MATERIAL SELECTION

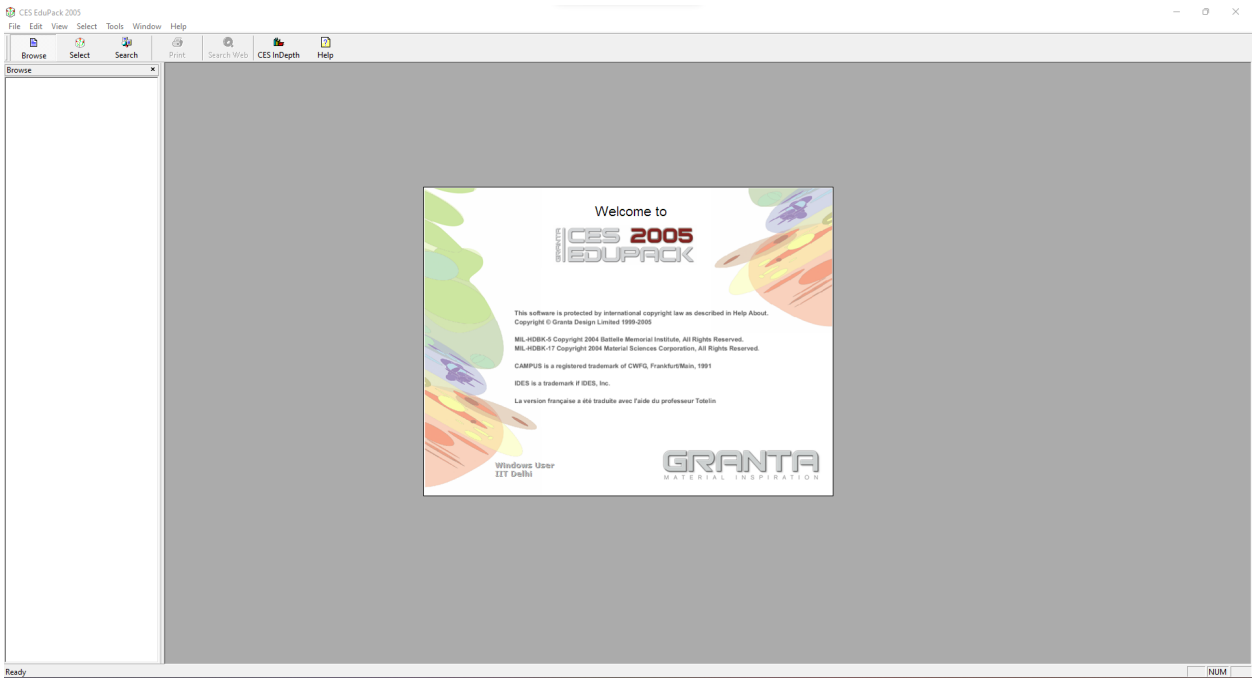
Use Material selection software to select material for the following three cases:

- **Body of electric switch/plug**
- **Coffee mug**
- **Cover of mobile phone**

Suggest manufacturing process(es) if 500000 units of the above component have to be produced.

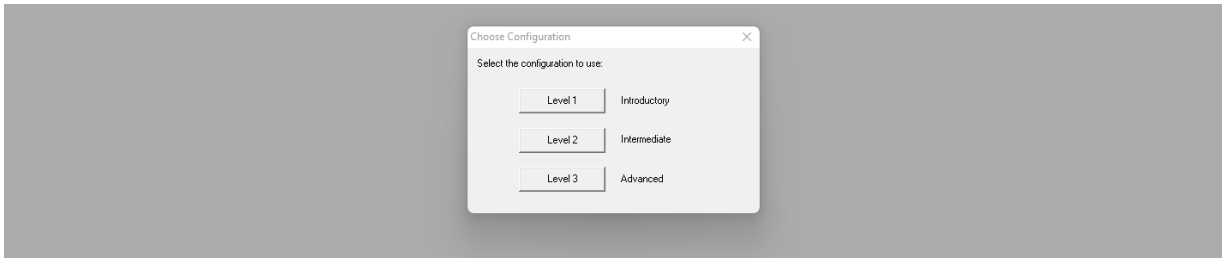
CHALLENGE

Knowledge of materials and the selection process is less. Using the software is very new. Used software ie: CES (Cambridge Engineering Selector) Edupack has been used for the process of selecting materials for this assignment.



