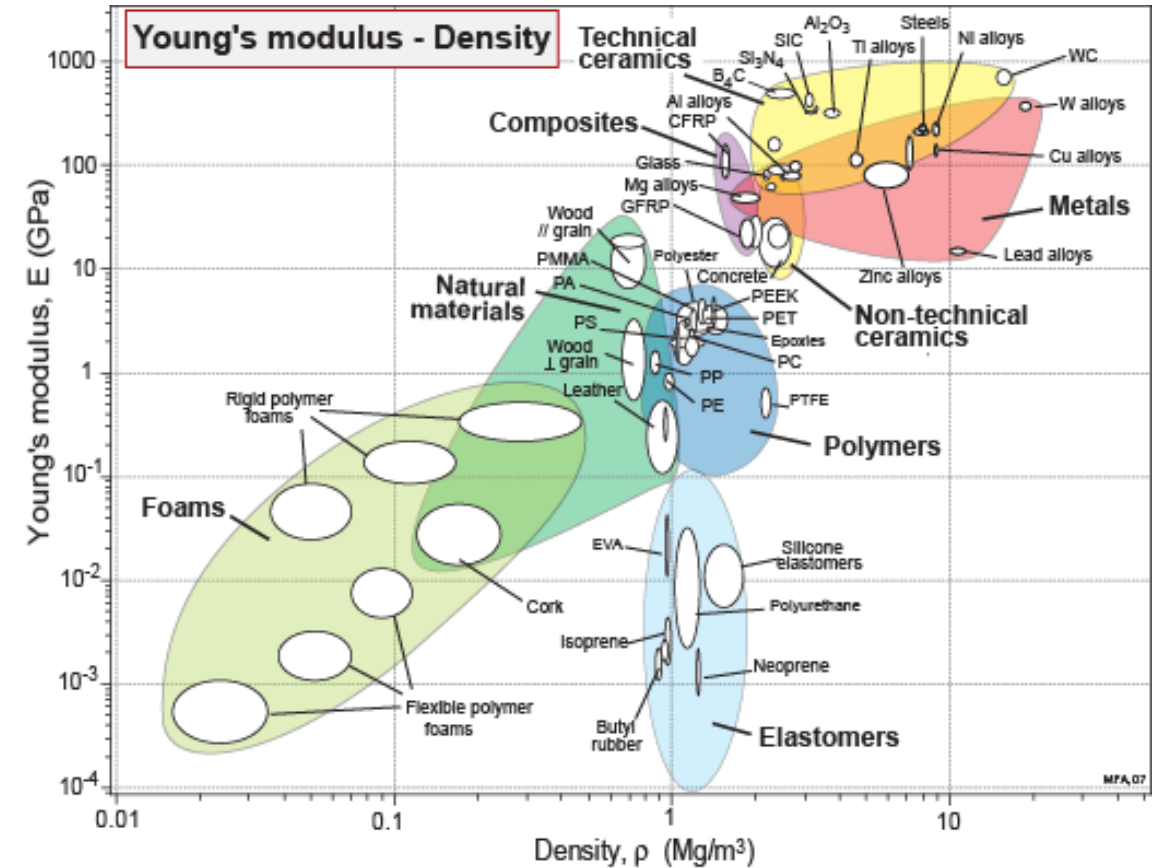# Material property charts:

Mapping materials

Mike Ashby

Department of Engineering,

University of Cambridge

Learning objectives for this lecture unit

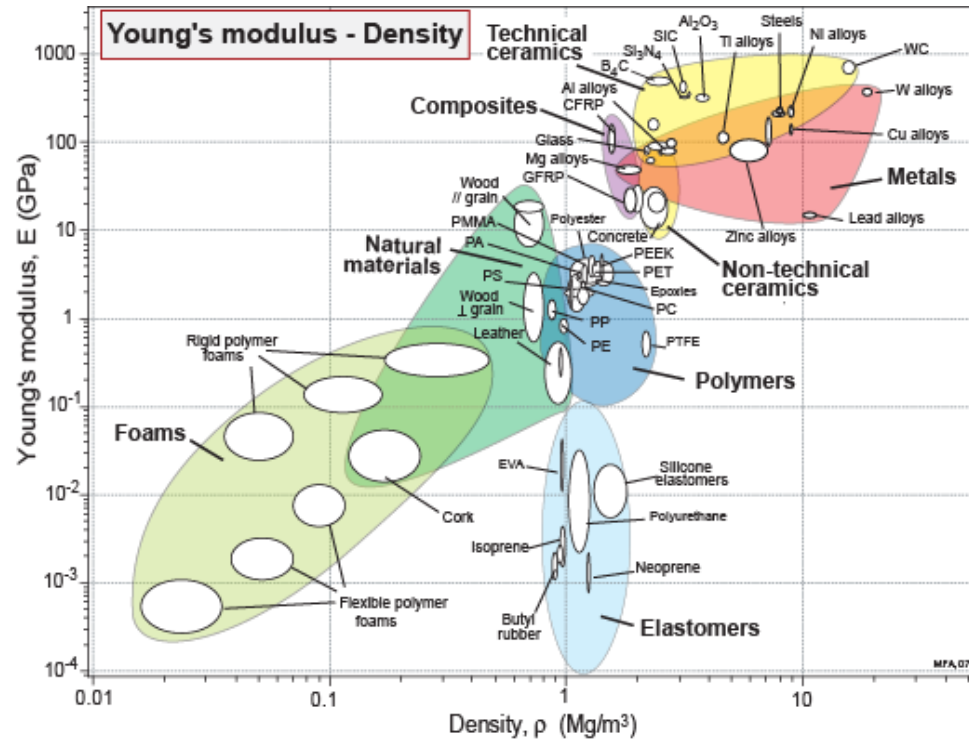| Ansys software mentioned	• Ansys Granta EduPack™, a teaching software for materials education

Intended Learning Outcomes	
Knowledge and Understanding	Understanding of material families and their property relationships
Skills and Abilities	Ability to create material property charts for specific purposes
Values and Attitudes	Grasping a broad view of materials information, the big picture

Resources

- **Text:** "Materials: engineering, science, processing and design" 4th edition by M.F. Ashby, H.R. Shercliff and D. Cebon, Butterworth Heinemann, Oxford, 2019, Chapters 1-2

- **Text:** "Materials Selection in Mechanical Design", 5th edition by M.F. Ashby, Butterworth Heinemann, Oxford, 2016, Chapters 1-2

