



# Eco seleção de materiais

# Eco seleção de materiais

## Base de dados sobre materiais e processos: CES EduPack

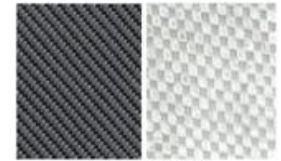
1. Select a table

<b>MaterialUniverse</b> >
ProcessUniverse
Reference
Producers

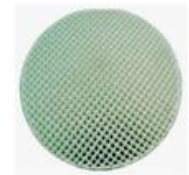
2. Filter by subset



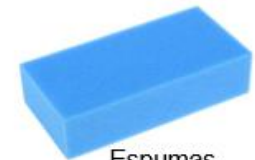
### Materiais híbridos



Compósitos



Estruturas favo de mel



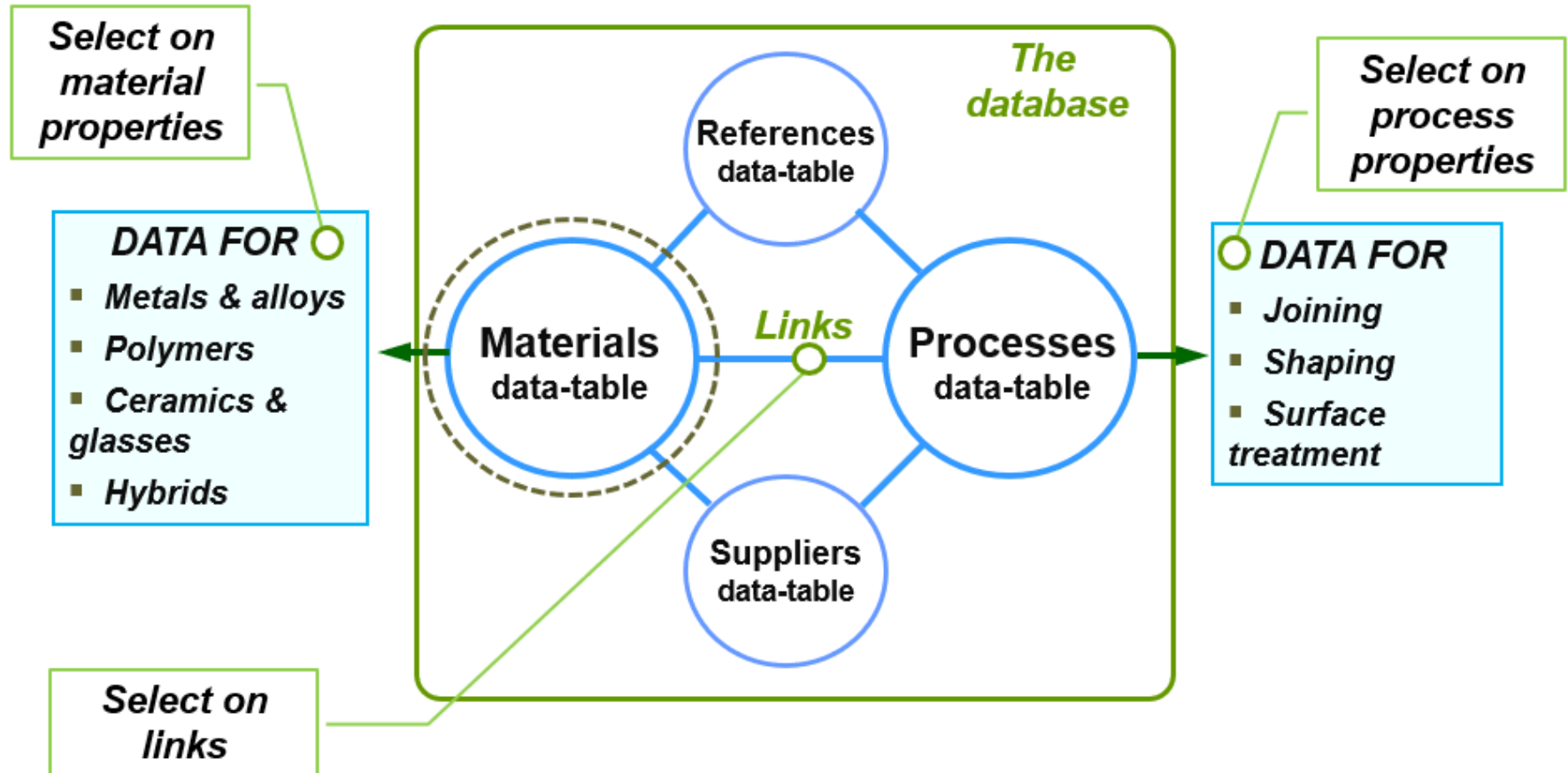
Espumas



Materiais naturais

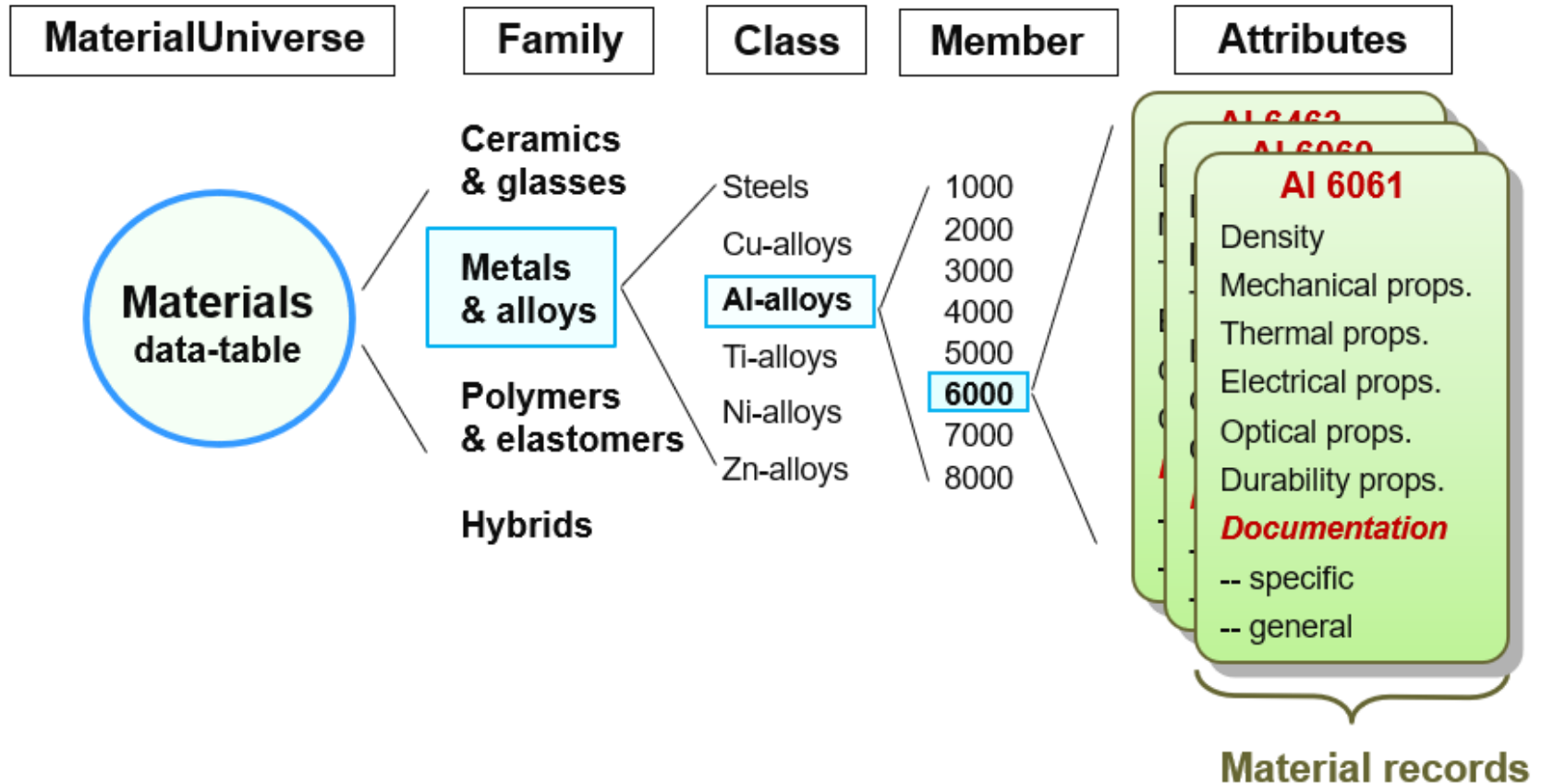
# Eco seleção de materiais

## CES EduPack: Organização da informação



# Eco seleção de materiais

**CES EduPack:** Organização da informação por **família de materiais**



# Eco seleção de materiais

**CES EduPack:** Organização da informação por **família de materiais**

**Exemplo:**




**Informação  
estruturada**

Polyethylene (PE)