Homescreen CES (Cambridge Engineering Selector) Edupack has been used for the process of selecting materials for this assignment

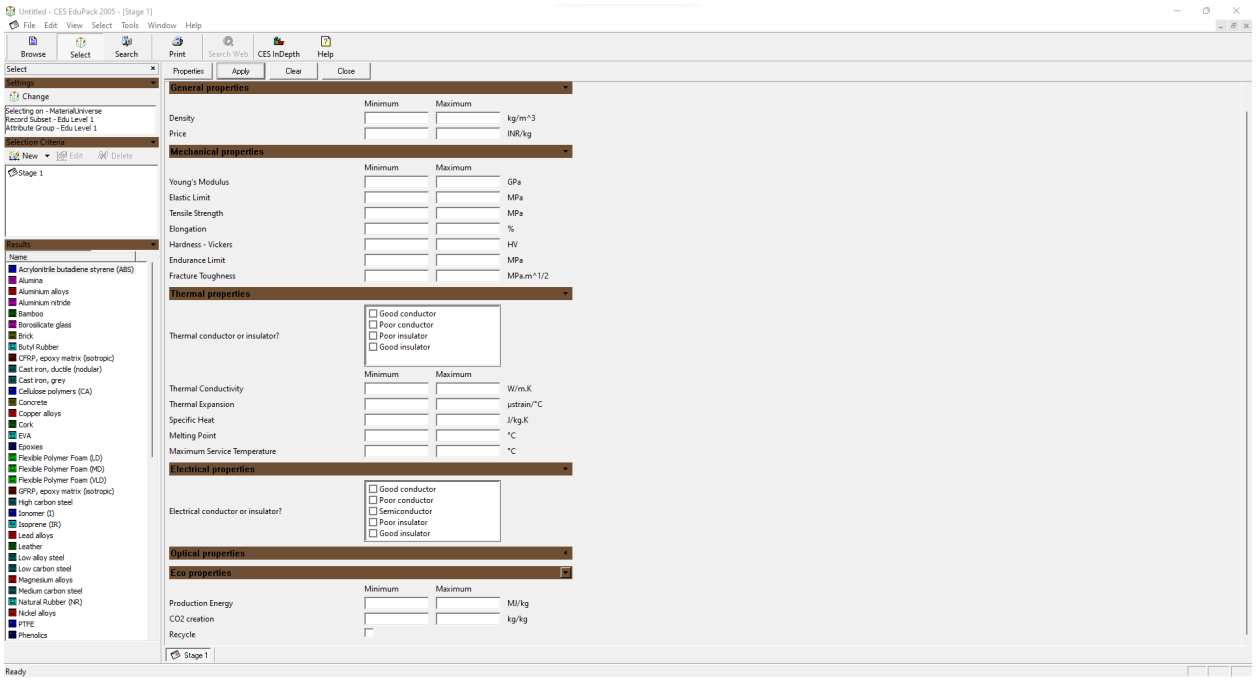
The selection depends on items are based on the user's needs and the material availability and scope.



For this assignment, Level 1 Introductory and Level 3 Advanced levels have been used to select the materials

PROCESS OF SELECTION

- Selected the configuration Level 1 – Introductory.
- Created a new project under material-based selection.
- Limit Stage as the selection criteria.
- Graph stage check perfect material
- In this stage, define the properties that are considered such as density, tensile strength, specific heat and insulation properties



Using different parameter we can modify the items and selection on the stage.

1 Material selection **ELECTRIC PLUG/ SWITCH**

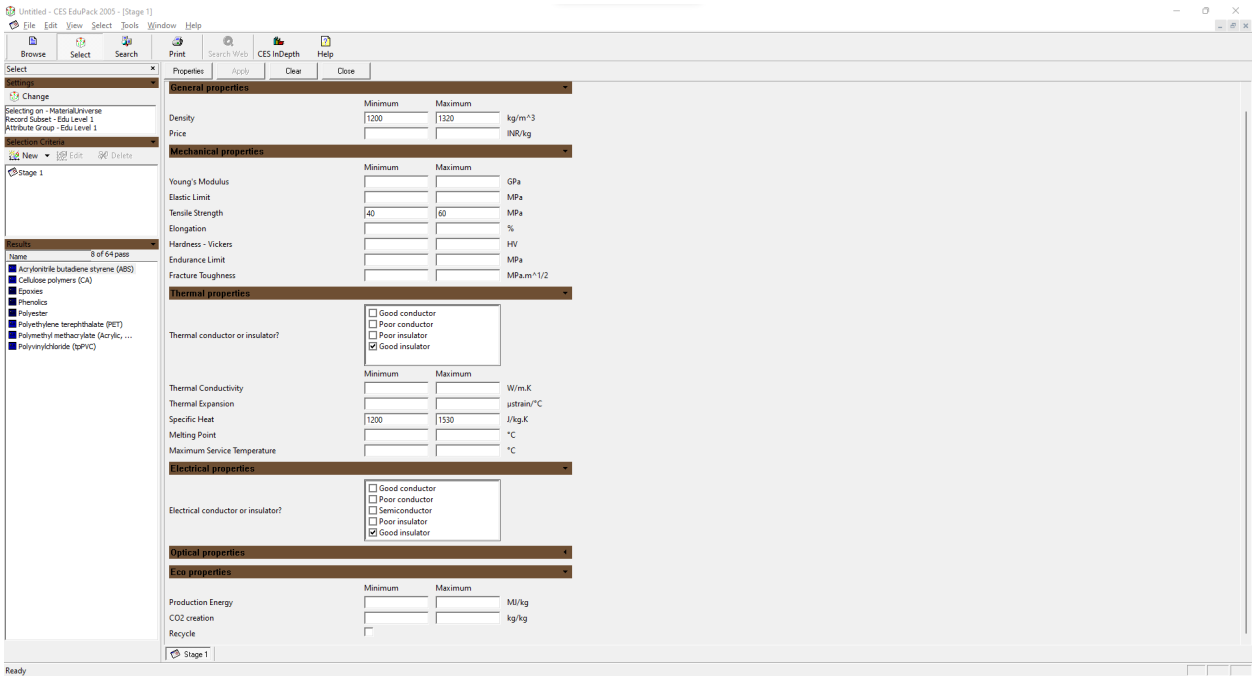
When designing devices that carry voltage the spacing of the contacts is fixed so the material separating them has to have a low minimum insulating property. This is called dielectric strength. Which is the voltage required to cause tracking along the material surface. So we chose a material with such properties in place.