- **Texts:** Callister, Budinski, Askeland and others – recommended reading in records
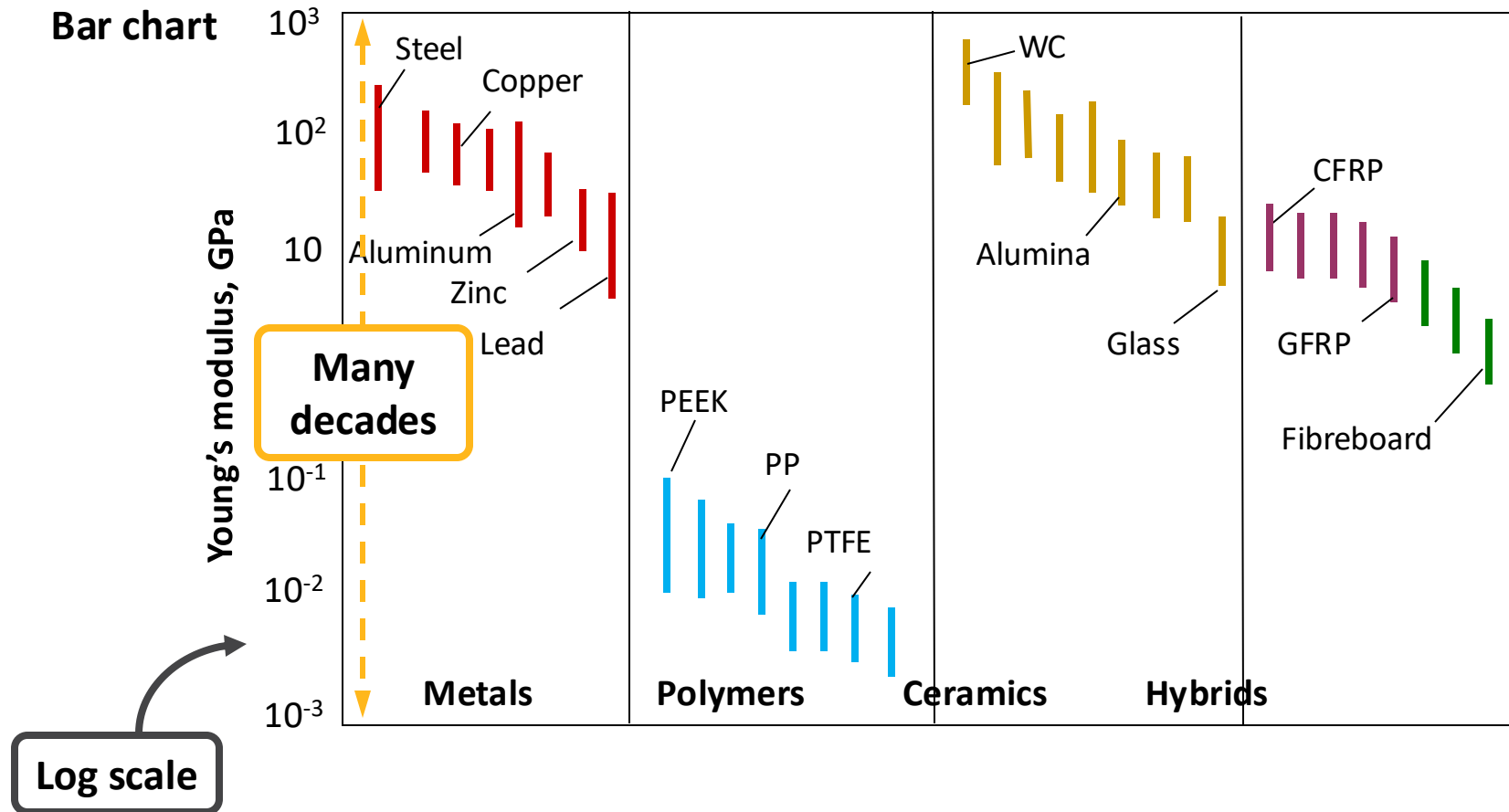
- Ansys Granta EduPack software

Outline of lecture unit

- Exploring relationships: property charts
- Making charts
- Custom subsets, adding your own materials
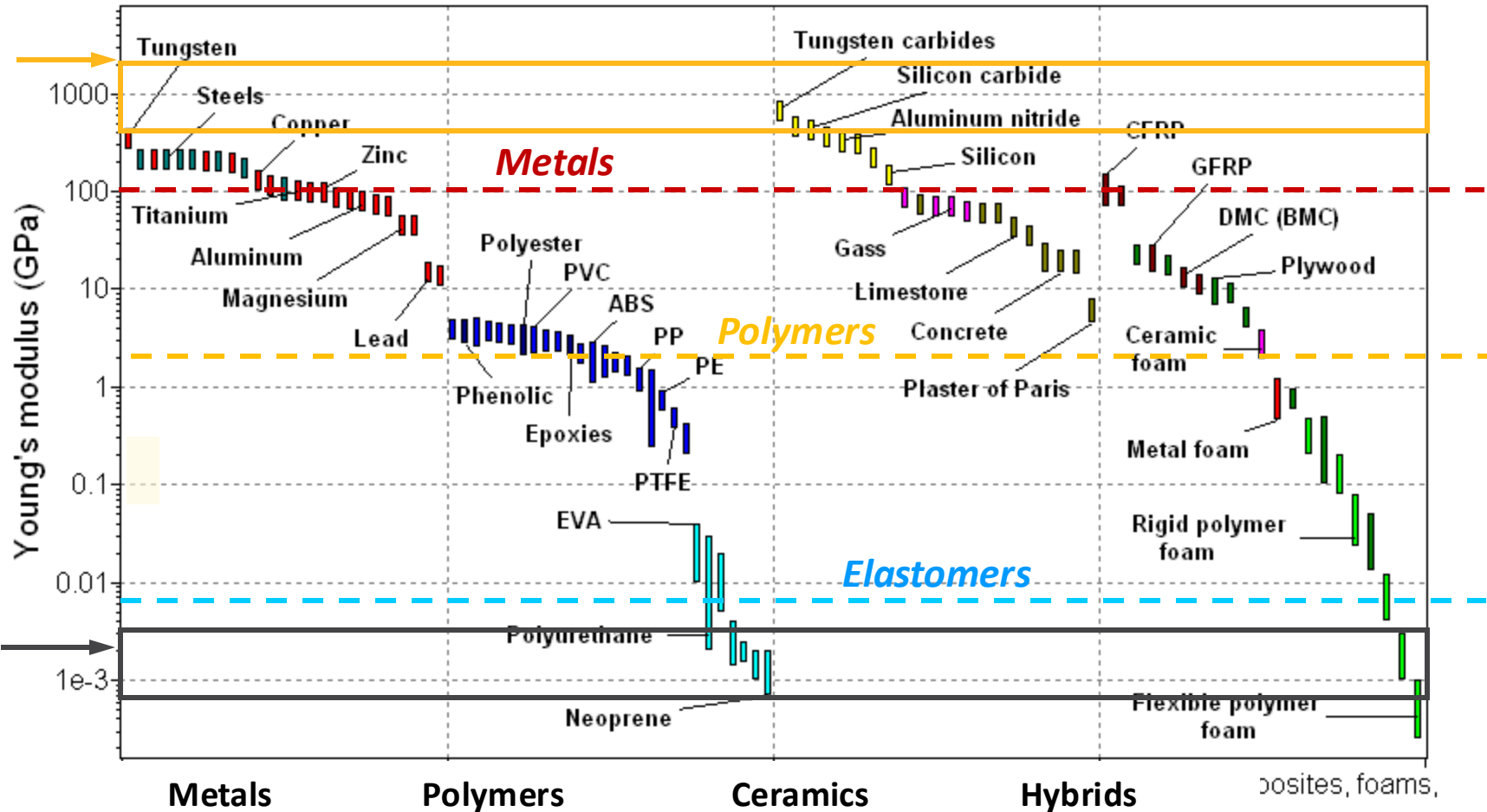- Report writing

Bar charts

Data sheets = numbers, words
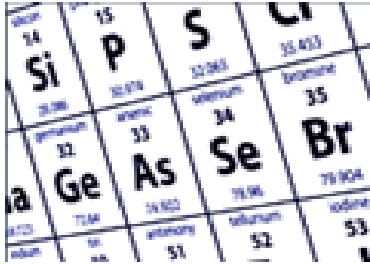
*We want **meaning*** ⟶ **Property charts**

Bar chart

Young's modulus, GPa

10^3

Steel

Copper

10^2

Aluminum

Zinc

10

Lead

Many decades

10^{-1}

PEEK

PP

PTFE

10^{-2}

10^{-3}

Log scale

Metals   **Polymers**   **Ceramics**   **Hybrids**

WC

Alumina

Glass

CFRP

GFRP

Fibreboard

Ansys / GRANTA EDUPACK

Ansys Granta EduPack software Bar Charts

Which courses? Campus-wide?