Datasheet view: All properties

Show/Hide









General properties

Density		939	-	960	kg/m^3
Price		* 1.36	-	1.41	EUR/kg
Date first used		1936			

Mechanical properties

Young's modulus		0.621	-	0.896	GPa
Shear modulus		* 0.218	-	0.314	GPa
Bulk modulus		2.15	-	2.25	GPa
Poisson's ratio		* 0.418	-	0.434	
Yield strength (elastic limit)		17.9	-	29	MPa
Tensile strength		20.7	-	44.8	MPa
Compressive strength		19.7	-	31.9	MPa
Elongation		200	-	800	% strain
Hardness - Vickers		5.4	-	8.7	HV
Fatigue strength at 10^7 cycles		21	-	23	MPa
Fracture toughness		* 1.44	-	1.72	MPa.m^0.5
Mechanical loss coefficient (tan delta)		* 0.0446	-	0.0644	

Thermal properties

Melting point		125	-	132	°C
Glass temperature		-125	-	-90	°C
Maximum service temperature		* 90	-	110	°C
Minimum service temperature		* -123	-	-73.2	°C
Thermal conductor or insulator?		Good insulator			
Thermal conductivity		0.403	-	0.435	W/m.°C
Specific heat capacity		* 1.81e3	-	1.88e3	J/kg.°C
Thermal expansion coefficient		126	-	198	µstrain/°C



# Eco seleção de materiais

**CES EduPack:** Organização da informação por família de materiais

**Exemplo:**

**Informação não estruturada**

## Polyethylene (PE)

Datasheet view: All properties



Show/Hide

### Supporting information

#### Design guidelines

PE is commercially produced as film, sheet, rod, foam and fiber. Drawn PE fiber has exceptional mechanical stiffness and strength, exploited in geo-textile and structural uses. PE is a good electrical insulator with low dielectric loss, so suitable for containers for microwave cooking. It has poor resistance to aromatics and chlorine; it is slow burning in fire. PE is cheap, easy to form, biologically inert and recyclable; it is one of the materials of the next 20 years.

#### Technical notes

Low density polyethylene (LDPE), used for film and packaging, has branched chains which do not pack well, making it less dense than water. Medium (MDPE) and High (HDPE) density polyethylenes have longer, less branched chains, making them stiffer and stronger; they are used for containers and pipes. Modern catalysis allows side-branching to be suppressed and molecular length to be controlled precisely, permitting precise tailoring both of the processing properties critical for drawing, blow molding, injection molding or extrusion and the use-properties of softening temperature, flexibility and toughness. Linear low-density polyethylene (LLPDE) is an example. In its pure form it is less resistant to organic solvents, but even this can be overcome by converting its surface to a fluoro-polymer by exposing it to fluorine gas. Treated in this way (when it is known as 'Super PE') it can be used for petrol tanks in cars and copes with oil, cleaning fluid, cosmetics and that most corrosive of substances: cola concentrate. Very low density polyethylene (VDLPE) is similar to EVA and plasticized PVC.

#### Typical uses

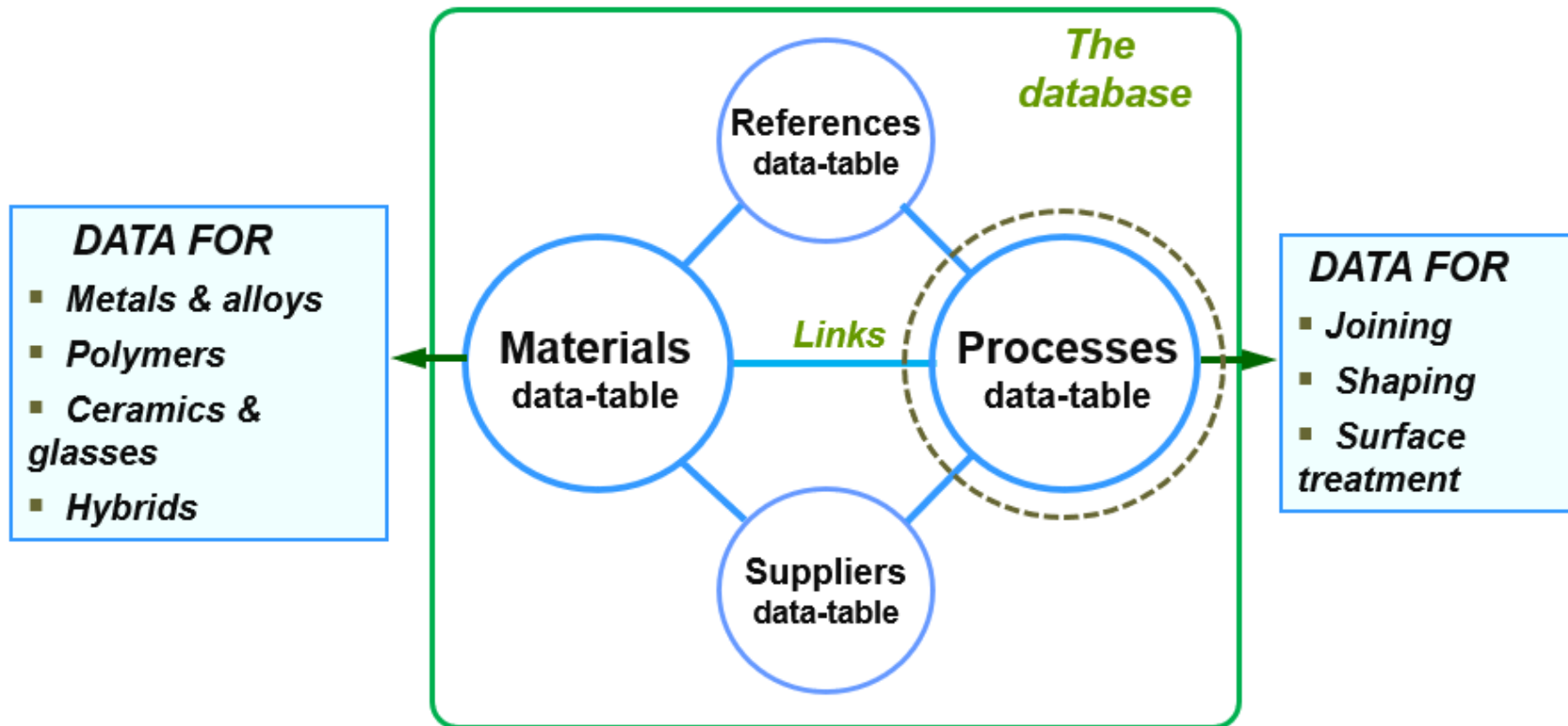
Oil container, street bollards, milk bottles, toys, beer crate, food packaging, shrink wrap, squeeze tubes, disposable clothing, plastic bags, paper coatings, cable insulation, artificial joints, and as fibers - low cost ropes and packing tape reinforcement.