CRITERIA

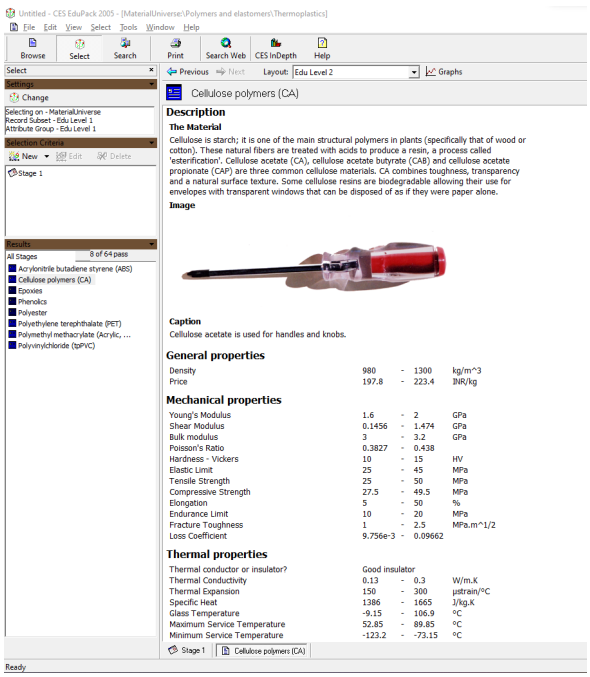
FUNCTION
To insulate the devices from electric current and provide protection against electric shocks. To protect the pins, fuse and wires from exposure.
CONSTRAINTS
Highly durable enough to withstand damage due to wear and tear over time.
VARIABLES
Properties considered: Density – 1320 kg/m3, Tensile Strength – 40-60 MPa, Specific Heat – 1530 J/kg.K, Good insulator. Material used may be of different colours, easy to manufacture and affordable.

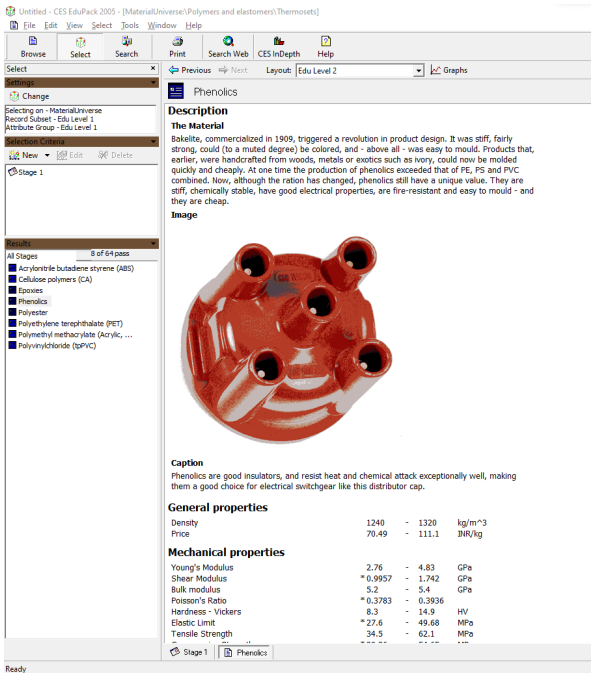
PROCESS OF SELECTION

- Selected the configuration Level 1 – Introductory.
- Created a new project under material-based selection.
- Limit Stage as the selection criteria.
- In this stage, define the properties that are considered such as density, tensile strength, specific heat and insulation properties