Materials science

General engineering

Polymer engineering

Aerospace engineering
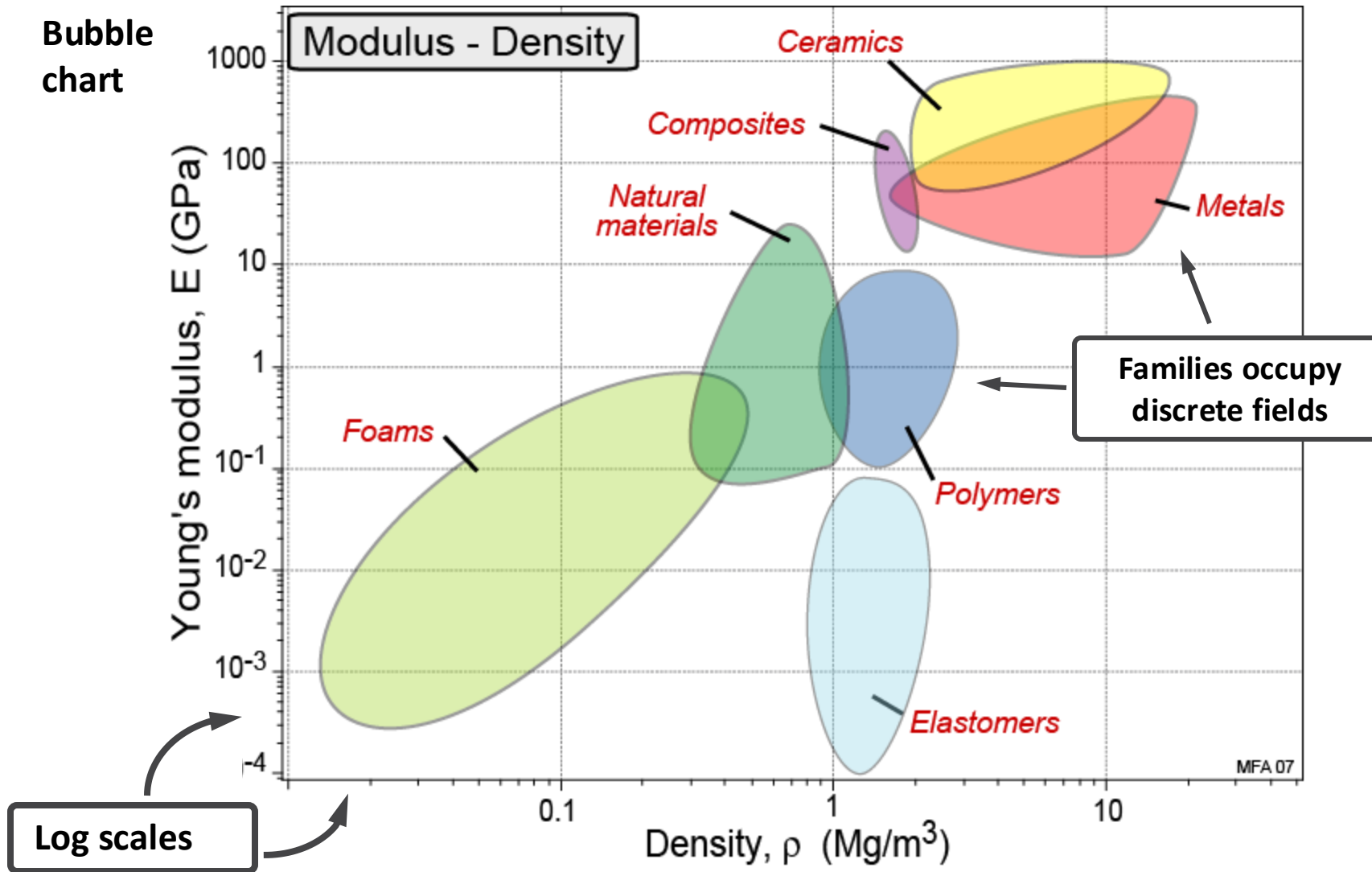

Architecture

Bioengineering
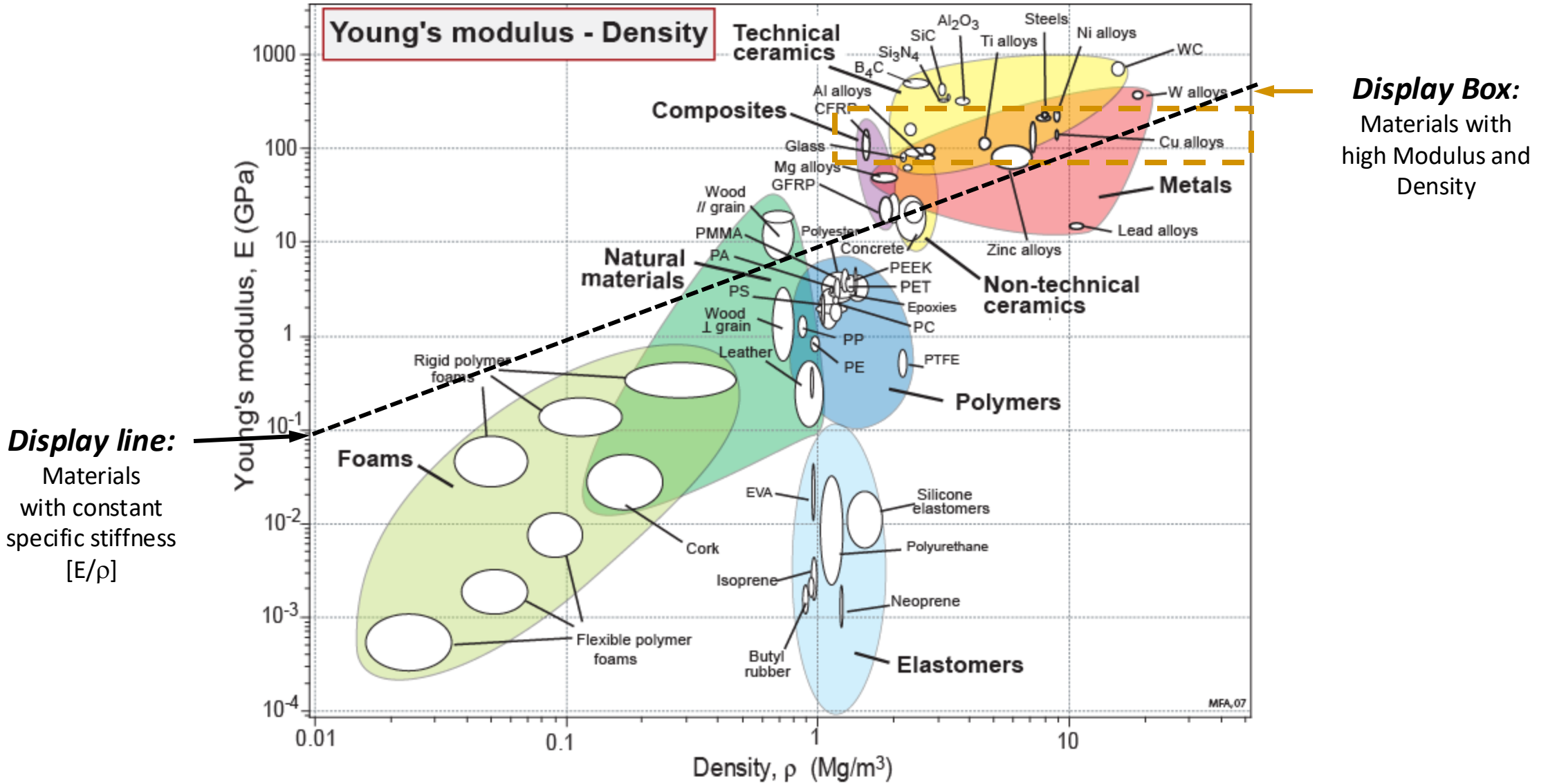

Product design

Environmental engineering

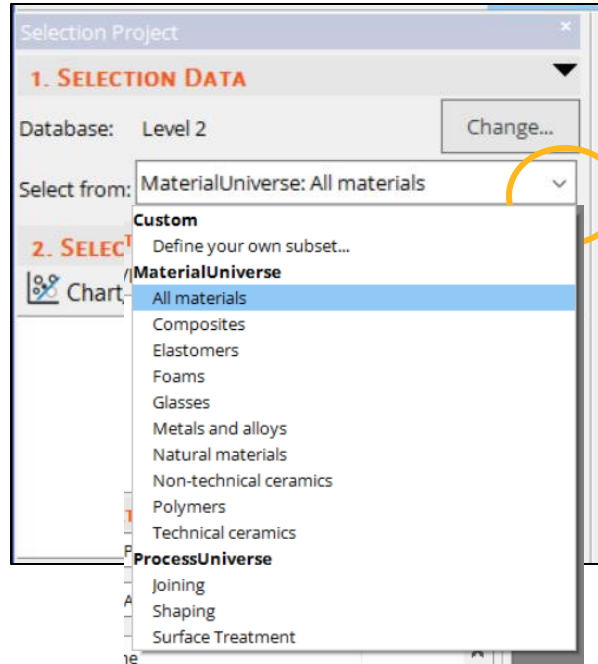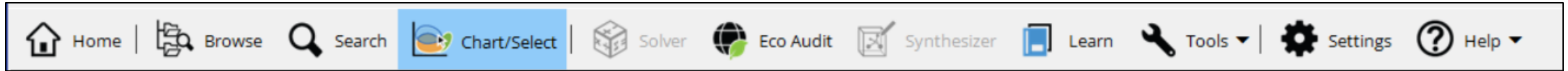Sustainability assessment