#### Tradenames

Alathon, Aquathene, Bapolene, Dowlax, Eltex, Empee, Eraclene, Ferrene, Fortiflex, HiVal, Hid, Kemcor, Lacqtene, Lupolen, Marlex, Nortuff, Novapol, Paxon, Petrothene, Polyfort, Rigidex, Sclair, Stamylyn, Statoil, Unival, Zemid

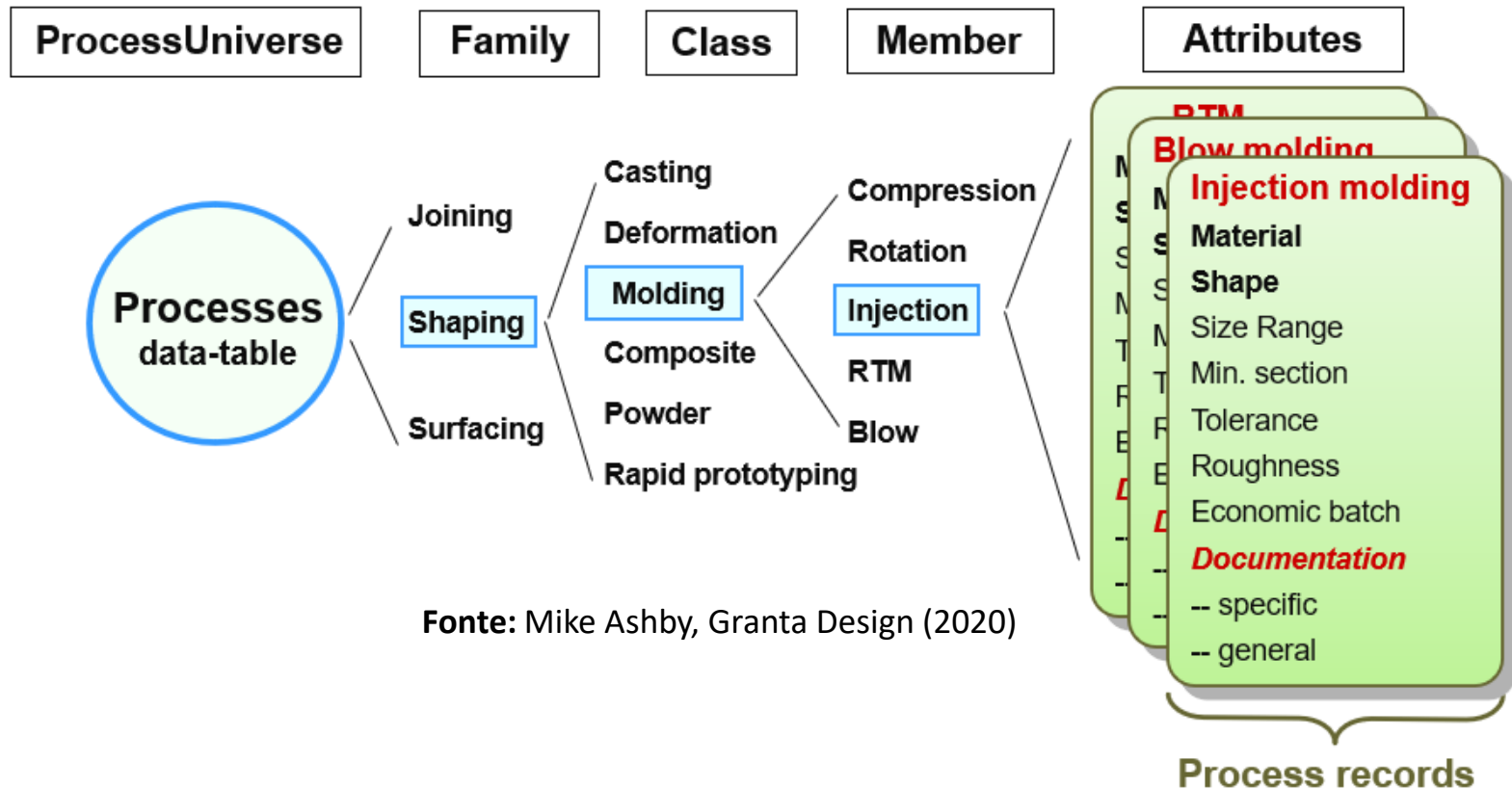
# Eco seleção de materiais

**CES EduPack:** Organização da informação por **processo de fabrico**



# Eco seleção de materiais

**CES EduPack:** Organização da informação por **processo de fabrico**



Fonte: Mike Ashby, Granta Design (2020)

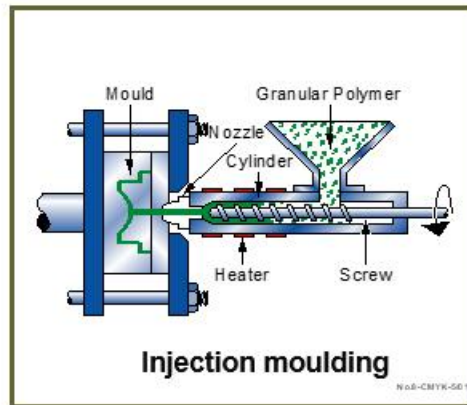
Os atributos dos processos dependem da família (união, conformação ou tratamento de superfície)