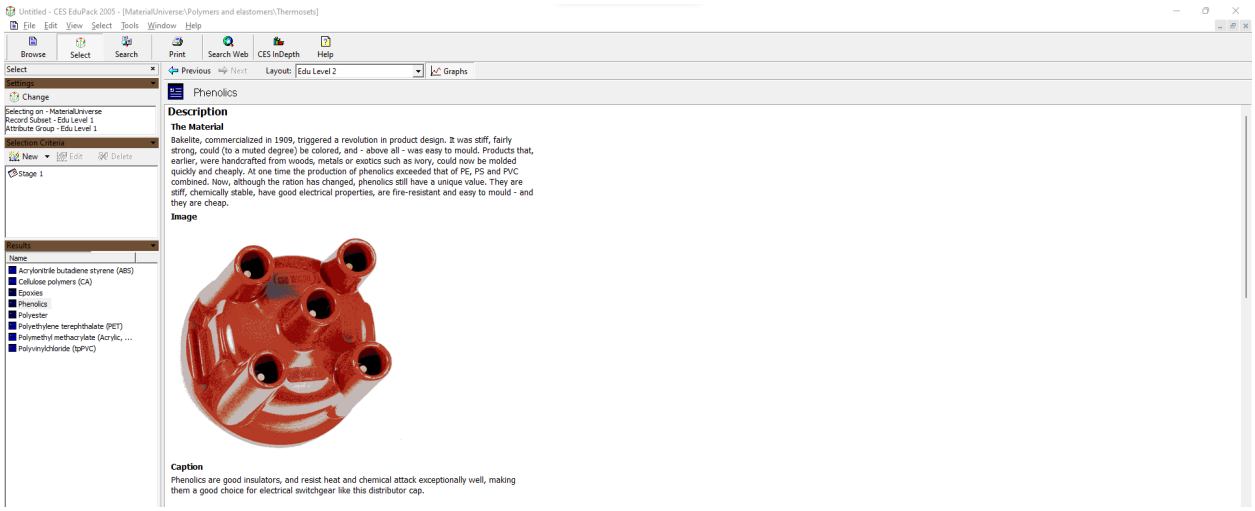
All the properties that have been used are by research on the internet.





RESULT

Considering the constraints both the materials **Bakelite and CA** are good for such properties and requirements. But since Bakelite has better flammability properties it's advisable to choose Bakelite as the material of choice.



RESULT of the analysis

General properties

Density	1240	-	1320	kg/m^3
Price	70.49	-	111.1	INR/kg

Mechanical properties

Young's Modulus	2.76	-	4.83	GPa
Elastic Limit	* 27.6	-	49.68	MPa
Tensile Strength	34.5	-	62.1	MPa
Elongation	1.5	-	2	%
Hardness - Vickers	8.3	-	14.9	HV
Endurance Limit	* 13.8	-	24.84	MPa
Fracture Toughness	* 0.7869	-	1.212	MPa.m^1/2

Thermal properties

Thermal conductor or insulator?	Good insulator			
Thermal Conductivity	0.141	-	0.152	W/m.K
Thermal Expansion	120.1	-	124.9	µstrain/°C
Specific Heat	* 1467	-	1526	J/kg.K
Maximum Service Temperature	* 141.9	-	156.9	°C

Electrical properties

Electrical conductor or insulator?	Good insulator

Optical properties

Transparency	Opaque

Eco properties

Production Energy	* 85.9	-	95	MJ/kg
CO2 creation	* 2.83	-	3.12	kg/kg
Recycle	✕			

Supporting information

Typical uses

Electrical parts - sockets, switches, connectors, general industrial, water-lubricated bearings, relays, pump impellers, brake pistons, microwave cookware, handles, bottles tops, coatings, adhesives, bearings, foams and sandwich structures.

Links

Reference	...
ProcessUniverse	...
Producers	...

PRODUCTION

For the production of 500000 switches, the best method to do is injection moulding.

2 Material selection **COFFEE MUG**

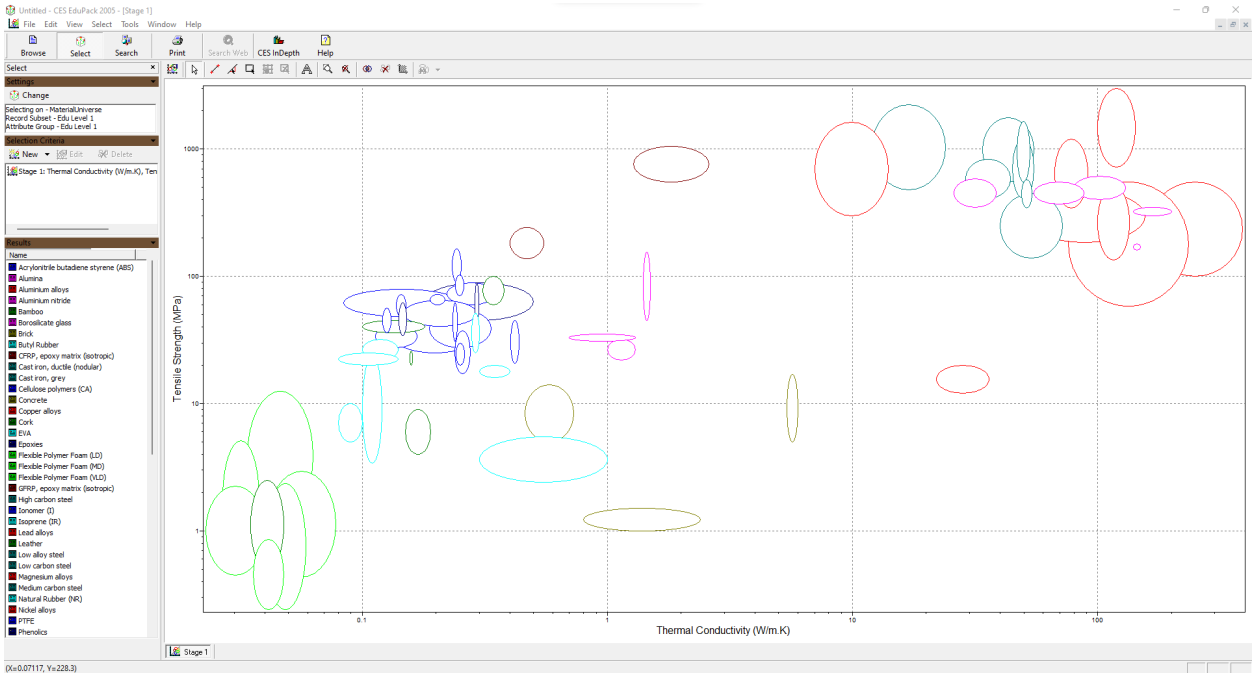
When designing a coffee mug the separating material must withstand hot beverages and should highly insulate the heat from the beverage to the hands hence it should be a good thermal insulator. It should reduce the transmission of heat to the outer environment. It should be able to add colours due to personalisation and customisation.