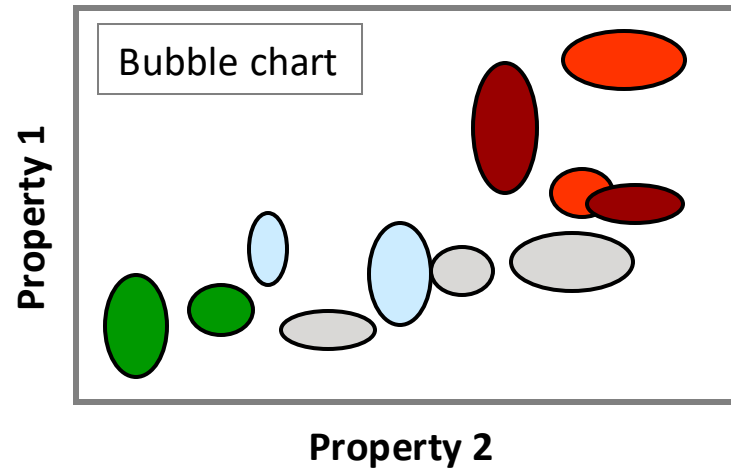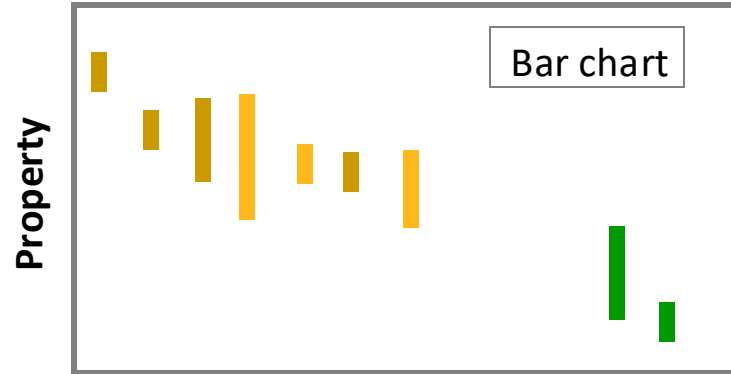
Bubble charts

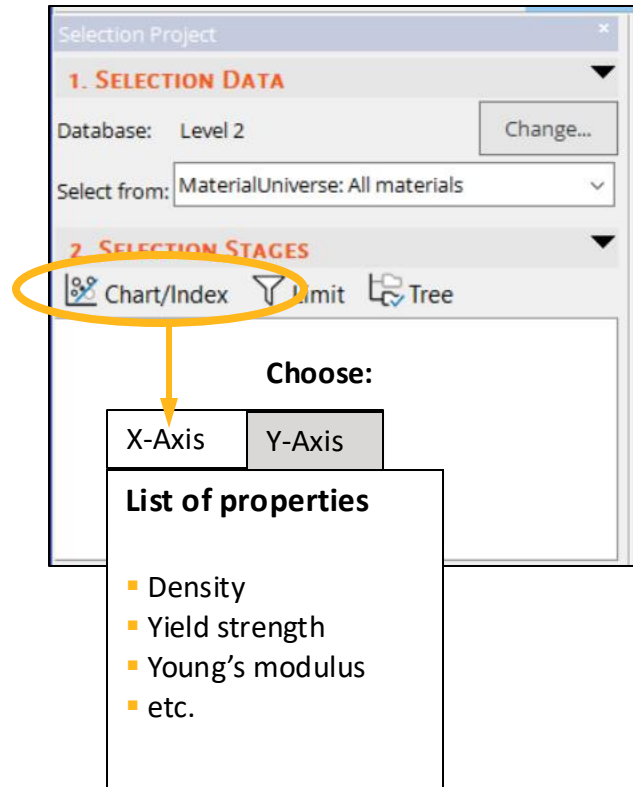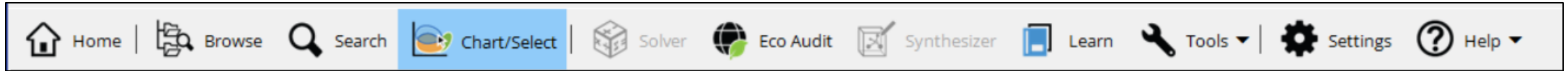**Bubble chart**

Log scales

Families occupy discrete fields
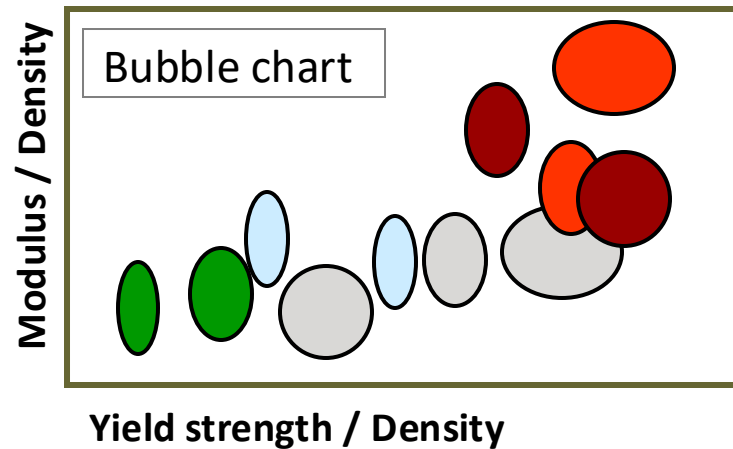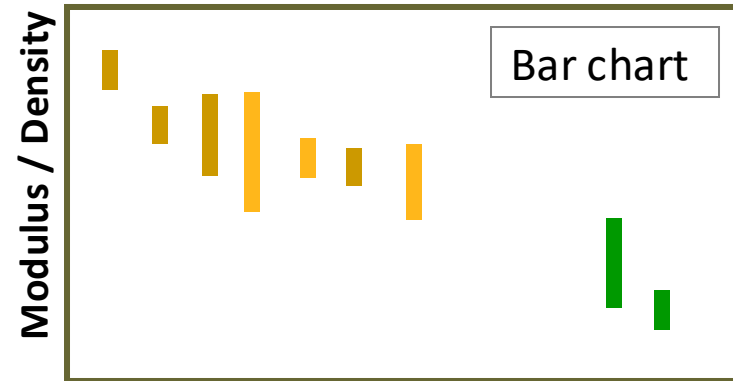
Ansys Granta EduPack software Bubble Charts

