Irena Nikolić

ENGLISH FOR MECHANICAL ENGINEERING

Student's book

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RECENZIJA UČBENIKA ENGLISH FOR MECHANICAL ENGINEERING avtorice Irena Nikolić, univ. dipl. anglistke

Pričujoče delo zajema vsa najpomembnejša področja strojništva. Napisano je v tekočem in nevsiljivem jezikovnem in strokovnem slogu, kar daje dijakom motivacijo za učenje. Najprej je poskrbljeno za razlago osnovnih strokovnih izrazov v strojništvu. Slike in diagrami zelo natančno in na preprost in razumljiv način razlagajo tehnologijo, tehnološke procese, inovativnost, prototipe, itd., v strojništvu. Vedno je na pravem mestu in ob pravem času poskrbljeno za preverjanje znanja. Strokovni izrazi so bogati, zato je dodeljena za ta učbenik najvišja možna ocena skladnosti s sodobnimi spoznanji na področju strojništva in prav tako najvišja možna ocena na področju metodično-didaktične ustreznosti.

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UNIT 1 MATERIALS AND THEIR PROPERTIES

We take many materials around us for granted. We classify materials into two groups: **natural** and **man-made.** All materials, like metals, ceramics, plastics, glasses and other, are comprised of **chemical elements**. Materials science aims at understanding the nature and behavior of matter.

NATURAL MATERIALS

These are the materials found around us.

Wood

Wood is very useful to us. It can be cut into different shapes. It is **hard wearing**. It is **abundant**, reasonably cheap and very attractive. It is widely used for furniture, frames for doors, shelves, in construction and other.

There is a drawback to using wood. It takes many years to grow trees. **Deforestation** can cause serious climatic changes, arid land, lack of water and animals move away.

Wood is environmentally friendly, non-toxic and biodegradable.

Leather

Leather comes from animal skins. It is very useful for making hard-wearing clothes and shoes.

Oil

Crude oil is one of our most **precious resources**. It is found deep in the underground and needs to be piped out from below the Earth's surface. We depend very much on oil, oil is used to help keep the transport system moving. It is used to make petrol and it is even needed to make soap. Oil is used to make **plastics**.

Crude oil is not the only oil we use. We can get oils from plants (sunflower oil, olive oil, walnut oil). All these oils are useful to us for cooking. Most of the fractions from crude oil are burned as fuels. Only a small percentage of crude oil is used for **chemical synthesis**.

Coal

Coal is a **fossil fuel**. Coal is mined out from the underground **mines**. It is used for **power stations** to **generate electricity**.

Cotton and silk

We grow **cotton** on fields to make clothes for ourselves. **Silk** is taken from the **cocoons** of moths and spun into a very fine material for clothes.

Clay is also natural. It is used to make pottery.

MAN-MADE (SYNTHETIC) MATERIALS

We use many natural materials and by working with them we change them into **man-made substances**.
Sand is heated and made into glass. It is also used for **concrete**. The **silicon chip**, for example, inside computers is made of sand. Wood is used to make into paper. Oil is made into nylon. There are a lot more man-made substances that we use every day.

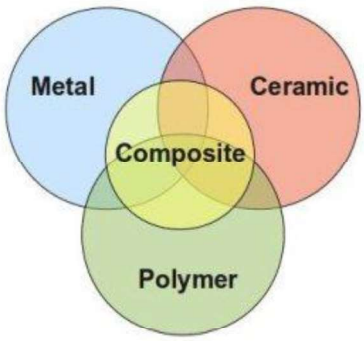
Materials can also be made of chemicals. Examples of these include plastics such as polythene. These are called **synthetic materials**.

PLASTICS (Polymerisation)

Some small molecules can join together to make very long molecules called **polymers**. This process is called polymerisation. Many polymers are made of chemicals that are obtained from crude oil.
By polymerising other small molecules, a wide variety of different polymers can be made. These synthetic materials have many uses. In a chemical reaction, the substances that react together are called the **reactants**, while the substances that are formed are called the **products**.