CRITERIA

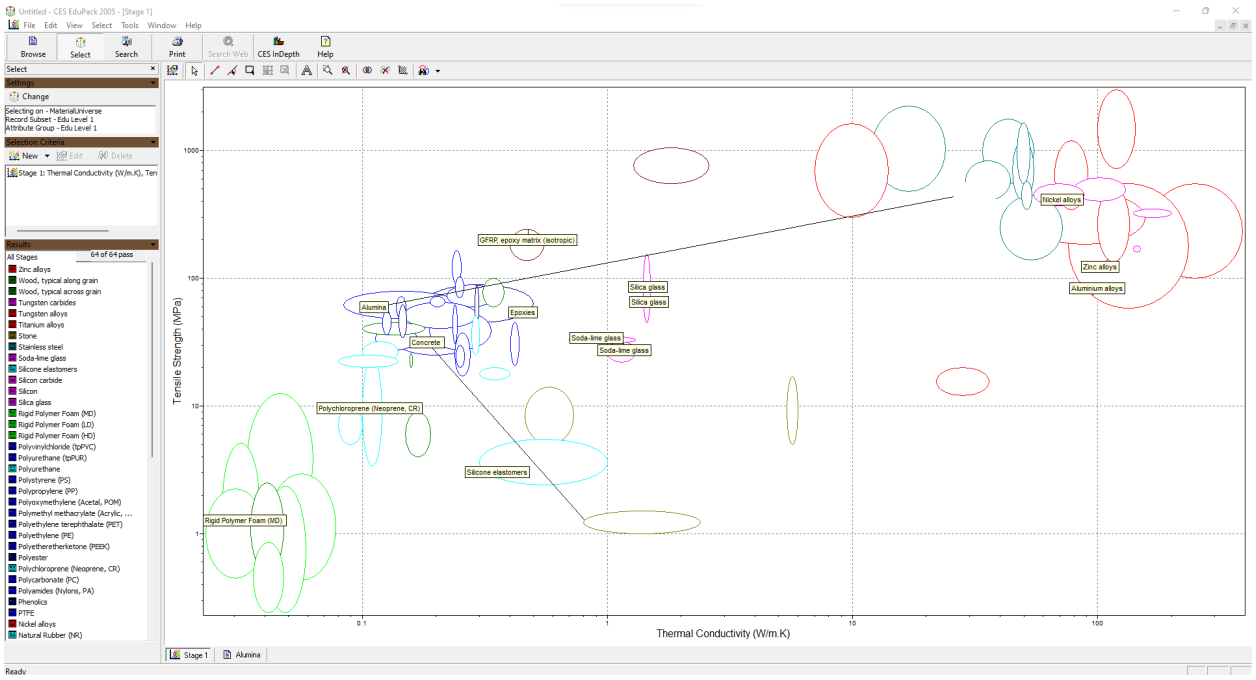
FUNCTION
To insulate the beverage from the hands. It should reduce the transmission of heat.
CONSTRAINTS
Highly customisable with the addition of colours
VARIABLES
The thermal conductivity of 3.8 W/mK.densities of 2607–2739kg/m3 makes it lighter to hold.

PROCESS OF SELECTION

- Selected the configuration Level 1 – Introductory.
- Created a new project under material-based selection.
- Limit Stage as the selection criteria.
- Graph stage check perfect material
- In this stage, define the properties that are considered such as density, tensile strength, specific heat and insulation properties.