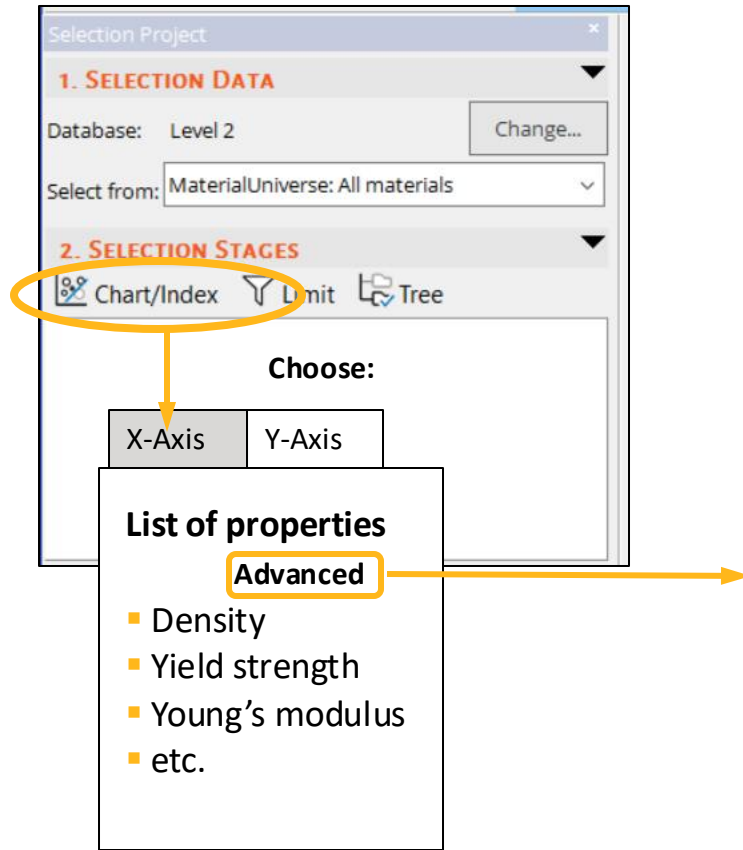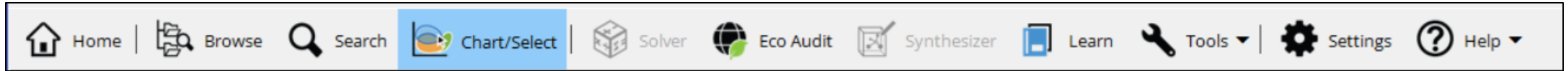# Creating Charts – choosing materials to plot

Creating Charts – single property charts

Choose:

X-Axis | Y-Axis

List of properties

- Density
- Yield strength
- Young's modulus
- etc.

Bar chart

Bubble chart

Creating Charts – advanced property charts

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The Chart tool bar

Materials Selection Tools

Delete lines & boxes

Box selection

Index line

Chart settings

Cursor

Chart Scale Tools

Zoom in

Zoom out

Autoscale

Chart Annotation Tools

Curve

Arrow

Text

Choosing data shown in chart

Show family envelopes

Show results from all enabled stages

Hide failed results

Data highlight tools*

Change to nearby record
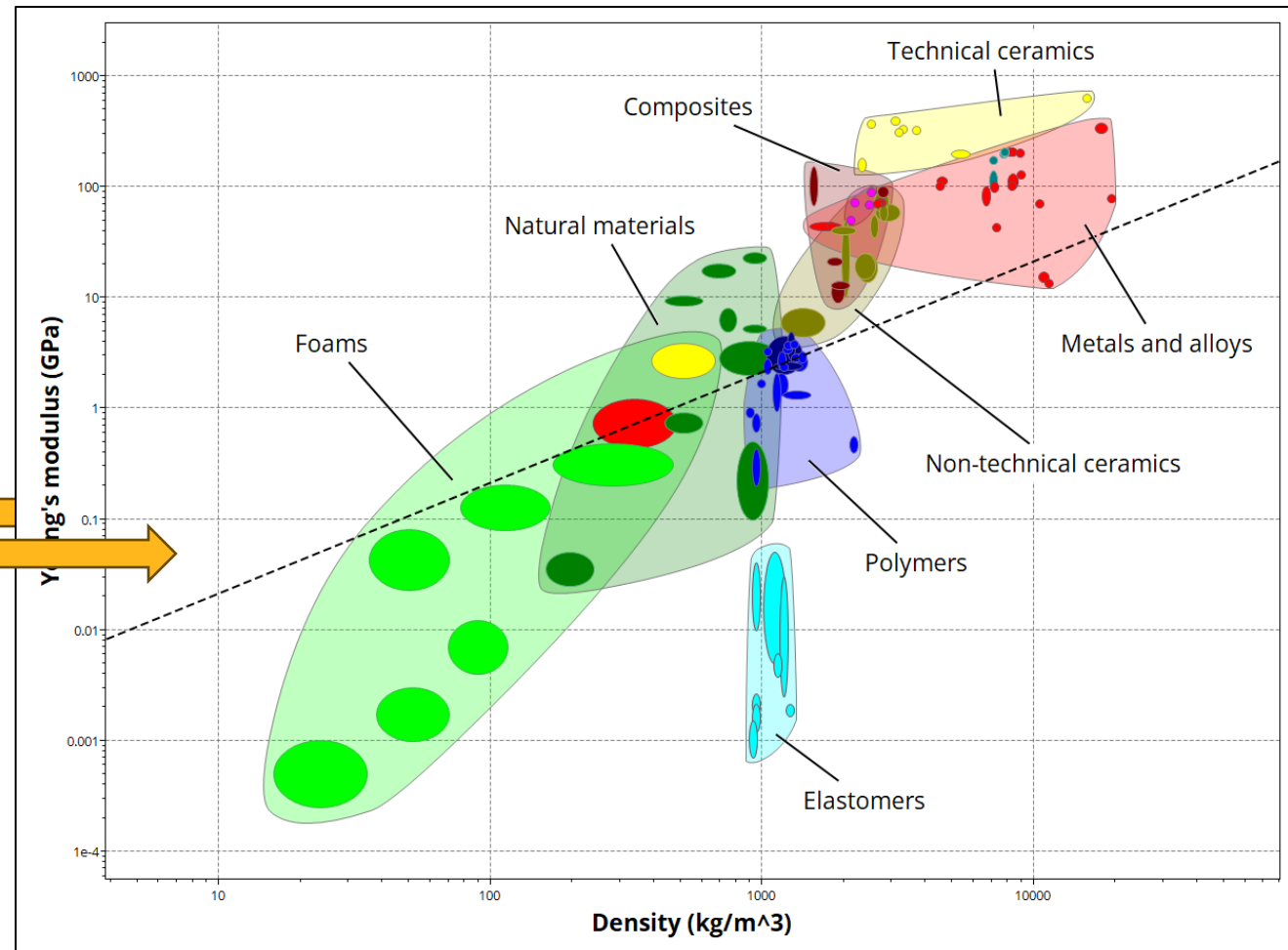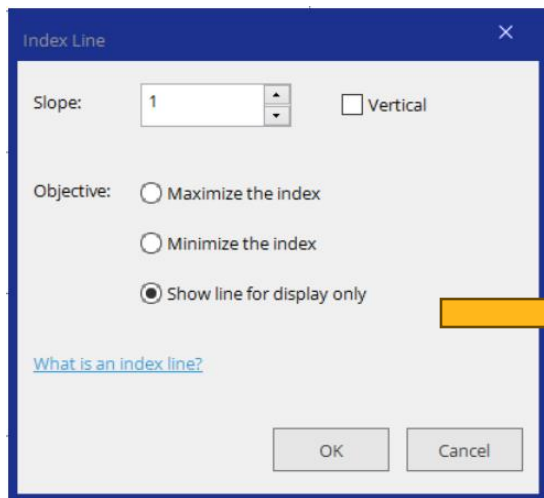
User defined records

