
6.9
15
GPa
Shear modulus
GPa
Bulk modulus
GPa
OK
Cancel


Record Details
Video tutorials
Name: Al (Tube, SF 25)
Color: Orange
Notes:
* Records are not added to the database, but saved with the project file.
Selection Attributes
General properties
Minimum
Maximum
Density
250
290
kg/m^3
Price
GBP/kg
Mechanical properties
Minimum
Maximum
Young's modulus
6.900000095367
8
GPa
Shear modulus
GPa
Bulk modulus
GPa
OK
Cancel

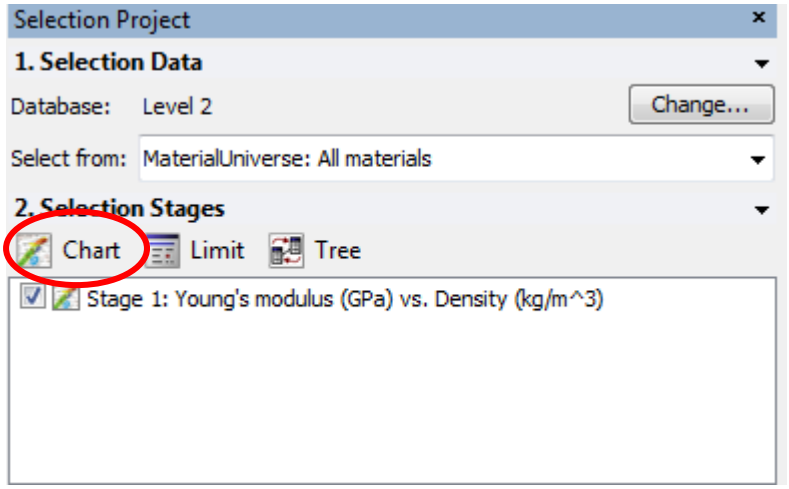
18. These materials will now show up on the plot and is shown to be potential choices for the application.



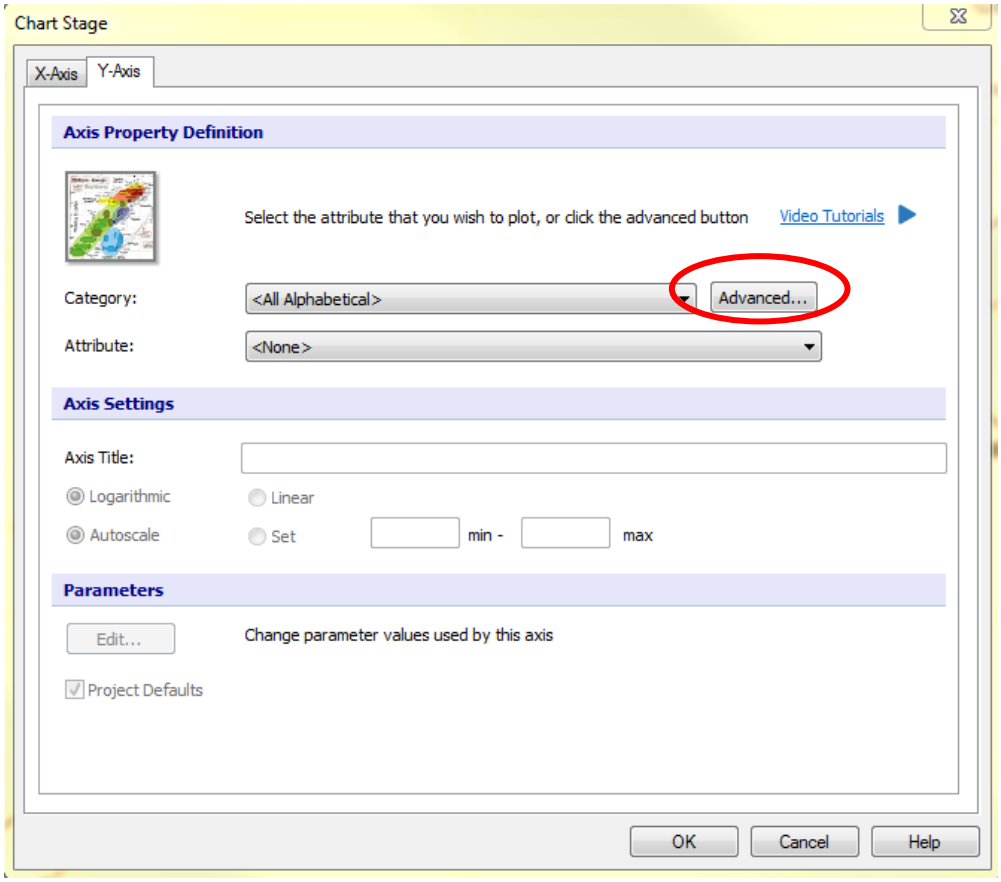
19. Click on show family envelopes to understand more about the potential materials.