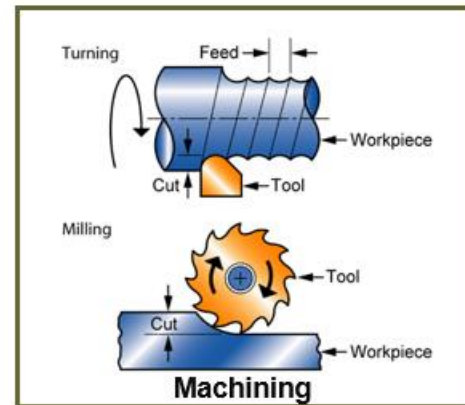
# Eco seleção de materiais

## CES EduPack: Processos de fabrico, exemplos

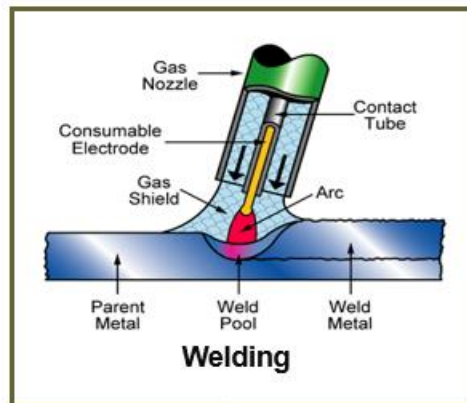
**Conformação primária**



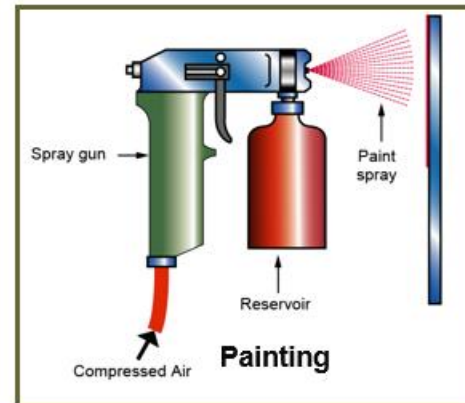
**Conformação secundária**



**União**



**Tratamento de superfície**

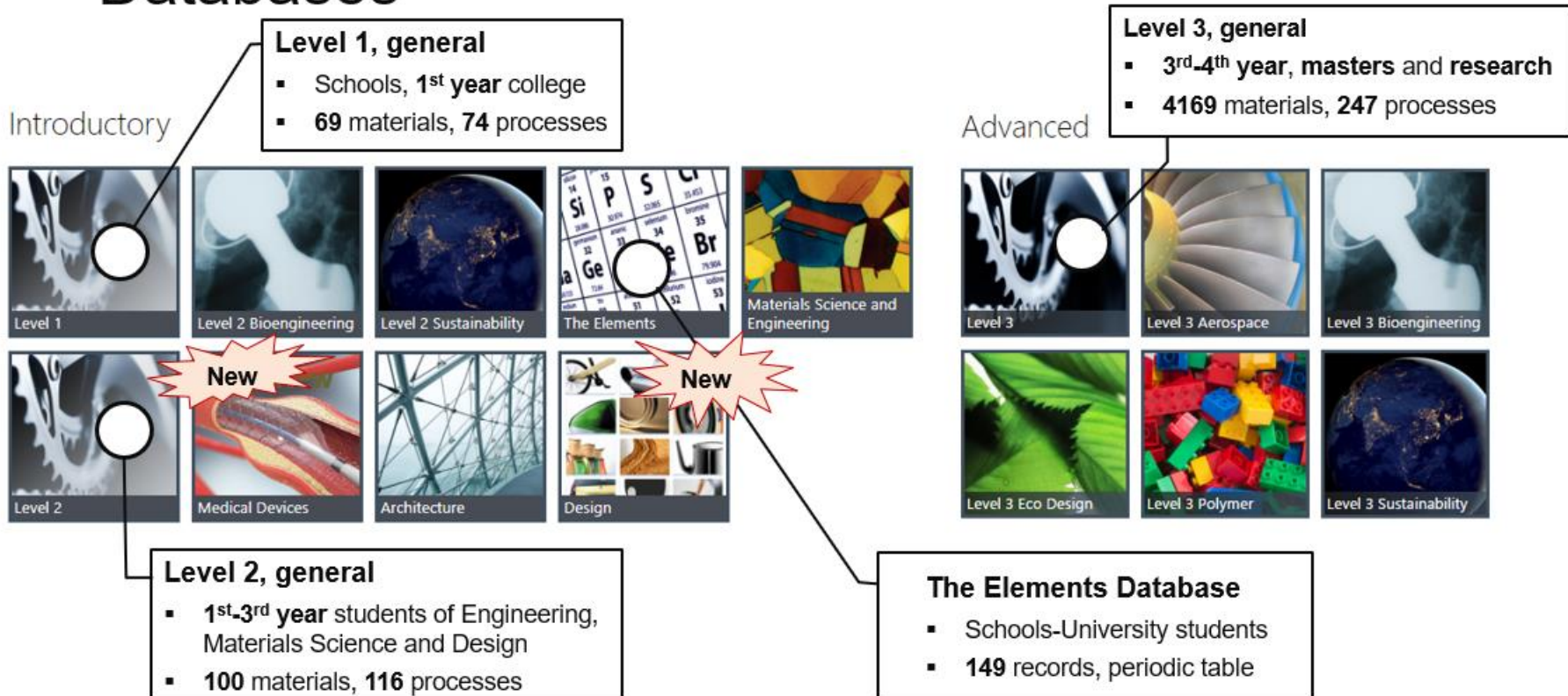


# Eco seleção de materiais

## O software CES EduPack

### Databases

[quick start](#) [★ what's new](#) [+ add database](#) [extra databases](#)



# Eco seleção de materiais

## O software CES EduPack: breve introdução

The screenshot displays the CES EduPack software interface. At the top is a menu bar with options: File, Edit, View, Select, Tools, Window, Feature Request, and Help. Below this is a toolbar with icons for Browse, Search, Chart/Select, Eco Audit, Synthesizer, Learn, Tools, Settings, and Help. The 'Browse' icon is highlighted with a red rectangle. Below the toolbar, the interface is divided into sections. On the left, under 'Level 1', there are buttons for 'change database' and 'first steps'. The main area is titled '1. Select a table' and shows two options: 'MaterialUniverse' (selected) and 'ProcessUniverse'. To the right, under '2. Filter by subset', there is a grid of material categories: All Materials, Composites, Elastomers, Foams, Glasses, Metals and Alloys, Natural Materials, Non-Technical Ceramics, Polymers, and Technical Ceramics. On the far right, under 'More information', there are buttons for 'Video tutorials' and 'Database information'. Below that, under 'More resources', there are buttons for 'Extra' and 'Education Hub'.

File Edit View Select Tools Window Feature Request Help

Home Browse Search Chart/Select Eco Audit Synthesizer Learn Tools Settings Help

Level 1

change database first steps

1. Select a table

**MaterialUniverse** >

ProcessUniverse

2. Filter by subset

All Materials Composites Elastomers Foams

Glasses Metals and Alloys Natural Materials Non-Technical Ceramics

Polymers Technical Ceramics

More information

Video tutorials Database information

More resources

Extra Education Hub

# Eco seleção de materiais

## O software CES EduPack: breve introdução

### Função “Browse”

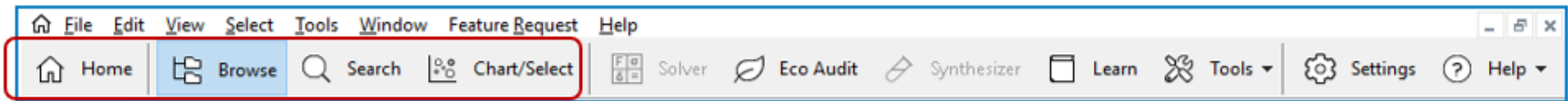
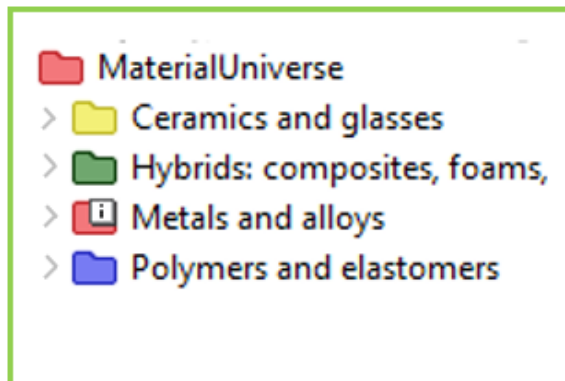


Table: **MaterialUniverse**

Subset: **All materials**



#### Acrylonitrile-butadiene-styrene (ABS)

**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.



#### General properties

Density	①	1.01e3	-	1.21e3	kg/m³3
Price	①	* 2.5	-	3	USD/kg
Date first used	①				1937

#### Mechanical properties

Young's modulus	①	1.1	-	2.9	GPa
Yield strength	①	18.5	-	51	MPa
Tensile strength (elastic limit)	①	27.6	-	55.2	MPa
Elongation	①	1.5	-	100	% strain
Hardness - Vickers	①	5.6	-	15.3	HV
Fatigue strength at 10 <sup>7</sup> cycles	①	11	-	22.1	MPa
Fracture toughness	①	1.19	-	4.29	MPa.m <sup>1/2</sup>

and...

[Thermal properties](#)

[Electrical properties](#)

[Optical properties](#)

[Processability](#)

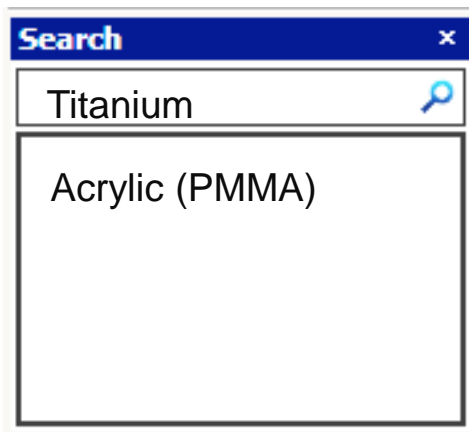
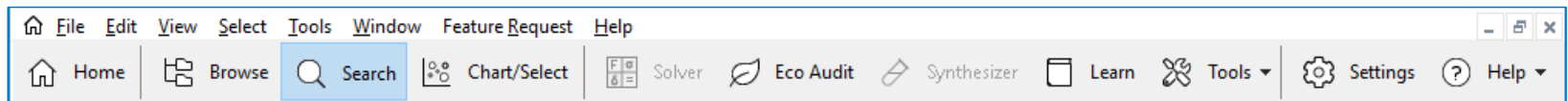
[Eco properties etc.](#)

[Links to Processes](#)

# Eco seleção de materiais

## O software CES EduPack: breve introdução

### Função “Search”



#### Polymethyl methacrylate (Acrylic, PMMA)

**The material.** When you think of PMMA, think transparency. Acrylic, or PMMA, is the thermoplastic that most closely resembles glass in transparency and resistance to weathering. The material has a long history: discovered in 1872, first commercialized in 1933, its first major application was as cockpit canopies for fighter aircraft during the second World War.



Caption Car rear light casing. © Chris Lefteri

**Compositional summary** ⓘ  
(CH<sub>2</sub>-C(CH<sub>3</sub>)COOCH<sub>3</sub>)<sub>n</sub>

#### General properties

Density	ⓘ	1.16e3	-	1.22e3	kg/m³
Price	ⓘ	* 3.14	-	3.74	USD/kg
Date first used	ⓘ				1933

#### Mechanical properties

Young's modulus	ⓘ	2.24	-	3.8	GPa
Yield strength (elastic limit)	ⓘ	53.8	-	72.4	MPa
Tensile strength	ⓘ	48.3	-	79.6	MPa
Elongation	ⓘ	2	-	10	% strain
Hardness - Vickers	ⓘ	16.1	-	21.9	HV
Fatigue strength at 10 <sup>7</sup> cycles	ⓘ	* 15.2	-	32.7	MPa

# Eco seleção de materiais

O software CES EduPack: breve introdução

## Função “Chart”

The screenshot displays the CES EduPack 2019 software interface. The main window shows the 'Selection Project' section with three stages: 1. Selection Data, 2. Selection Stages, and 3. Results: 4026 of 4026 pass. The 'Chart/Select' menu item is highlighted with a green circle and an arrow pointing to the 'Chart Stage' dialog box.

