

UNIT 3

PROPERTIES OF MATERIALS

Vocabulary

- Properties of materials
- Word formation: Nouns from adjectives; verbs from adjectives:

Grammar and functions

- Comparison and contrast
- Specific structures of comparison of adj/adv
- Expressions of comparison and contrast

PROPERTIES

Brittle ≠ Tough

Soft ≠ Hard

smooth ≠ rough

Flexible ≠ Rigid

Light ≠ Heavy

Transparent ≠ opaque

Elastic ≠ Plastic

soluble ≠ insoluble

- It is hard but fractures easily when hit or worked **brittle hit-hit-hit**
- It bends easily without breaking **flexible**
- It has a high mass **heavy**
- It is easy to scratch **soft**
- It cannot be dented or scratched **hard**
- It retains its new shape when force is applied, as opposed to elastic materials **plastic**
- It can be drawn or stretched into coils/wires **ductile draw-drew-drawn**
- It is able to withstand a stretching load without breaking **tensile strength**
- It produces friction when rubbed **rough**
- It returns to its original shape when the deforming force is removed **elastic**
- It has low density **light**
- It is able to resist an impact load without breaking- *it doesn't break easily* **tough**
- It is difficult to bend **rigid**
- It burns easily **combustible (ADJ) NOUN- fuel**
- You can see through it **transparent**
- It can be hammered/worked into a shape **malleable**
- It produces little friction **smooth**
- It does not rust/corrode **corrosion resistant**
- It allows the flow of electricity **good conductor**
- It dissolves in water **soluble**

- 1) Find **CONTRACTIONS** (it's , that's , they're...) **READING: TYPES OF PLASTICS**
Pages 33-34
- 2) Underline **ADJECTIVES** and **NOUNS** related to properties

WE DO NOT USE CONTRACTIONS IN FORMAL WRITING

There are two main groups of plastics: thermosetting materials and thermoplastic materials. Thermosetting materials can be heated and shaped only once. Thereafter they are **rigid** and can be broken, but they cannot be softened again by heat without decomposing them. Urea formaldehyde or UF, a resin obtained from urea ($\text{NH}_2\text{CO}\cdot\text{NH}_2$) and formaldehyde (CH_2O), and the similar melamine-formaldehyde or MF, from melamine ($\text{C}_3\text{H}_6\text{N}_6$) and formaldehyde, are two of the most widely used thermosets. Their **toughness** and **high electrical and thermal resistance** make them ideal for electric light switches and plugs, and for the handles of irons, kettles, pans, etc., while they are also used to impregnate paper sheets from which heat- and scratch-resistant surfaces are made. Where dark colours are acceptable, the cheaper phenolic material, phenolformaldehyde or PF, is often used.

Thermoplastic materials can be shaped and re-shaped as many times as required. If the temperature is not too high, they soften again without decomposing. Polyethylene, produced by the polymerization of ethylene ($\text{CH}_2=\text{CH}_2$) is still the most widely used thermoplastic. It is cheap to produce, **tough** and **light**. **Low density** polyethylene is used for making **transparent** sheet or film, cable and flex covering and **flexible** bottles, while more **rigid** bottles and containers are made from **high density** polyethylene. The more recently developed polypropylene, from propylene ($\text{CH}_3\text{CH}=\text{CH}_2$) has replaced polyethylene for many applications, since it is **more resilient**, less **liable/inclined/prone to stress-cracking** and it is not **weakened** by flexing. However, it is more **costly** than other plastics and tends to be **brittle** at very low temperatures. It is used to make a variety of products, including hinges, vehicle-engine radiator fans and moulded chair seats. Polystyrene, obtained by reacting benzene with ethylene, is an extremely cheap, **light, rigid** material, which is **brittle** and is often **toughened** by the addition of rubber. It is used especially for making toys and small rigid containers where low cost may be more important than **durability**. Expanded polystyrene is an extremely **light, rigid** foam for insulating and packaging. Polyvinylchloride or PVC, from vinyl chloride ($\text{CH}_2=\text{CHCl}$) is used, for example, to make **rigid** and **flexible** pipes, furniture coverings and floor tiles. Unsupported PVC and PVC-coated fabrics are used to make bags and clothing. PVC is a **relatively heavy** plastic. Nylon, the generic name for the polyamide thermoplastics, has different properties depending on the relative lengths of the $-\text{CH}_2-$ groups in the polymer. Nylon was the first synthetic plastic fibre to be introduced into the clothing industry, but it is also used wherever its **great tensile strength** or **thermal resistance/heat resistance/resistance to heat** are needed, for example, to make ropes or bristles. Polytetrafluoroethylene or PTFE is made from fluoroethylene, a compound of carbon and fluorine. Although it is **difficult and costly to process**, it is **extremely resistant to** chemicals and erosion, has very **high temperature resistance** and has **low frictional properties**. Apart from industrial uses, it provides the coating for non-stick cooking utensils.