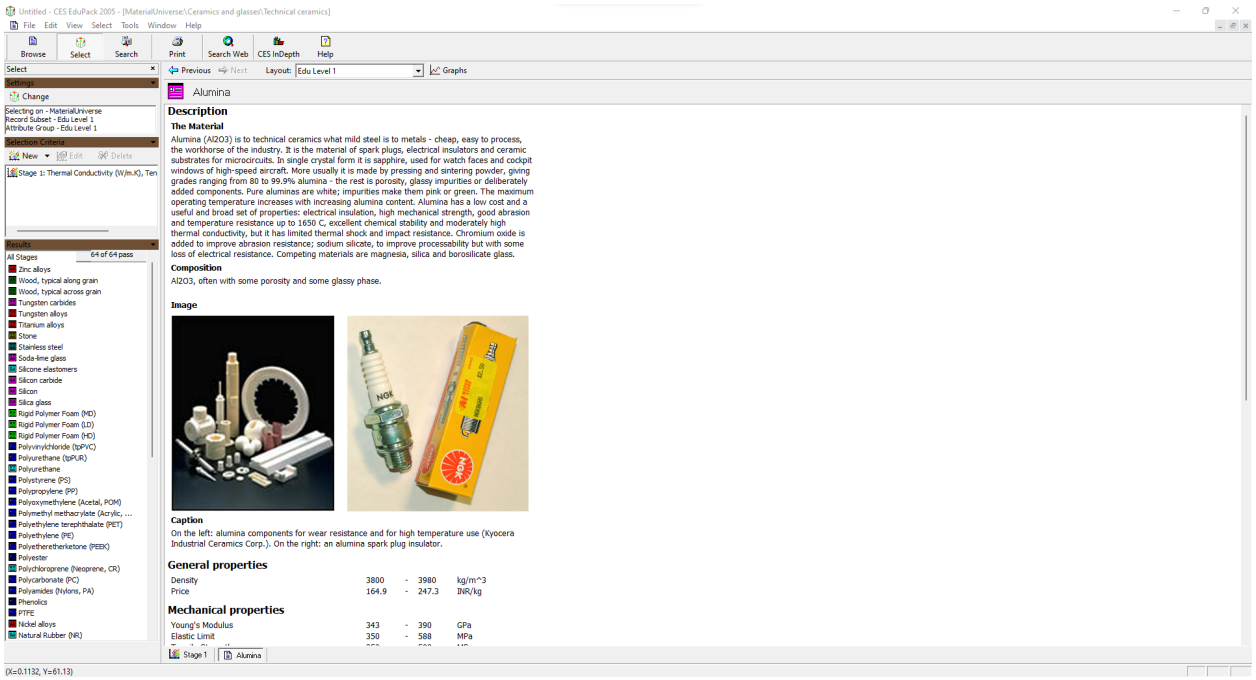


FInding best material that fits both thermal and strength needs.



Silicate glass and alumina was the perfect material for glasses/ mug

When designing a coffee mug the separating material must withstand hot beverages and should highly insulate the heat from the beverage to the hands hence it should be a good thermal insulator. It should reduce the transmission of heat to the outer environment. It should be able to add colours due to personalisation and customisation.



Alumina is chosen

General properties

Density	3800	-	3980	kg/m^3
Price	164.9	-	247.3	INR/kg

Mechanical properties

Young's Modulus	343	-	390	GPa
Elastic Limit	350	-	588	MPa
Tensile Strength	350	-	588	MPa
Elongation	0			%
Hardness - Vickers	1200	-	2060	HV
Endurance Limit	*200	-	488	MPa
Fracture Toughness	3.3	-	4.8	MPa.m^1/2

Thermal properties

Thermal conductor or insulator?	Poor conductor			
Thermal Conductivity	26	-	38.5	W/m.K
Thermal Expansion	7	-	7.9	µstrain/°C
Specific Heat	790	-	820	J/kg.K
Melting Point	2004	-	2096	°C
Maximum Service Temperature	1077	-	1841	°C

Electrical properties

Electrical conductor or insulator?	Good insulator

Optical properties

Transparency	Opaque

Eco properties

Production Energy	*49.5	-	54.7	MJ/kg
CO2 creation	*2.67	-	2.95	kg/kg
Recycle	✕			

Supporting information

Typical uses

Electrical insulators and connector bodies; substrates; high temperature components; water faucet valves; mechanical seals; vacuum chambers and vessels; centrifuge linings; spur gears; fuse bodies; heating elements; plain bearings and other wear resistant components; cutting tools; substrates for microcircuits; spark plug insulators; tubes for sodium vapor lamps.

Links

Reference	...
ProcessUniverse	...
Producers	...

RESULT

Considering the constraints materials **Alumina** are good for such properties and requirements. Since alumina has the features required such as

- Cheap, easy to process, the workhorse of the industry. (for 50000 units)
- Poor conductor of heat
- Good insulator
- As per human tendency, the Coffe is drank always in an opaque glass.

PRODUCTION

This is used for multiple casting and batch-wise baking. For using for 50000 units at a time.