The 'Chart Stage' dialog box is open, showing the 'X-Axis' tab. It includes the following sections:

- Axis Property Definition:** A section for selecting the attribute to plot. It includes a 'Category' dropdown set to '<All Alphabetical>' and an 'Attribute' dropdown set to '<None>'. There is an 'Advanced...' button and a 'What is a performance index?' link.
- Axis Settings:** A section for configuring the axis. It includes an 'Axis Title' text box, radio buttons for 'Logarithmic', 'Linear', 'Autoscale', and 'Set', and input fields for 'min' and 'max' values.
- Parameters:** A section for changing parameter values used by this axis. It includes an 'Edit...' button and a checkbox for 'Project Defaults'.

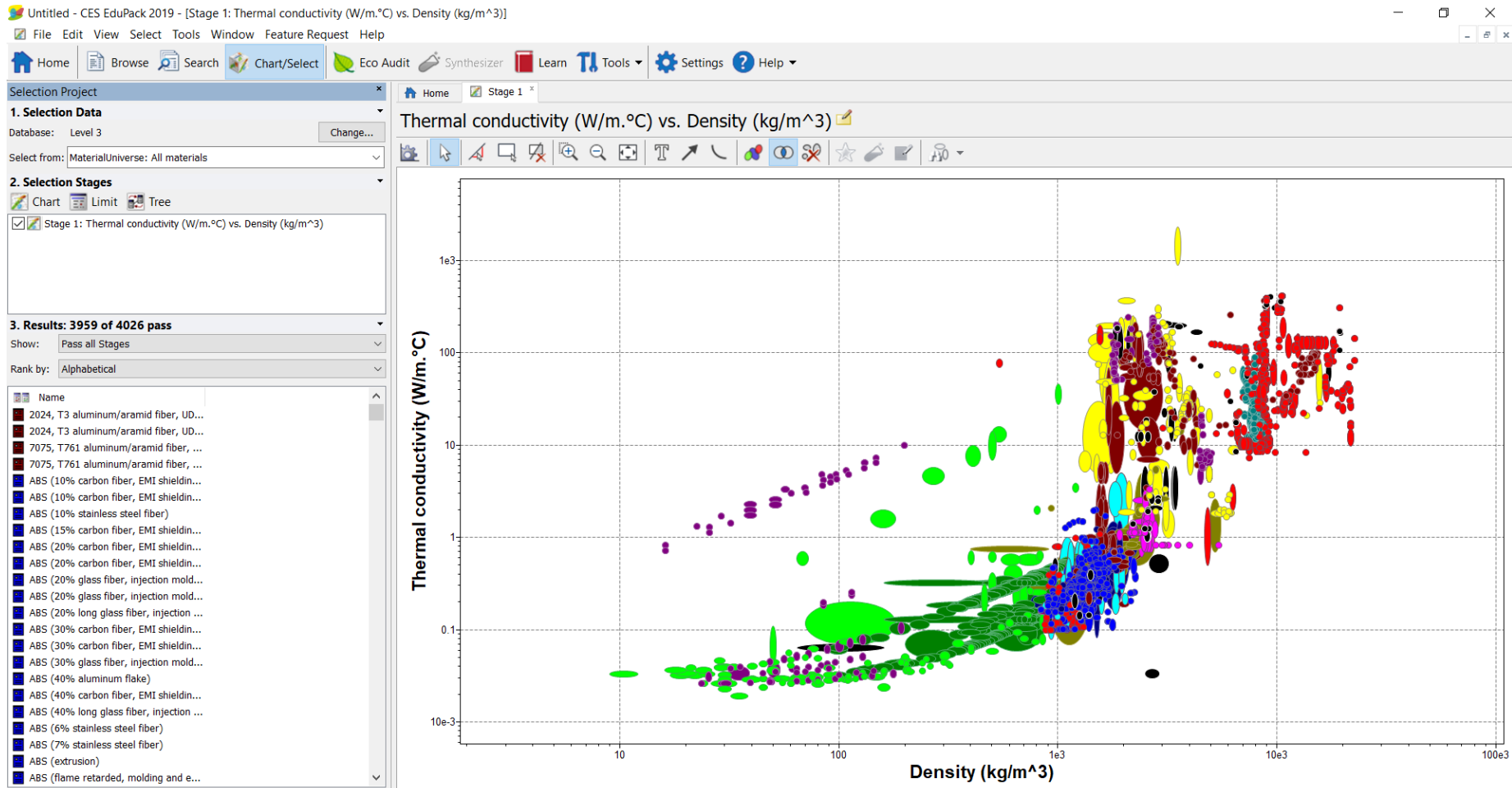
The dialog box has 'OK', 'Cancel', and 'Help' buttons at the bottom. The background shows a list of materials under the 'Results' section, including various aluminum/aramid fiber composites and ABS composites with carbon and glass fibers.



# Eco seleção de materiais

## O software CES EduPack: breve introdução

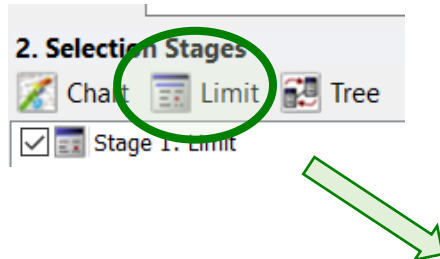
### Função “Chart”



# Eco seleção de materiais

## O software CES EduPack: breve introdução

### Função “Chart”



[Can't find the property you are looking for?](#)

- Composition overview
- Composition detail (metals, ceramics and glasses)
- Composition detail (polymers and natural materials)
- Price
- Physical properties
- Mechanical properties
- Impact & fracture properties
- Thermal properties
- Electrical properties
- Magnetic properties
- Optical, aesthetic and acoustic properties
- Critical materials risk
- Processing properties
- Durability
- Primary production energy, CO2 and water
- Processing energy, CO2 footprint & water
- Recycling and end of life

# Eco seleção de materiais

## O software CES EduPack: breve introdução

### Função “Chart”

The screenshot displays the CES EduPack software interface. On the left, the 'Composition overview' panel is highlighted with a blue box. It contains a list of material selection criteria: Form, Material family, Base material, % filler (by weight), Filler/reinforcement, Filler/reinforcement form, Additive, and Renewable content. A green arrow points from 'Material family' to the 'Composition detail (polymers and natural materials)' section. This section is further highlighted with a green box and contains a list of material types: Select all, Metal (ferrous), Metal (non-ferrous), Metal (precious), Metal (other), Plastic (thermoplastic, semi-crystalline), Plastic (thermoplastic, amorphous), Plastic (thermoset), Elastomer (thermoplastic, TPE), Elastomer (thermoset, rubber), Ceramic (technical), Ceramic (non-technical), Glass, and Natural. The 'Natural' option is circled in green. A purple arrow points from the 'Form' option to the 'Bulk material' selection chart on the right. This chart is a dropdown menu with a list of material types: Select all, Bulk material (checked), Fiber, Foam, Honeycomb, Liquid, Particulate, Wire, and Other.

Limit

Settings Apply Clear

Can't find the property you are looking for?