Synthesized records

Reference Record

Favorite records
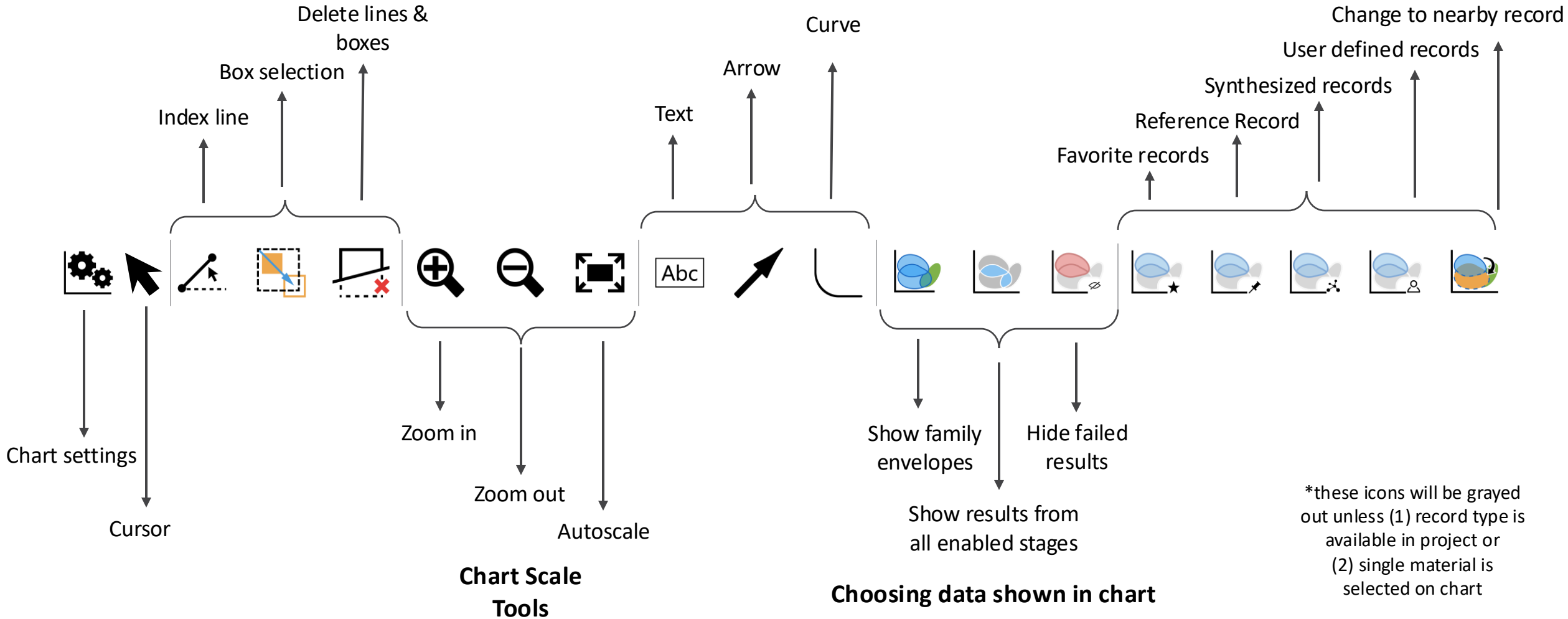
*these icons will be grayed out unless (1) record type is available in project or (2) single material is selected on chart
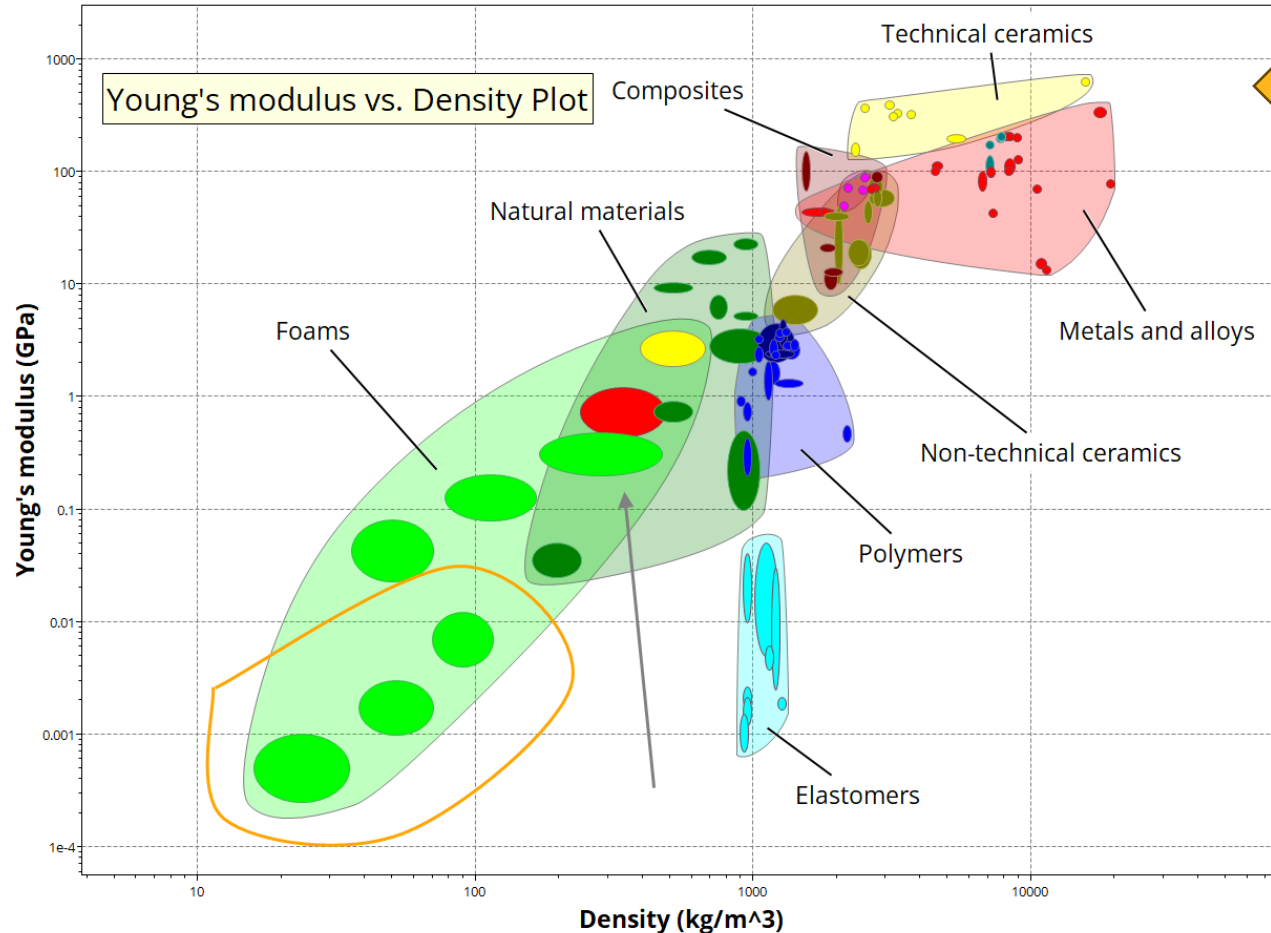
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Materials selection chart tools- line and box
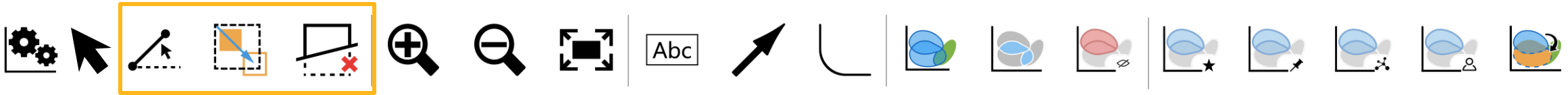
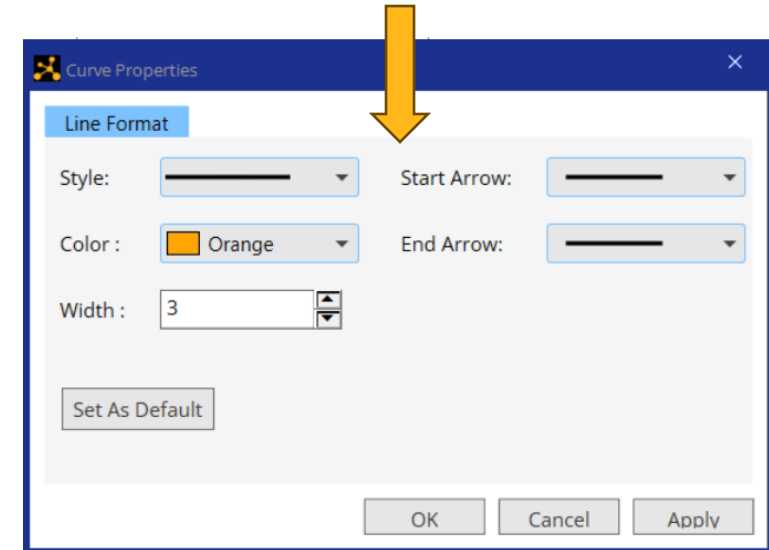For a selection, choose "Show line for display only"