rigid → rigidity → stiffness
 tough → toughness
 resistant to heat and electricity → electrical and thermal/heat resistance
 light → lightness → Low density
 Flexible → flexibility
 heavy → high density
 resilient → resilience
 inclined to stress-cracking
 brittle → brittleness
 durable → durability

relatively/quite+/fairly/rather
 /extremely/a bit/a little
 much/

tensile strength
 resistant to chemicals and erosion
 high temperature resistance
 low frictional properties

(a)+ few (C) – coins, minutes
 (a)+ little (U)- money, time

LISTENING: PROPERTIES OF MATERIALS

COPPER	ALUMINIUM	LEAD	ZINC
non ferrous	low density	high density	non-ferrous
high electrical and thermal conductivity	ductile	melts fairly easily LOW MELTING POINT	low hardness
high tensile strength	malleable	very low tensile strength	Very corrosion resistant
ductile	relatively low tensile strength		relatively heavy
malleable			relatively high fusibility

Today we are going to look at the most important properties of four metals: copper, zinc, lead and aluminium.

Copper is a non-ferrous metal. It has high electrical and thermal conductivity. It also has high tensile strength and is ductile and malleable. Zinc is also a non-ferrous metal. It has low hardness but is very corrosion resistant. It is a relatively heavy metal, but **has a lower density than cast iron , copper or lead**. It has relatively high fusibility but **its fusibility is lower than the fusibility of lead**. Lead has high density. It melts fairly easily and has very low tensile strength. Aluminium has low density, and is ductile and malleable. however, it has relatively low tensile strength.

WORD FORMATION

When talking about the properties of materials we can use the adjective, the noun or the verb. Here you will find the most common suffixes (*and prefix*) to form verbs or nouns from adjectives.

FROM ADJECTIVE/noun TO VERB

-EN harden

EN- endanger

Widen- thicken-deepen-broaden **length**EN-**strength**EN embrittle

All regular – it has strengthened**ed** - weakened**ed**

FROM ADJECTIVE TO NOUN

LATIN ORIGIN

ENGLISH ORIGIN

-ITY activity *reliability, availability* -NESS hardness *toughness*

-NCE importance *resilience* -TH/HT truth/height *breadth /θ/*

(from unit 1) page.19 Measurement nouns are difficult to spell. Circle the correct spelling:

STRONG	strength				
LONG	longth	length	length	lenght	longht
HIGH	haight	hight	heigth	hieght	height
WIDE	wideth	wiedth	width	widht	wiedht
DEEP	depeth	depht	deepth	depth	deepht

To WEIGH	wieg	weight	weigth	waight	wight
BROAD	broadth	breadness <i>(literature)</i>	breadth	broadht	breahht
THICK	thickness	thought	thoughth	thicknes	thickht
THIN	thinness	thineth	thinnes	thineht	thinness

Rigid – rigidity
EXERCISE

A: Using the matching exercise on properties transform the adjectives into nouns (use the reading text as well)

Lightness
Hardness
Brittleness
Smoothness
Heaviness
Toughness
Roughness
Softness
Corrosion resistance
Transparence

Plasticity
Solubility
Combustibility
Ductility
Good conductivity
Elasticity
Flexibility
Rigidity
Malleability