ENGINEERING MATERIALS

Materials that are used as raw material for any sort of **construction** or **manufacturing** in an organized way of **engineering application** are known as engineering materials. Engineering materials are classified into the following broad groups:



Elements in the periodic table are classified as either **metals** or **non-metals** and **metaloids**, based on their properties.

PROPERTIES OF OTHER MATERIALS

CERAMICS

Ceramics is made by heating together materials such as **silica, chalk and clays**. Engineering ceramics is wear resistant, hard, stiff and corrosion resistant and has a relatively high mechanical strength at high temperatures. They are good **electrical insulators.** Ceramics has been regarded as **hard but**

brittle, however, modern ceramics has been developed which are viable alternatives to metals and their alloys. Engineering ceramics is chemically resistant to most **acids, alkalis** and **organic solvents** and can withstand high temperatures.

COMPOSITES

They are mixtures of materials which give improved properties. One of the materials is the matrix or binding chemical and the other is the reinforcer. **Concrete** is a composite (**cemen**t is the matrix and the **gravel and steel rods** are the reinforcer) as are bricks made of **clay reinforced with straw**. Natural composites include **wood, shell and bone**. Composites are used in car bodies, especially sports cars, boat hulls and supports in bridge building and the construction industry. In aerospace, the use of carbon fibre composites as well as high tech ceramic parts has revolutionised this industry.

WOOD

Timber is one of the most **environmentally friendly materials** available. It is **renewable, biodegradable, non-toxic, energy efficient and greenhouse gas friendly**. All other major construction materials are finite and one day they may run out. Trees can be cut down and **replanted.** Timber can be **recycled** and when it reaches the end of its life **it can be disposed of with minimal impact to the environment because of its non-toxic nature.** Timber is one of the best **insulation materials**. That makes it an excellent material for use in construction to reduce energy bills for both households and business. Trees are usually divided into two broad groups: hard wood and soft wood.

GLASS

Glass is a hard material normally fragile and transparent common in our daily life. It is composed mainly of **sand** (silicates) and an alkali. These materials melt at high temperature, fuse together and then they are cooled rapidly forming a rigid structure not having enough time to form a crystalline regular structure.

These are the common ingredients to obtain glass: sand, soda ash, limestone or dolomite.

The main properties of glass:
- solid and hard,
- fragile and breakable into sharp pieces,
- transparent to visible light,
- recyclable.

Glass does not deteriorate, corrode, stain or fade and therefore is one of the safest packaging materials.

Task 1. Find the right answer. Useful chemicals from crude oil.

1. Which of these is a synthetic material? ***cotton - nylon- silk***
2. Most of the molecules in crude oil are: ***carbohydrates –hydroxides- hydrocarbons***
3. Most of the fractions from crude oil are used as: ***fuels -lubricants -raw materials***
4. Joining small molecules to make long chains is called: ***photosynthesis- oxidation- polymerisation***

5. The number of atoms of each element in the reactants is: ***less than the number of atoms in the product -the same as the number of atoms in the product- more than the number of atoms in the product***

6. Why is PVC a better material for window frames than wood***? more durable -more expensive - denser***

Task 2. Look at the pictures and decide what material is used.