Annotation tools- curve, arrow, and text

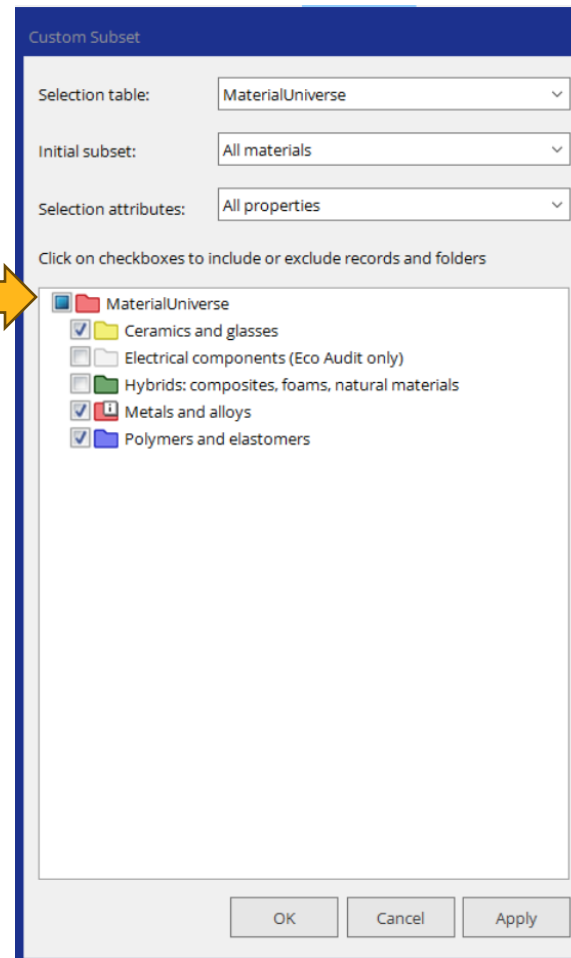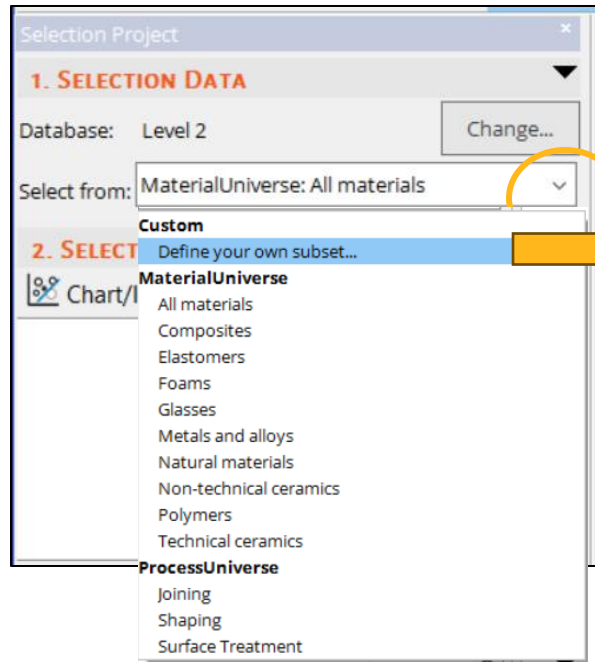Use text, arrows, and curves to increase clarity of information presented

Right click to format line/text

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How to make a custom material subset for a selection project

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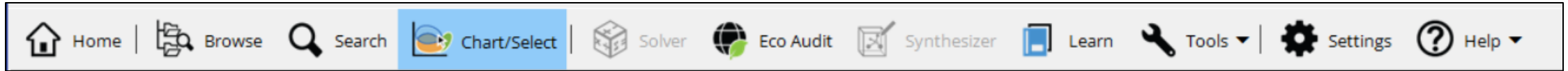
Changing the chart settings (labels etc)

Making your own records in Tools and other ways

Can also right-click on a chart to add records, but will only be able to add the attributes from that chart!