Composition overview

Form

Material family

Base material

% filler (by weight)

Filler/reinforcement

Filler/reinforcement form

Additive

Renewable content

Composition detail (metals, ceramics and glasses)

Composition detail (polymers and natural materials)

Price

Physical properties

Mechanical properties

Impact & fracture properties

Thermal properties

Electrical properties

Magnetic properties

Optical, aesthetic and acoustic properties

Critical materials risk

Processing properties

Durability

Primary production energy, CO2 and water

Bulk material

Select all

☒ Bulk material

☐ Fiber

☐ Foam

☐ Honeycomb

☐ Liquid

☐ Particulate

☐ Wire

☐ Other

☐ Select all

☐ Metal (ferrous)

☐ Metal (non-ferrous)

☐ Metal (precious)

☐ Metal (other)

☐ Plastic (thermoplastic, semi-crystalline)

☐ Plastic (thermoplastic, amorphous)

☐ Plastic (thermoset)

☐ Elastomer (thermoplastic, TPE)

☐ Elastomer (thermoset, rubber)

☐ Ceramic (technical)

☐ Ceramic (non-technical)

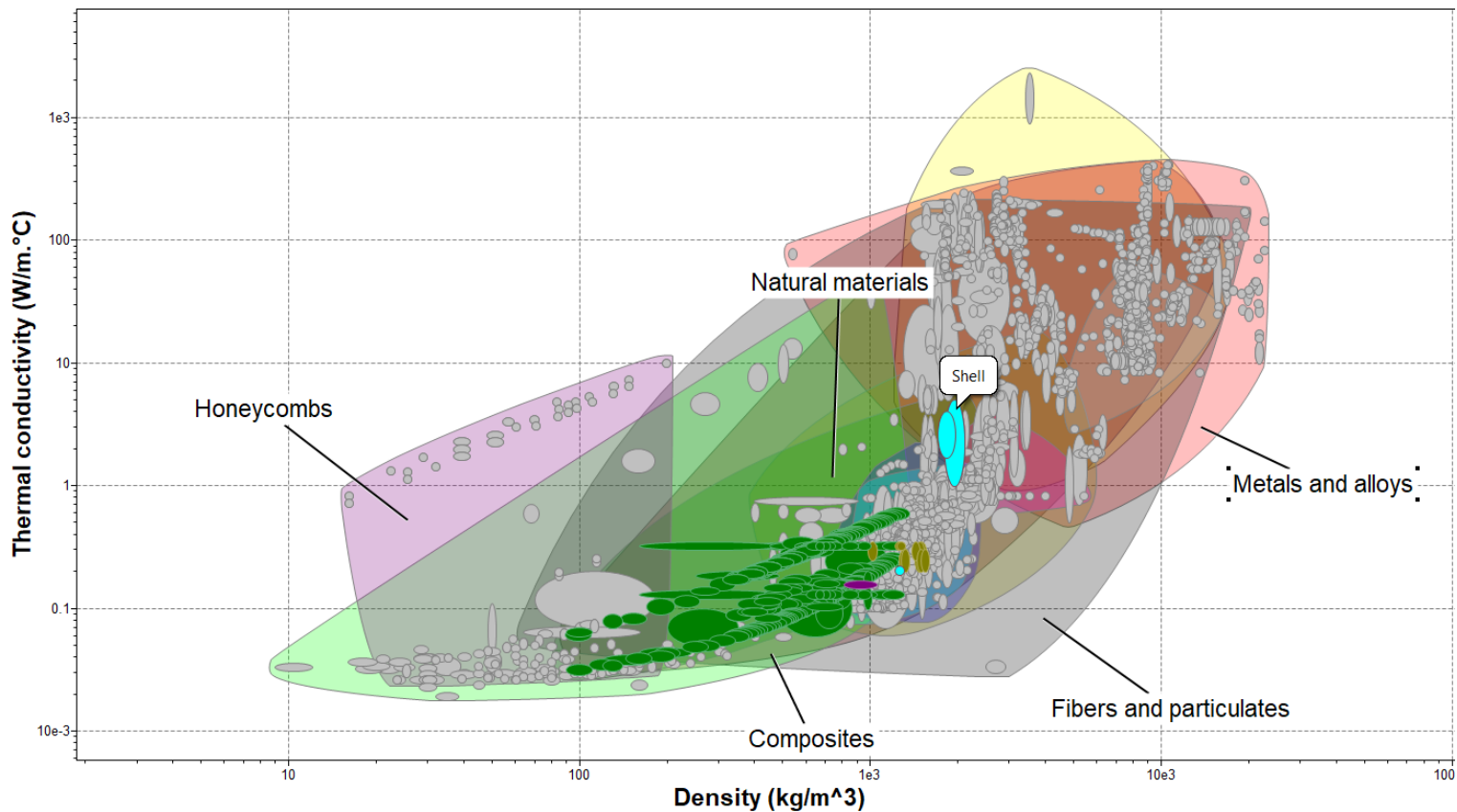
☐ Glass

☐ Natural

# Eco seleção de materiais

O software CES EduPack: breve introdução

## Função “Chart”



# Eco seleção de materiais

O software **CES EduPack**: breve introdução

**Alterar as definições** (p. ex. unidades)

The screenshot displays the CES EduPack 2019 software interface. The main window shows a sidebar with 'MaterialUniverse' and 'ProcessUniverse' options, and a central area with material categories like 'All Materials', 'Composites', 'Glasses', 'Metals and Alloys', 'Polymers', and 'Technical Ceramics'. A 'Settings' dialog box is open, with a red circle highlighting the 'Settings' icon in the top toolbar and a blue arrow pointing to the 'Units' tab. The 'Units' tab is selected, showing 'Unit options' with 'Preferred Currency' set to '<Automatic - EUR>' and 'Preferred Unit System' set to 'SI (Consistent)'. There are also radio buttons for 'Use Absolute Units for Temperature' and 'Use Display Units for Temperature', with the latter being selected. The dialog box has 'OK', 'Cancel', 'Apply', and 'Help' buttons at the bottom.

Untitled - CES EduPack 2019 - [Home]

File Edit View Select Tools Window Feature Request Help

Home Browse Search Chart/Select Eco Audit Synthesizer Learn Tools Settings Help

Level 1

change database first steps

1. Select a table

MaterialUniverse

ProcessUniverse

2. Filter by subset

All Materials Composites Glasses Metals and Alloys Polymers Technical Ceramics

Settings

Selection Selection Privacy

Datasheet Chart Units Numbers Labels

Unit options

Preferred Currency: <Automatic - EUR>

Preferred Unit System: SI (Consistent)