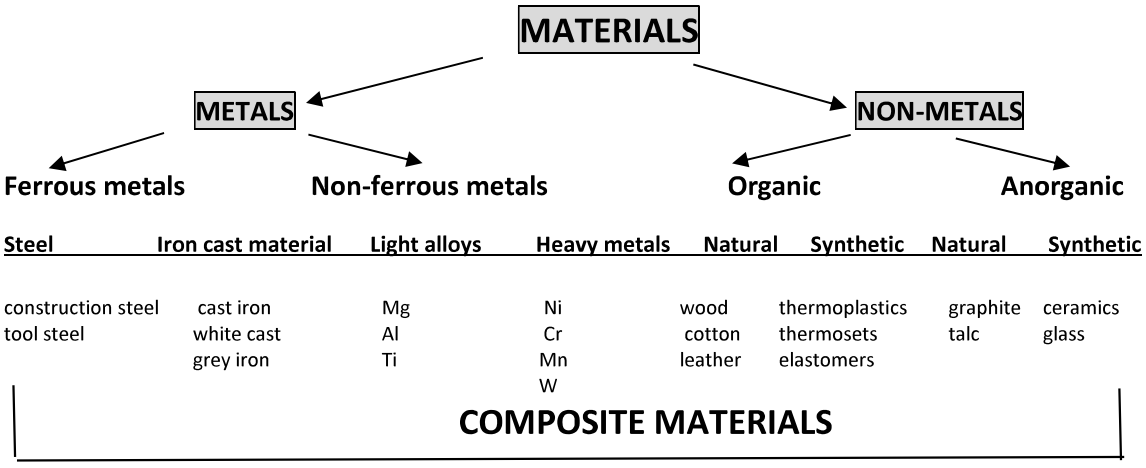





Task 3. Complete the exercise. MATERIALS TESTING

Materials are tested in order _____ find out their properties and _____ optimal application. The most often _____ of testing is mechanical and technological.
Mechanical testing is performed to test strength (tensile, pressure, bending) _____ hardness (by Brinell, for example). Technological testing is performed _____ wires (bending, deep drawing, for example). Tests are performed according to the temperature: room temperature, higher temperatue and lower temperature. According to the way of loading we can _____ between the static and dynamic loads.

Task 4. Look at the materials chart and discuss it in the class.



UNIT 2 METALS

Metals are opaque, lustrous elements that are good conductors of heat and electricity. Most metals are malleable and ductile and are, in general, denser than the other elemental substances. Metals are used in:

1. transportation : cars, buses, trucks, trains, ships, and airplanes,
2. aerospace : unmanned and manned rockets and the space shuttle,
3. computers and other electronic devices that require conductors (tv, radio, stereo, calculators, security devices, etc.),
4. communications including satellites that depend on a tough but light metal shell,
5. food processing and preservation : microwave and conventional ovens and refrigerators and freezers,
6. construction : nails in conventional lumber construction and structural steel in other buildings,
7. biomedical applications : as artificial replacement for joints and other prostheses,
8. power generation and distribution : boilers, turbines, generators, transformers, power lines, nuclear reactors, oil wells and pipelines,
9. farming : tractors, combines, planters, etc.,
10. household conveniences : ovens, dish and clothes washers, vacuum cleaners, blenders, pumps, lawn mowers and trimmers, plumbing, water heaters, heating/cooling and other.

CLASSIFICATION OF METALS

Metals are classified as:
- **ferrous metals** which contain iron (chemical symbol Fe). Some examples of ferrous metals are pig iron, cast ingots and steels.
- **non - ferrous metals** which do not contain iron, but other metals. Some of the examples of non-ferrous metals are aluminium, copper, lead, magnesium, chromium, tungsten and their alloys.

PROPERTIES OF METALS

Metals have physical, chemical and technological properties.
The **physical properties** of metals are **physical state (**solid except mercury**), tensile strength, high melting** and **boiling points, thermal** and **electrical conductivity, toughness**, **hardness, ductility, elasticity, plasticity**, **density, lustre**.

Chemically, the metals form **positive ions** and basic oxides and hydroxides. Upon exposure to moist air, a great many undergo **corrosion**, for example, **iron rusts** when exposed to moist air. The oxygen of the atmosphere unites with the metal to form the **oxide** of the metal. Aluminium and zinc do not appear to be affected. Tin, lead, and copper react slowly under ordinary conditions.

Technological properties are those properties that apply during manufacturing and forming processes using metal. These properties can also be said to be mechanical properties. Hence, the technological properties of metals are: **malleability**, **machinability**, **weldability**, **castability** and **ductility**.

Task 1. Explanations of properties of metals. Match the words with the definitions.