Manage your charts in Tools

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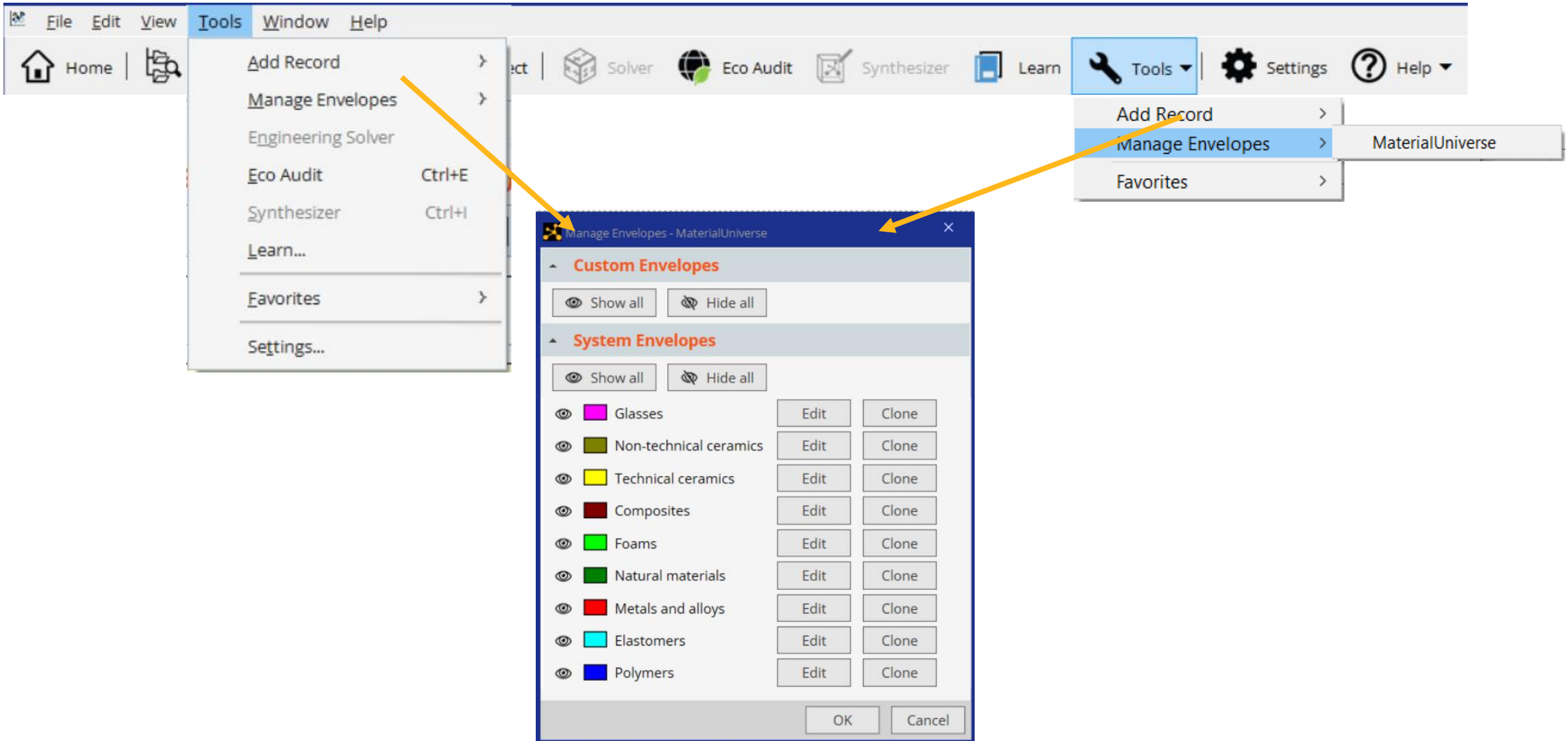
Saving projects, report writing

Menu bar: File Edit View Select Tools Window Help

Toolbar: Home | Browse | Search | Chart/Select | Solver | Eco Audit | Synthesizer | Learn | Tools ▼ | Settings | Help ▼
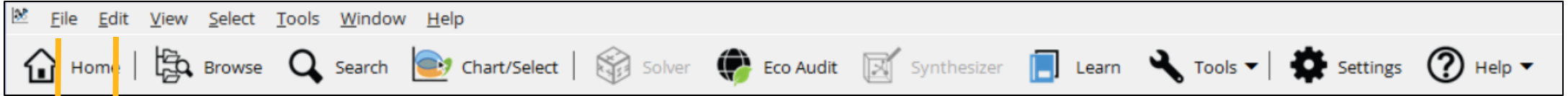
Open project

Save project

Print …

Cut

Copy

Paste….

Clip-board

To WORD

For best results
Paste Special -
Device Independent Bitmap.

Paste

Acrylonitrile butadiene styrene (ABS)
Description
Image

Caption
1. ABS pellets. © Shutterstock 2. ABS allows detailed moldings, accepts color well, and is non-toxic and tough enough to survive the worst that children can do to it. © Gettyimages
The material
ABS (Acrylonitrile-butadiene-styrene) is tough, resilient, and easily molded. It is usually opaque, although some grades can now be transparent, and it can be given vivid colors. ABS-PVC alloys are tougher than standard ABS and, in self-extinguishing grades, are used for the casings of power tools.
Compositional summary
Block terpolymer of acrylonitrile (15-35%), butadiene (5-30%), and styrene (40-60%).
General properties

Density	1.01e3	-	1.21e3	kg/m^3
Price	* 2.5	-	3	USD/kg
Date first used	1937			

Mechanical properties

Young's modulus	1.1	-	2.9	GPa
Shear modulus	0.319	-	1.03	GPa
Bulk modulus	3.8	-	4	GPa
Poisson's ratio	0.391	-	0.422	
Yield strength (elastic limit)	18.5	-	51	MPa
Tensile strength	27.6	-	55.2	MPa
Compressive strength	31	-	86.2	MPa
Elongation	1.5	-	100	% strain
Hardness - Vickers	5.6	-	15.3	HV

Typical uses
Safety helmets; camper tops; automotive instrument panels and other interior components; pipe fittings; home-security devices and housings for small appliances; communications equipment; business machines; plumbing hardware; automobile grilles; wheel covers; mirror housings; refrigerator liners; luggage shells; tote trays; mower shrouds; boat hulls; large components for recreational vehicles; weather seals; glass beading; refrigerator breaker strips; conduit; pipe for drain waste-vent (DWV) systems.
Tradenames
Claradex, Comalloy, Cycogel, Cycolac, Hanalac, Lastilac, Lupos, Lustran ABS, Magnum, Multibase, Novodur, Polyfabs, Polylac, Porene, Ronfalin, Sinkral, Terluran, Toyolac, Tufrex, Ultrastyr
Links
Reference
ProcessUniverse
Producers

Copy - Paste
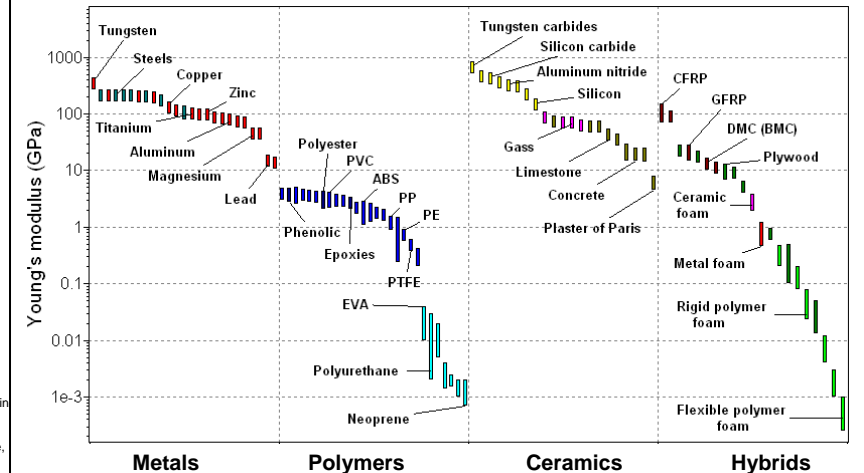
Summary

- **Material property charts** gives meaning to data

- **The texts** contain many charts – you can copy them for teaching

- Ansys **Granta EduPack software** lets you make any chart you want

- You can **visualize** any database, and **add your own records**

- Comprehensive **report-writing** facilities

- **Data** ➡ **Visualization**
  (understanding the data) ➡ **Selection**
  (using the data)

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Feedback Survey Link

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Document Information
This lecture unit is part of a set of teaching resources to help introduce students to materials, processes and rational selections.

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