3 Material selection **MOBILE COVER**

When designing a mobile cover the requirements usually are the material should be durable and elastic material that can easily protect your phone from small scratches and moisture. Moreover, impact proofing can be done using the elastic property

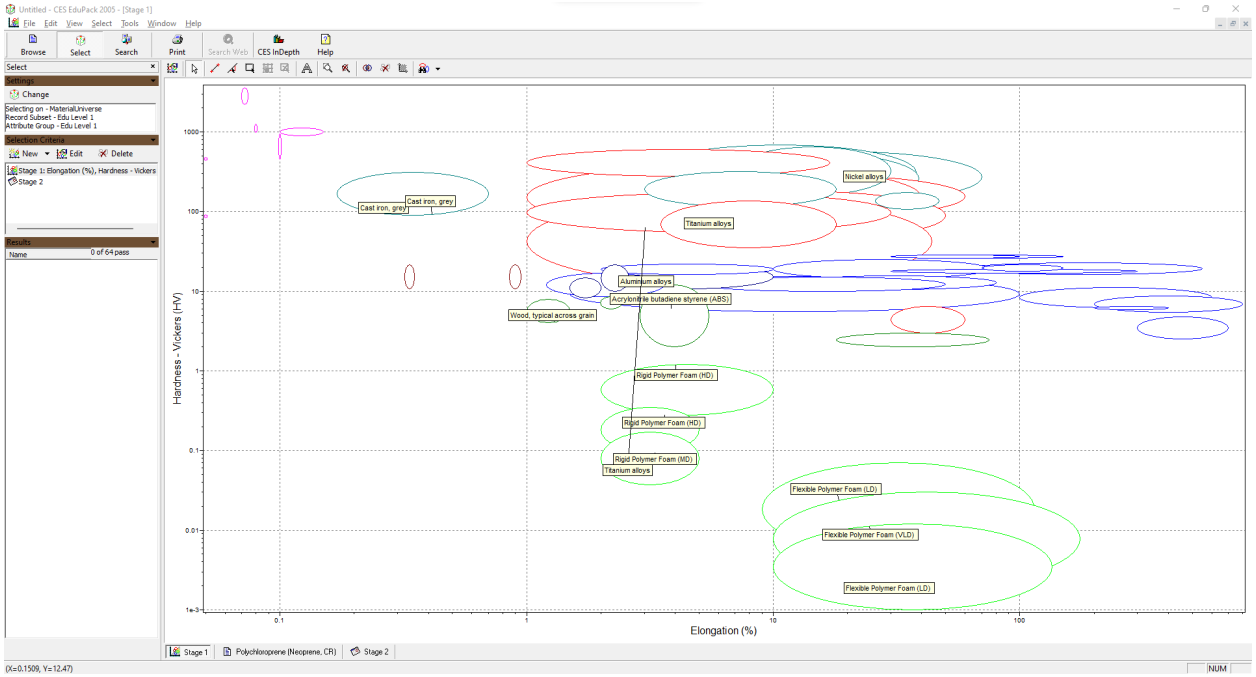
CRITERIA

FUNCTION
To protect the mobile from sudden impact and to protect from accidental moisture contact.
CONSTRAINTS
Highly customisable with the addition of colours
VARIABLES
The thermal conductivity of 3.8 W/mK.densities of 2607–2739kg/m3 makes it lighter to hold. elasticity and rigidity

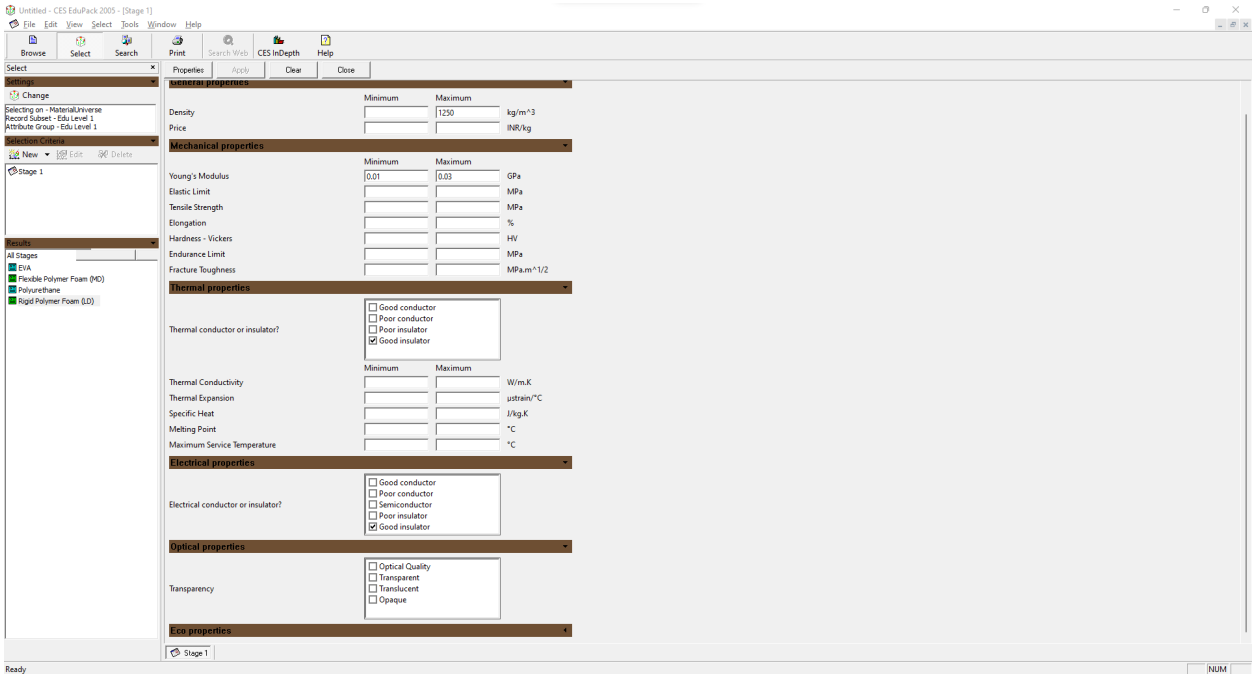
Density – 1250 kg/m3 • Specific Heat – 1700 J/kg.K • Good insulator highly elastic