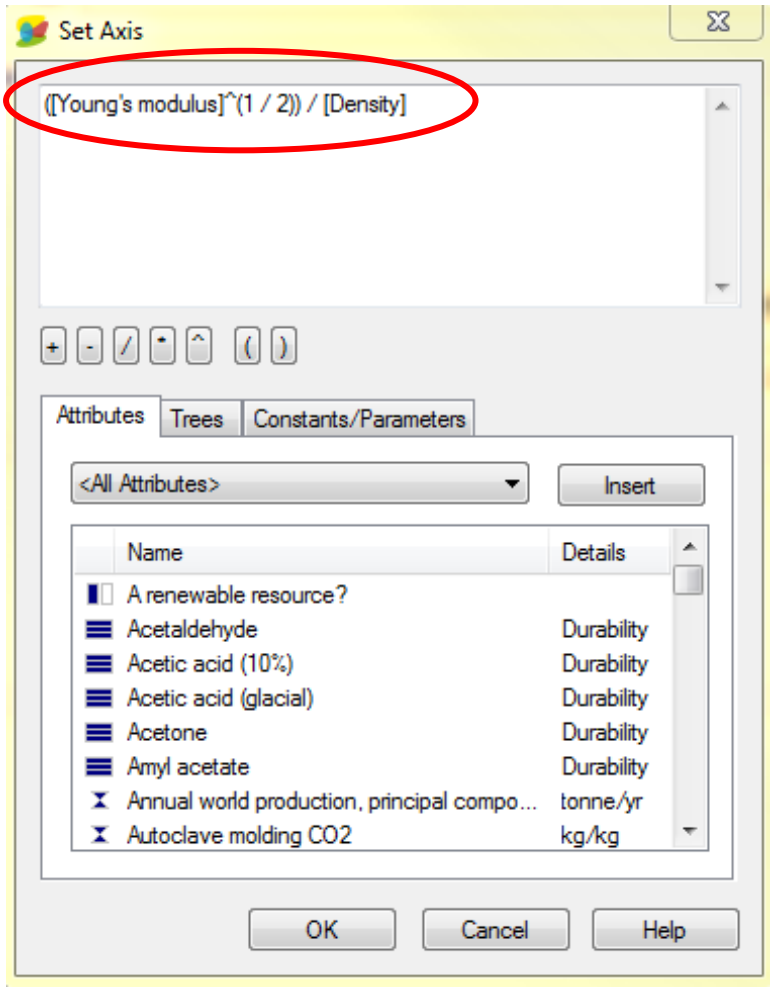
20. Inorder to rank these materials, another chart is required. Click the Chart option.



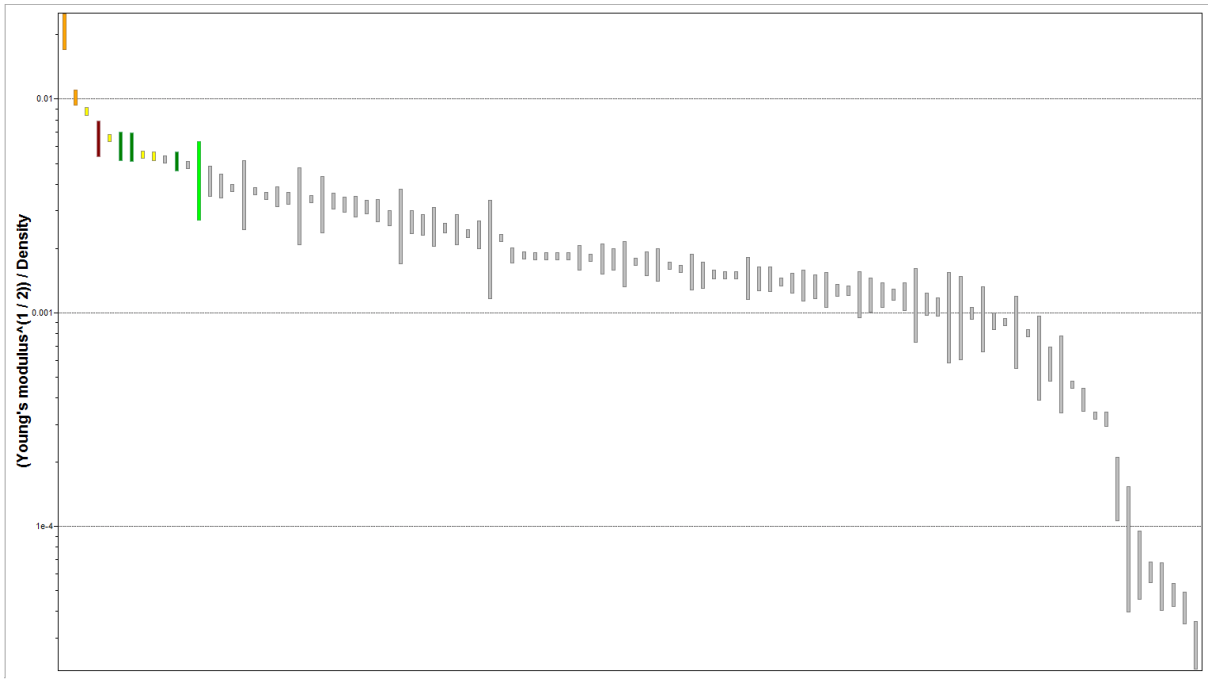
21. Define the Y-Axis by clicking on Advanced option.