B: LATIN ORIGIN _____ **ENGLISH ORIGIN** _____

_difference_____ _thickness_____

_availability_____ _thinness_____

_reliability_____ _breadth (broad)_____

_resistance_____ _width, depth_____

_fusibility, resilience_____ _____

C: Complete the following table

ADJECTIVE	NOUN	VERB
FLEXIBLE	FLEXIBILITY	FLEX
DEEP	DEPTH	DEEPEN
LONG	LENGTH	LENGTHEN
ABLE-capable-unable	ABILITY	ENABLE-disable
DIFFERENT	DIFFERENCE	DIFFER
HARD	HARDNESS	HARDEN
WIDE	WIDTH	WIDEN
ACTIVE	ACTIVITY/action	ACT

D: The attractive_ corrosion resistANCE_ of copper-nickel alloys in sea water has led to their substantiAL_ use in marine services. They have good mechanicAL_ strenGTH_ and ductiLITY_ but cannot be hardENED_ by heat treatment. Of particulAR_ interest are their thermAL conductivity_; this explains their populariTY_____ for heat enchangers, where higher strenGTH is not the most importANT factor. They are also nonmagneTIC and have a magneTIC permeabiLITY close to unITY.

LISTENING: 6 METALS *(not included this year)*

METAL	PROPERTIES	USES
cast IRON	- FERROUS metal contains 3% CARBON very HARD but brittle it will not BEND	- bodies of machine tools - vices
spring STEEL	- tough	SPRINGS (clocks) car ENGINE (piston rings)
mild STEEL	it has LESS CARBON than cast iron SOFTER but not brittle - tough can be worked into SHAPES	- girders in bridges - car bodywork - nuts and bolts
ALUMINIUM	-base or pure metal LIGHT and RESISTANT to CORROSION though SOFT and easily shaped it is very STRONG	- pots and pans - foil PISTONS in CAR ENGINE
COPPER	easily BENT and stretched GOOD CONDUCTOR of HEAT and ELECTRICITY	electrical WIRING water PIPES car RADIATORS
ZINC	- a pure metal RESISTANT to CORROSION - easily cast making complex SHAPES	- carburettors

ADVERBS AND ADJECTIVES

	ADJECTIVE		ADVERB
A	careful	worker works	carefully
A	weak/brittle	metal breaks	easily
A	good	student studies	hard
<p>Many adverbs are formed by adding -LY to the adjective. But there are others which have no corresponding adjective (NEVER, ALWAYS), which are different (GOOD/WELL) or which use the same word as the adjective (FAST/HARD).</p> <p style="text-align: center;"> He drives a fast car - He drives fast He lives in a far country – He lives far It is a hard material – He works hard </p> <p>Remember that some also have a change of meaning, for example, “she works <i>hard</i>” means she works a lot. On the other hand, “she <i>hardly</i> works” means she does not work at all.</p> <p style="text-align: center;">Hard-hardly</p> <p>ADJECTIVES are used:</p> <ul style="list-style-type: none"> -BE+ADJ=This metal is weak / it is important. -ADJ + NOUN =a weak metal. <p style="text-align: right; color: blue;"><i>ADJ always singular – important questionS</i></p> <p style="text-align: right; color: blue;"><i>Any word with the function of an ADJ- Million Dolar Baby</i></p>			
<p>-MAKE + OBJECT + ADJ = this method makes the metal hard.</p>			
<p><i>This method makes the new alloy (that) we have introduced more suitable than the old one</i></p>			
<p><i>This method makes IT more suitable</i></p>			
<p>ADVERBS are used:</p> <ul style="list-style-type: none"> -ADV+ADJ = Aluminium is extremely light. -VERB+ADV= Cool the bar slowly. 			
<p>-ADV+ Past Participle= This alloy is highly recommended for propellers.</p>			
<p><i>It is a very useful material/it is the most useful/it is more useful now +ADJ</i></p>			
<p><i>The most commonly/widely/often/frequently used metal is iron</i></p>			
<p><i>A widely used element</i></p>			