PROCESS OF SELECTION

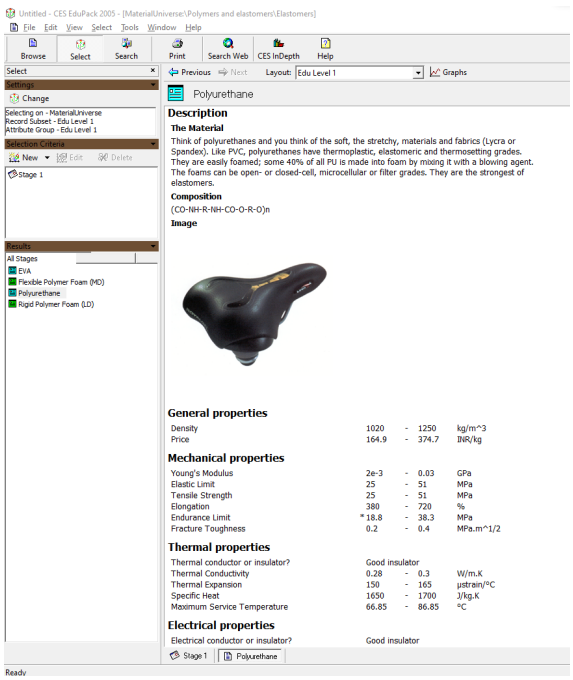
- Selected the configuration Level 1 – Introductory.
- Created a new project under material-based selection.
- Limit Stage as the selection criteria.
- Graph stage check perfect material

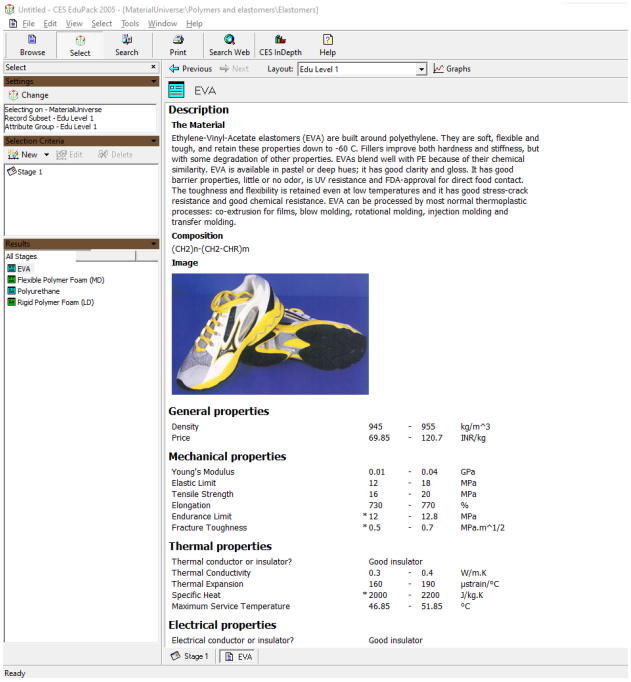


The selection of an idea for which type is possible



Choosing the material with required properties





Hence we choose the material EVA or Poluethanes

General properties

Density	1020	-	1250	kg/m^3
Price	164.9	-	374.7	INR/kg

Mechanical properties

Young's Modulus	2e-3	-	0.03	GPa
Elastic Limit	25	-	51	MPa
Tensile Strength	25	-	51	MPa
Elongation	380	-	720	%
Endurance Limit	*18.8	-	38.3	MPa
Fracture Toughness	0.2	-	0.4	MPa.m^1/2

Thermal properties

Thermal conductor or insulator?	Good insulator			
Thermal Conductivity	0.28	-	0.3	W/m.K
Thermal Expansion	150	-	165	µstrain/°C
Specific Heat	1650	-	1700	J/kg.K
Maximum Service Temperature	66.85	-	86.85	°C

Electrical properties

Electrical conductor or insulator?	Good insulator

Optical properties

Transparency	Translucent

Eco properties

Production Energy	*109	-	120	MJ/kg
CO2 creation	*4.47	-	4.94	kg/kg
Recycle	✓			

Supporting information

Typical uses

Cushioning; packaging; shoe soles; tires; fuel hoses; gears; bearings; car bumpers; adhesives; fabric-coating.

Links

Reference	...
ProcessUniverse	...
Producers	...

RESULT

Considering the above conditions of elasticity and even the rigidity it is advisable to use polyurethane for the material for mobile covers.

PRODUCTION

For having a production basis of 50000 units moulding can be used for doing the same.