☐ Use Absolute Units for Temperature

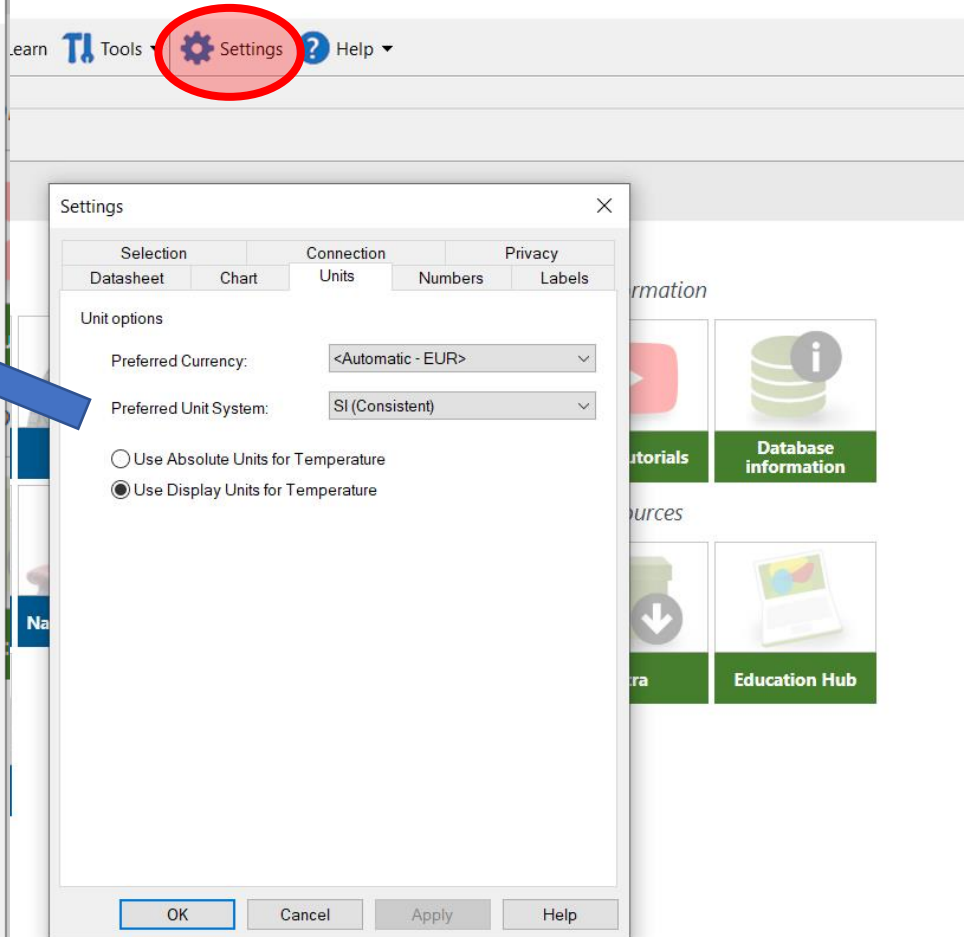
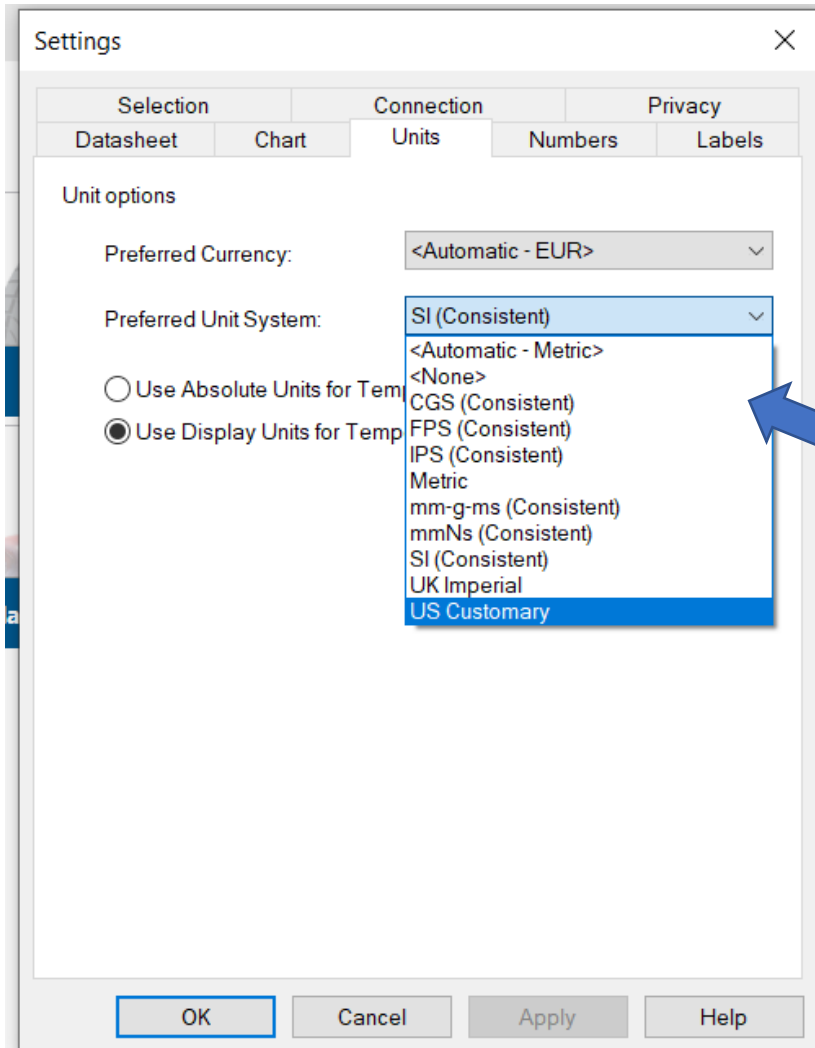
☒ Use Display Units for Temperature

OK Cancel Apply Help

# Eco seleção de materiais

O software **CES EduPack**: breve introdução

**Alterar as definições** (p. ex. unidades)






# Eco seleção de materiais

## O software CES EduPack: breve introdução

### Atributos

Cada atributo de um dado material tem um registo ao qual se associam **Notas científicas**; texto e figuras explicando o significado desse atributo/propriedade e como se determina. Cada **nota** termina com **links** que fornecem bibliografia adicional acerca dessa propriedade.

**Description**



**Caption**  
1. Close-up of the material. © John Fernandez 2. Cork, used to make wine bottle stoppers (corks). © Chris Lefferi 3. Cork is the bark of the cork oak, Quercus Suber. © Granta Design

**The material**  
Cork is a natural closed-cell foam, and is waterproof and remarkably stable, surviving in the neck of a wine bottle for 50 years or more without decay or contaminating the wine. Corkboard, made by compressing granulated cork under heat, is used for wall and ceiling insulation. Cork itself has a remarkable combination of properties. It is light yet resilient, insulates against heat and sound, has a high coefficient of friction, is imperious to liquids, chemically stable and fire resistant. Demand for cork exceeds 500,000 tonnes per year - and one tonne of cork has the same volume as 56 tonnes of steel.


**Composition (summary)** ⓘ  
40% Suberin / 27% Lignin / 12% Cellulose / 4% Friedelin / 17% Water

# Eco seleção de materiais

## O software CES EduPack: breve introdução

### Atributos

**Description**  
Image



**Caption**

1. Close-up of the material. © John Fernandez
2. Cork, used to make wine bottle stoppers (corks). © Chris Letteri
3. Cork is the bark of the cork oak, Quercus Suber. © Granta Design

**The material**

Cork is a natural closed-cell foam, and is waterproof and remains stable for 50 years or more without decay or contaminating the wine under heat, is used for wall and ceiling insulation. Cork itself is yet resilient, insulates against heat and sound, has a high coefficient of thermal expansion, is stable and fire resistant. Demand for cork exceeds 500,000 tonnes annually as 56 tonnes of steel.

**Composition (summary)**

40% Suberin / 27% Lignin / 12% Cellulose / 4% Friedelin / 17%

#### General properties

Density	i	177	-	218
Price	i	* 4.04	-	6.52

#### Mechanical properties

Young's modulus	i	2.51e7	-	4.99e7
Yield strength (elastic limit)	i	1.1e6	-	2.19e6
Tensile strength	i	1e6	-	2.5e6
Elongation	i	0.2	-	0.7
Fatigue strength at 10 <sup>7</sup> cycles	i	* 5.52e5	-	1.1e6
Fracture toughness	i	6.97e4	-	1e5

#### Thermal properties

Maximum service temperature	(i)	118	-	142	°C
Thermal conductor or insulator?	(i)	Good insulator			
Thermal conductivity	(i)	0.0398	-	0.0482	W/m.°C
Specific heat capacity	(i)	1.9e3	-	2.1e3	J/kg.°C
Thermal expansion coefficient	(i)	1.3e-4	-	1.81e-4	strain/°C

#### Electrical properties

Electrical conductor or insulator?	i	Poor insulator		
------------------------------------	---	----------------	--	--

#### Optical properties

Transparency	i	Opaque		
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Science Note

Back Forward Copy Print

### Yield strength, tensile strength, compressive strength and elongation

**Definition and measurement.**  
**Drilling down: yield, ultimate and elongation.**  
**Why does a shear stress make a dislocation move?**  
**Further reading.**

**Definition and measurement.** The yield strength  $\sigma_y$  (or elastic limit  $\sigma_{el}$ ), (units: MPa or MN/m<sup>2</sup>) requires careful definition. For metals, we often identify  $\sigma_y$  with the 0.2% offset yield strength, that is, the stress at which the stress-strain curve for axial loading deviates by a strain of 0.2% from the linear-elastic line as shown in Figure 1 (this 0.2% offset point is also associated with plastic strain).  $\sigma_y$  can also be defined by the proportional limit. For metals, it is often, but not always the same in tension and compression - notice for example that the wrought aluminum alloys datasheets show a tension/compression anisotropy. For polymers,  $\sigma_y$  is identified as the stress at which the gradient of the stress-strain graph is zero. When such a local maximum is not present, then it is defined as the stress at which the stress-strain curve becomes markedly non-linear: typically, a strain of 1% (Figure 2). Polymers are a little

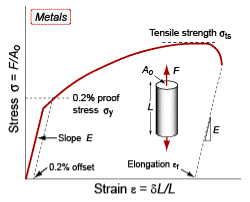


Figure 1. Stress-strain curve for a metal.