Underline the correct form (adj. or adv) in the following sentences:

1. Such a concentration of lead is high/highly dangerous for men.
 2. Hard steel is general/generally preferred when building huge bridges.
 3. Magnesium is known as a metal which burns easy/easily.
 4. The cable is to be covered by a thin/thinly rubber coating.
 5. Stainless steel consists of slight/slightly high/highly proportions of chromium.
 6. If you put a pipe here, it should not be easy/easily bent.
 7. This alloy performs well due to its exceptional/exceptionally electrical conductivity.
 8. Researchers found extreme/extremely rare/rarely compounds on Mars.
 9. Chalk is a good example of soft/softly material.
 10. Protons are positive/positively charged particles.
- Protons have a positive charge

STRUCTURES OF COMPARISON

Study these structures of comparison:

- There is **AS MUCH** water **AS** we thought - *uncountable*
- There are **AS MANY** people **AS** we thought. - *countable*
- It costs **AS MUCH AS** \$100 a pound – (*Sp. 'hasta' for big amounts*)
- It produces **AS MUCH/many AS** 2.000.000 volts (2 million volts)
- It is **SO IMPORTANT** that + SENTENCE (CLAUSE)
- It is **SUCH AN IMPORTANT** issue **THAT**.... + SENTENCE (CLAUSE)
- **TOO MUCH** money / **TOO MANY** products. (*'too' always means EXCESS*)
- (a) **Little** money / (a) **few** products
- This box is **THE SAME** size **AS** that one.
- This box is **TWICE** | (two times)
HALF | **AS** large **AS** the other box.
- This box is **DOUBLE** the size of that one*
- Technology is becoming **MORE AND MORE** sophisticated. (*Progressive idea*)
- Prices are getting **HIGHER and HIGHER**
- **MOST METALS** are good conductors.
- MOST OF THE ENERGY** used today comes from fossil fuels.
- Most of us/them**
- The most **WIDELY/COMMONLY/OFTEN/FREQUENTLY USED** metals are steel and copper.
(*very/more/most + WIDELY... + PP*) *very useful = very + ADJ the most useful = most + ADJ*
- **THE GREATER** the amount of carbon added, **THE LESS SOFT** (the) steel becomes (*cuanto mayor/menor... menor/mayor*).
- THE GREATER** the amount of carbon added, **THE HARDER** the steel
- THE FORMER... THE LATTER** (*needs two previous options. They can be used together or separately*)
- We are going to speak about **Al.** and **Fe.** **The former** is a light metal, **the latter** is heavy.
- This car is **QUICKER**. This car runs **MORE QUICKLY**
FASTER- **FASTER**

COMPARING AND CONTRASTING

	Glass	Iron	Aluminium	Copper	Rubber	Plastic
Electrical & Thermal conductivity	D	C	B	A	D	E
Hardness	A	B	C	C	E	D
Weight	C	B	D	A	E	E
Malleability	E	C/B	C/B	A	D/C	-
Toughness	E	C	B	A	B	D
Recyclability	B	D	A	D	C	B

DOUBLING CONSONANTS

stopP -ED

travelling – traveller metallic

THIS – THESE

FATE - FATER

(C)+C+V+C

BIG G - ER

NICE - R

THIN

To write – writing –

Wrote- written

Forget forgot forgotten

SPELLING: Cross out the wrong comparative form:

Bigger/~~biger~~

slower/~~slowwer~~

shorter/~~shortter~~

widder/~~wider~~

Deeper/~~deepper~~

taller/~~taler~~

fatter/~~fater~~

hotter/~~hoter~~

Nearer/~~nearer~~

farer/~~farther~~

heavier/~~heavier~~

greater/~~greater~~

Bigger

Fatter

hotter

EXERCISE

- 1.- As copper has become *rarer* and *more expensive*, aluminium has come into use even though it has a *higher* resistance *than* copper. *Scarce – not abundant*
- 2.- In early days, people thought that the electric current flowed in *the same* way *as* water
- 3.- In Volta's cell, one of the metals is chemically *more active than* the other and gives off electrons which are attracted by *the more/the most active* metal.
- 4.- If we let the bar cool *faster than* before, we obtain a metal which is *harder* and *more easily* machineable/machined. [*easier to machine*]
- 5.- Hydrogen is one of *the lightest* elements while /whereas uranium is one of *the heaviest*.
- 6.- Electrons orbiting *further* from the nucleus are those which are *more easily* drawn away.[*easier to draw away*] – draw-drew-drawn
- 7.- In generators, *the faster* the wires move, *the greater* the generation of emf.(electromotive force)
- 8.- Thermoplastics can be reheated *as many times as* required.
- 9.- *Most* metals are alloyed to get better properties.
- 10.- Oil is *the most widely/commonly/frequently/often used* energy source (MÁS USADA).
- 11.- If the layer is *too thin*, it will not protect the metal below
- 12.- We spend *so much* energy in producing electricity that we should concentrate our efforts on other possibilities to generate it.

EXERCISE: Complete this text

Cast iron is *the least* malleable of these metals. Similarly, high carbon steels are not *very/much/highly malleable* either. However, with *less* carbon, steels become *more* malleable. Medium carbon steels are *more* malleable *than* high carbon steels. Low carbon steels have even *more* malleability. Wrought iron is *the most malleable* of these ferrous metals.

Wrought iron is also *the most* elastic of these metals. Low carbon steels are *less* elastic because they contain *more* carbon. Medium carbon steels are *less* elastic *than* low carbon steels. High carbon steels have even *less* elasticity because they have even *more* carbon in them. Cast iron has *much* carbon in it and therefore it is *the least* elastic.

The more carbon these materials contain, **the less** malleable and elastic they are. Wrought iron contains **less** carbon and it is **the most** elastic. Cast iron contains **more** carbon and it has **less** elasticity.

READING: PLASTICS AND OTHER MATERIALS

Plastics have specific properties which may make them preferable to traditional materials for certain uses. In comparison with metals, for example, plastics have both advantages and disadvantages. Metals tend to be corroded by inorganic acids whereas plastics tend to be resistant to these acids; however, they can be dissolved or deformed by solvents which have the same carbon base as the plastics. Colour must be added to the surface of metals, which have to be mixed in with plastics. Metals are more rigid than most plastics, whereas plastics are very light, with a specific gravity, contrarily to what happens to metals, which are normally good thermal and electrical conductors. Plastics soften slowly and can easily be shaped while they are soft. It is their plasticity at certain temperatures which gives plastics their main advantage over many other materials. It permits the large scale production of moulded articles, such as those involving cutting, shaping, machining, assembly and decoration.

A plastic article differs in design and appearance from a similar article made from another material such as metal or wood. This is due not only to the properties of plastics but also to the techniques employed in fabricating plastic products.

	ADVANTAGES	DISADVANTAGES
	They tend to be resistant to inorganic acids	dissolved or deformed by solvents
PLASTICS	light	
	Soften slowly, easily shaped when soft (<i>easy to shape</i>)	
	It permits the large scale production of moulded articles	
METALS	More rigid than most plastics	They tend to be corroded by inorganic acids
	good thermal and electrical conductors	

EXPRESSING COMPARISON AND CONTRAST

When **COMPARING**:

We compare X with/to Y

X, in comparison with/to Y, has the following advantages

as **regards** (size)

with **regard** to (size)

as far as (size) **is concerned** *as far as I am concerned (from my point of view)*

with **respect** to (size)

regarding (size) *very useful for the start of a new paragraph*

SIMILARITIES

as.....as X

• A is **identical TO** X

• A is **similar TO** X in (that)

• A is **the same AS** X

• A is **like** X

• A resembles X

• A, like X, is a (gas)

• A and X have (their elasticity) in common

Likely, likewise,

Similarly (to), in the same way (as),

Like

*Al. is ductile and malleable; **in the same way**, Cu. also has these properties*

similarly,

likely,

likewise,

In the same way as *Al., Cu. is a ductile and malleable metal*

Similarly to

Like

DIFFERENCES

• **COMPARATIVES** *(explained in previous parts)*

• A **differs** FROM X in (that)

• A is **different** FROM X in (that)

• The **differences** between A and X are...