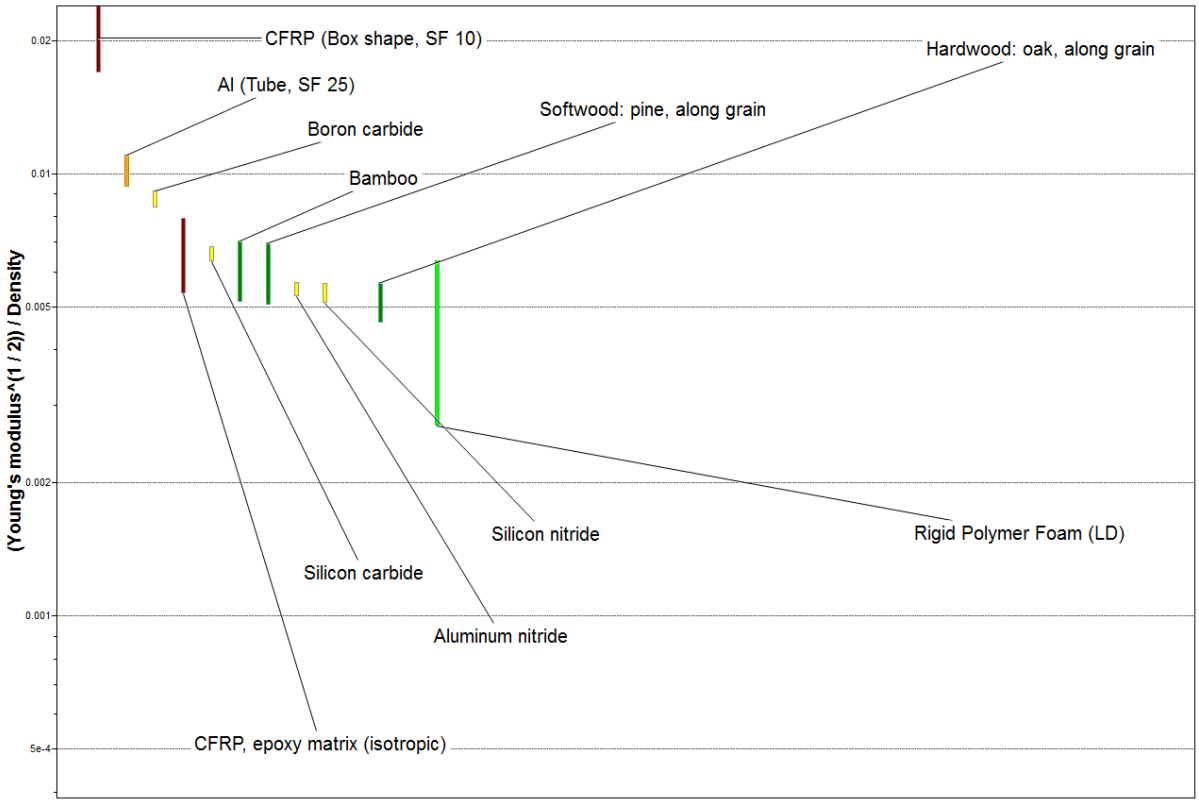
22. Use the equation developer to form the Material Performance Index as shown.



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