#### Further reading references



Ashby, M.F. (2012)  
*Materials and the Environment: Eco-informed Material Choice*  
2<sup>nd</sup> edition, Butterworth-Heinemann, Oxford, UK.  
ISBN: 978-0-12-385971-6



Ashby, M. Shercliff, H. and Cebon, D. (2014)  
*Materials: Engineering, Science, Processing and Design*  
3<sup>rd</sup> edition, Butterworth-Heinemann, Oxford, UK.  
ISBN: 978-0-08-097773-7



Ashby, M.F. and Jones, D.R.H. (2012)  
*Engineering Materials 1: An Introduction to Properties, Applications and Design*  
4<sup>th</sup> edition, Elsevier Butterworth-Heinemann, Oxford, UK.  
ISBN: 978-0-08-096665-6

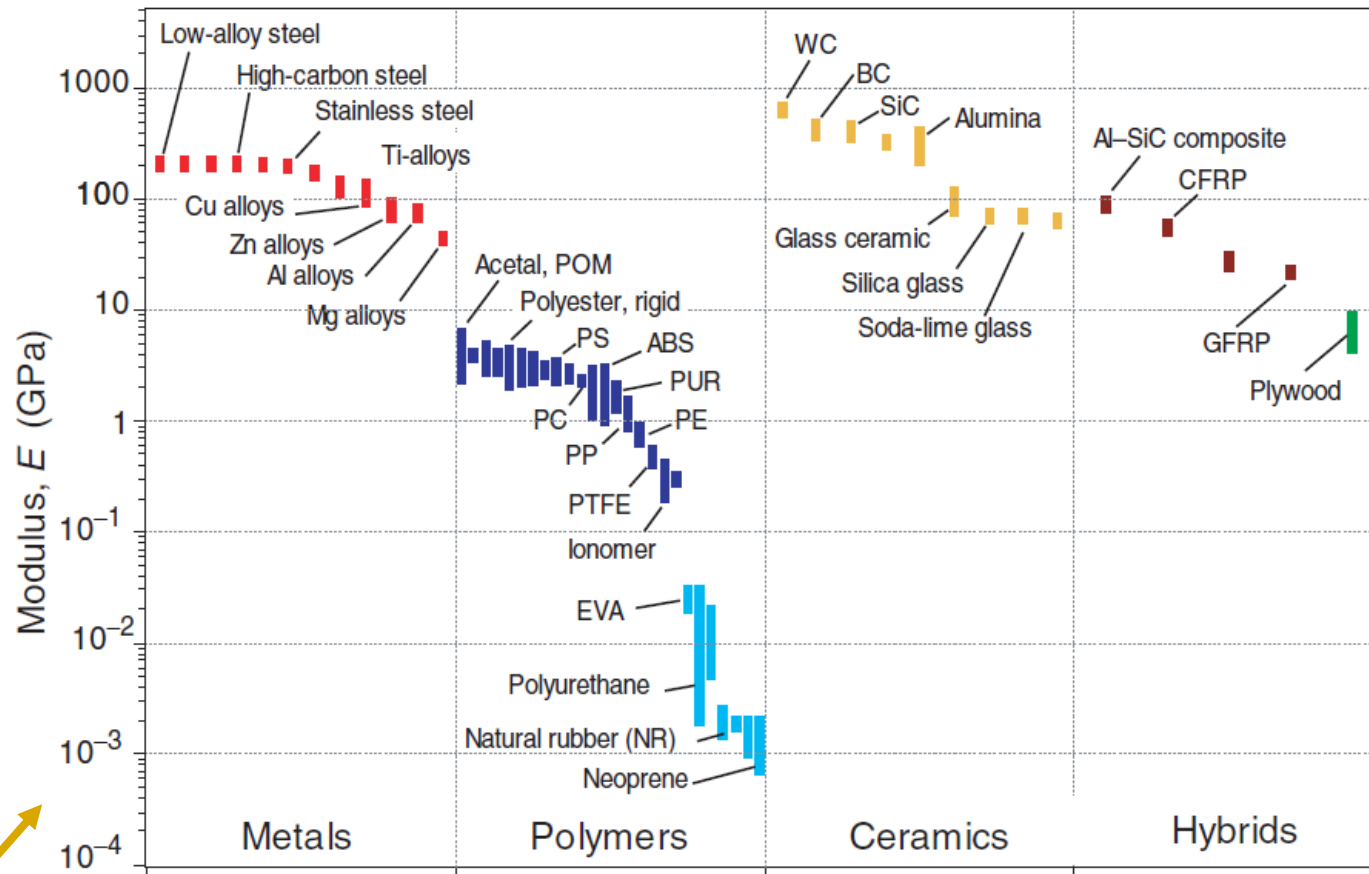


Ashby, M.F. and Jones, D.R.H. (2013)  
*Engineering Materials 2: An Introduction to Microstructures, Processing and Design*

# Eco seleção de materiais

O software CES EduPack: funcionalidades/representação dos dados

## Gráfico de barras



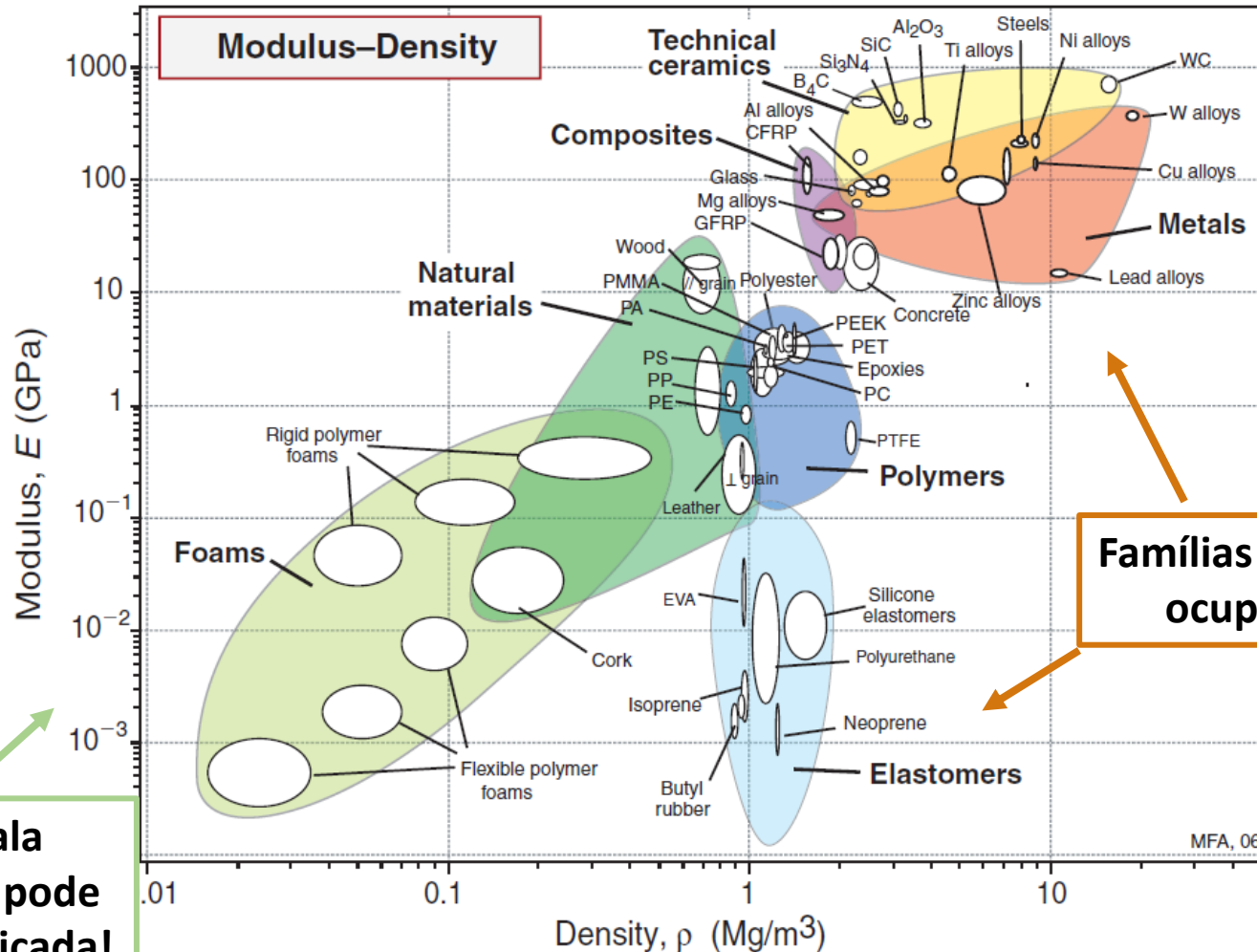
Esca  
logarítmica

CFRP – Carbon fiber reinforced polymer  
GFRP – Glass Fiber Reinforced Polymer  
Plywood – Prensado de madeira (contraplacado)

# Eco seleção de materiais

O software CES EduPack: funcionalidades/representação dos dados

## Gráfico de áreas



Famílias de materiais ocupam áreas

A escala utilizada pode ser modificada!