• We can

differentiate
distinguish
make a distinction
tell the difference

between A and X

• A can be **distinguished** from X by....(its shape)

• A,

unlike X,
as distinct FROM X,
in contrast TO X,
as opposed TO X,

- *very useful – (a diferencia de)*

• ON (the) one hand.....,ON the other (hand).....

but/

although=though (also at the end) /

(Al)though I don't like fish, I try to have it at least once a week

I try to have fish at least once a week, (al)though I don't like it

I try to have fish at least once a week; I don't like it, though

• whereas (no time) / while (contrast and time) ***mientras que***

Iron is a pure metal whereas/while steel is an alloy

These people are using their phones while/whereas I'm speaking

- in spite of /Despite +NOUN/ -ING = **a pesar de**
In spite of/Despite its lightness, Al. is a strong metal
In spite of/Despite being light, Al. is a strong metal
- Despite **the fact that/** in spite of **the fact that** +SENTENCE **a pesar de que**
In spite of the fact that it is light, Al. is a strong metal
Despite the fact that it is light, Al. is a strong metal
Although it is light, Al. is a strong metal
[Despite it being light, Al. is a strong metal]

- Instead (of)/ **en lugar de/ en vez de**
Architects use aluminium instead of steel for window structures because it is light
Steel is too heavy for window structures, so Aluminium is used instead
Steel would be too heavy; instead, Aluminium has the right density for this application

rather (than) – expresses a preference
Aluminium is used rather than steel in window structures because it is lighter
Let's go to a party... no, I'd rather go to the cinema

- However/ /nevertheless/notwithstanding
Yet = aun así (NOT yet – aún no/todavía no)
Yet=however – Not yet=still not
I haven't studied yet. I have never been to Iceland yet
*I don't like fish at all. Yet/however, I try to have it at least once a week **aun así**=however*

- **Otherwise** (=if not)
We will have a party tomorrow. Otherwise, we will not find a date for it
We have used Aluminium in all the windows. Otherwise, they would be too heavy.

Likely, likewise,
Similarly (to), in the same way (as)

- ON the contrary, / unlikely, / - **very useful; only one word to express a diferencia de lo anterior**
/ contrarily TO *this/the examples given...*
/ BY contrast (to this/to the examples given),

EXERCISE

Complete this text about ferrous metals with the expressions mentioned above.

If we...**COMPARE**.. (*comparamos*) wrought iron and cast iron, we may find some...**SIMILARITIES**..... (*semejanzas*).. Both of them are ..**SIMILAR IN THAT**..... (*parecidos en que*) they contain iron; wrought iron, . **LIKE/IN THE SAME WAY AS**..... (*al igual que*) cast iron, is a ferrous metal..**HOWEVER**... (*Sin embargo*), **.ALTHOUGH**..... (*aunque*) they are very....**SIMILAR IN** (*similares*) their composition, we may notice some ...**DIFFERENCES**..... (*diferencias*), .

REGARDING/WITH RESPECT TO (*con respecto a*) their properties;

AS FAR AS their properties **ARE CONCERNED**

thus ,wrought iron is very malleable, **WHEREAS/WHILE** (*mientras que*) cast iron is **THE LEAST MALLEABLE** (*el menos maleable*) of all ferrous metals.. **ON THE OTHER HAND/unlikely** (*Por otra parte*), cast iron ...**DIFFERS FROM** (*se diferencia del*) wrought iron in elasticity because **WHEREAS/WHILE** (*mientras*) the former has a very poor elasticity, the latter is very elastic. The..**DIFFERENCE** (*diferencia*) between these two metals comes from the different amount of carbon content: **THE HIGHER** (*cuanto mayor*) the content of carbon, **THE LESS MALLEABLE AND ELASTIC** (*menos maleables y elásticos*) these metals are.