1. melting point	the resistance of a material to a force tending to tear it apart, measured as the maximum tension the material can withstand without tearing
2. conductivity	capable of being shaped or formed, as by hammering or pressure
3. malleability	the ability or power to conduct or transmit heat, electricity, or sound
4. tensile strength	the temperature at which a solid becomes a liquid at a fixed pressure
5. elasticity	easily drawn into wire or hammered thin
6. density	the property of returning to an initial form or state following deformation
7. lustre	the state or quality of shining by reflecting light
8. ductility	the mass per unit volume of a substance under specified conditions of pressure and temperature

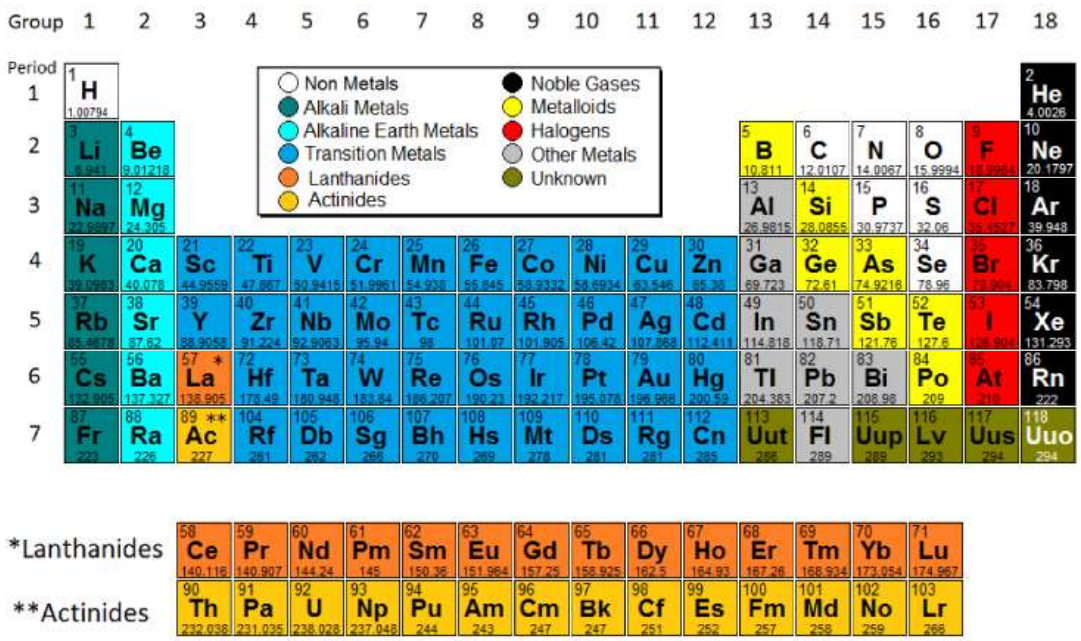
NON-METALS

Non-metals are not lustrous, they have dull appearance and are poor conductors of heat and electricity, non-ductile and brittle solids. They may be solids, liquids or gases at room temperature, they can be transparent as a thin sheets and not sonorous. They also form acidic oxides. The non-metal elements occupy the upper righthand corner of the periodic table. The non-metal element group consists of hydrogen, carbon, nitrogen, oxygen, phosphorus, sulphur and selenium. Hydrogen acts as a non-metal at normal temperatures and pressure and is generally accepted to be part of the non-metal group.

METALLOIDS

The elements that border the stair-stepped line are classified as metalloids or **semi-metals**, have properties that are somewhat of a cross between metals and non-metals. Metalloids tend to be economically important because of their unique **conductivity properties** (they only partially conduct electricity), which make them valuable in the **semi-conductor** and **computer chip** industry. A well-known examples are **silicon** and **germanium**.

Task 2. Look at the periodic table and find the group of metals, non-metals and metalloids. Give examples.



BASE AND PRECIOUS METALS

A **base metal** is a common and inexpensive metal, as opposed to a **precious metal** (or noble metal) such as gold or silver. A base metal may be distinguished by oxidizing or corroding relatively easily and reacting variably with diluted hydrochloric acid (HCl) to form hydrogen.

Examples include iron, nickel, lead and zinc. Copper is also considered a base metal because it oxidizes relatively easily, although it does not react with HCl.

A **precious metal** is a rare, naturally occurring metallic chemical element of high economic value. Chemically, the precious metals tend to be less reactive than most elements. They are usually ductile and have a high lustre. **Gold, silver, platinum,** and **palladium** are the examples of the group.

Task 3. Find the words.