VIDEO: POLYMERS

Different products often require polymers **WITH DIFFERENT PROPERTIES**; often several need to be combined in the same object. This needs to be **TOUGH** and **DURABLE, FLEXIBLE ENOUGH NOT TO BREAK, RIGID ENOUGH** not to distort, **IT NEEDS TO KEEP ITS SHAPE** precisely if the quality of sound reproduction is not to decrease. It mustn't be **TOO SENSITIVE TO TEMPERATURE**, otherwise it would warp.

But so far we have only been concerned with the properties related to the end use of the product. Now **PVC IS THE MAJOR CONSTITUENT** of gramophone records and as such meets these demands very well. But often these conflict with the needs for its manufacture. The microgrooves of modern LPs **REQUIRE THAT THE MATERIAL FROM WHICH** the gramophone record is moulded to faithfully follow the **TINY** modulations of the master recording. **PVC DOES NOT HAVE** excellent flow properties. The solution to this is **TO MIX THE PVC MONOMER WITH A SMALL AMOUNT**, say **15%**, of ethanol ethanoide. This **IMPROVES** the flow properties of PVC without detriment of its other good **PROPERTIES**.

IMPROVING PROPERTIES

But, **IT'S NOT JUST THE QUESTION OF PHYSICALLY MIXING THE TWO POLYMERS**, although that is done under certain circumstances. A much more stable and radical alteration of the properties is achieved by **CHEMICAL COMBINATION**: copolymerization. But I must stress that copolymerization is just one solution to the problem but is a chemically intriguing one.

Let me show you **HOW THE PROPERTIES OF THE COPOLYMER** can be radically different to the properties of a homopolymer **MADE FROM THE SAME MONOMERS**.

The two monomers we have chosen are finallythene, that's styrene made from finallythene, and butadiene, both are products of the **PETROCHEMICAL INDUSTRY** split off from crude oil at plants like the one at Grangemouth. Styrene's **A LIQUID** and butadiene is **A GAS AT ROOM TEMPERATURE**, but on polymerization **THEIR PROPERTIES CHANGE** drastically.

The homopolymer styrene, polystyrene, is probably more familiar to you in **ITS LOW DENSITY FORM** used for ceiling tiles or packing materials.

This high density polystyrene is **TOUGH AND HARD, BRITTLE** and inextensible. This is polybutidene, it's a rather **SOFT**, gummy material, and it has to be handled between these two cellophane wrappers because it is rather **STICKY**. Clearly, these two polymers have **VERY DIFFERENT PROPERTIES**.

So, what happens if we physically mix the two together, say we mix powdered polystyrene in a polybutidene matrix? Well, we get this material; it is **SOFT** and gritty, **WITHOUT THE EXTENSIBILITY** of polybutidene and **THE STRENGTH** of polystyrene.

WOOD:

1. Where does it come from? **{trees}**.
2. It is one of the **{oldest manufacturing}** materials
3. Properties:
 - it is **{easy to cut}** and **{shape into}** a different form. E.g. Clocks
 - it can be **{strong}**. Uses: furniture and **{construction}**
4. At one time homes **{were made entirely of wood}** but now **{we also use many other construction materials}** including **{brick}** and **{concrete}**
5. it is a **{renewable}** resource. If we replant our forests and protect them from fire, we can maintain a constant **{reliable}** supply.

{METALS} are mined from the ground. **{These}** raw materials are not useful in their natural form

6. But **{iron ore}** can be changed into **{steel}** at a steel mill. USES: It is transported to foundries and factories where **{it is made into engine}** blocks, **{cars}**, **{construction}** beams, and thousands of other products.

7. **{Aluminium/alluminum}** : is also a popular **{manufacturing material}**.

8. How much does it weigh? **{One third as much as steel}** but it is very **{strong}**.

9. USES: jet **{engines}** and **{bicycles}**

10. **{Unlike}** other metals, it can be **{recycled}** Eg: **{aluminium cans}** : they can be collected, **{melted down}**, **{reshaped}** and used again. Recycling is good for the **{environment}** - because it helps to reduce **{waste}** and to conserve **{metal}**, a **{non-renewable}** material.