P	C	A	P	P	M	E	T	H	A	N	E	N	N
I	A	O	R	E	M	D	R	P	L	F	I	C	I
R	R	X	O	R	U	I	A	S	R	T	O	D	T
O	B	Y	P	E	I	X	T	E	R	P	A	I	R
N	O	G	A	V	L	O	O	I	P	E	C	C	O
E	N	E	N	L	E	N	C	E	L	M	A	M	G
G	D	N	E	I	H	O	R	R	M	U	M	U	E
O	I	I	D	S	X	M	B	B	E	I	U	I	N
R	O	C	O	I	L	N	A	R	R	N	N	N	B
D	X	K	D	R	E	O	D	O	C	A	I	I	R
Y	I	E	T	D	E	B	L	N	U	T	T	M	A
H	D	L	I	W	T	R	O	Z	R	I	A	U	S
N	E	O	N	O	S	A	G	E	Y	T	L	L	S
B	U	T	A	N	E	C	N	I	Z	O	P	A	D

METALS: steel - brass - gold - iron - zinc - lead - aluminium - tin - platinum - titanium - mercury - silver - copper - nickel - bronze
GASES: carbon monoxide - carbon dioxide - nitric oxide - nitrogen - freon -methane propane - butane - helium - oxygen - neon - hydrogen

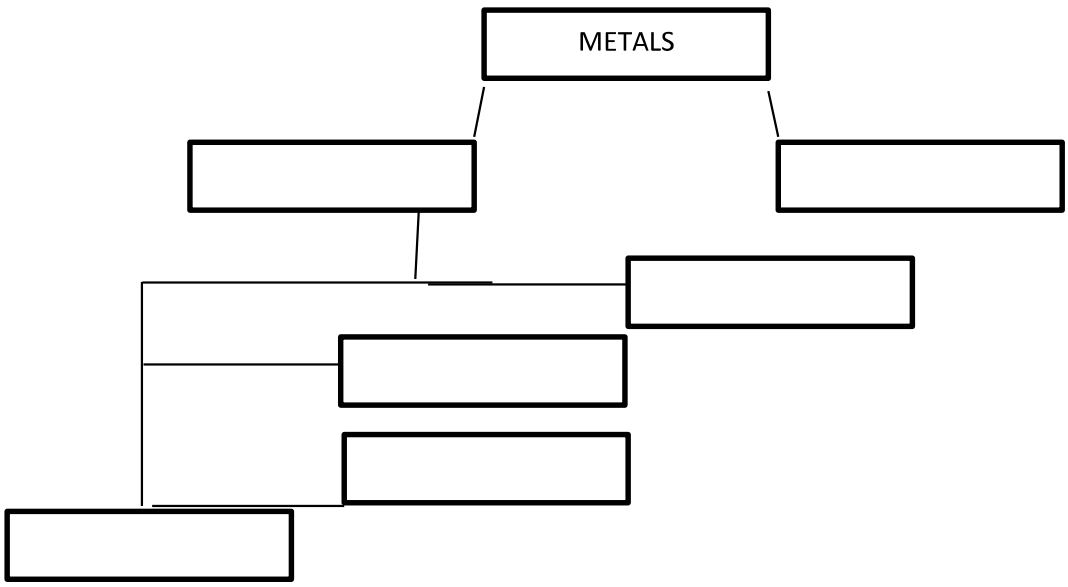
Task 4. Find the right metal.

1. a generally hard, strong, durable, malleable alloy of iron and carbon S _ _ _ _
2. a silvery-white, lustrous, malleable, ductile, magnetic element, symbol Fe I _ _ _
3. a soft, malleable, ductile, bluish-white, dense metallic element, symbol Pb L _ _ _
4. a silvery metallic element, symbol Sn T _ _
5. a ductile, malleable, reddish-brown metallic element, symbol Cu C _ _ _ _ _
6. a silvery-white poisonous liquid metallic element, symbol Hg M _ _ _ _ _ _

Task 5. Complete the text. What is "*heavy metal poisoning*"? Insert the words: *sick -environment – heavy - group- poisoning – chemical – found – our - products – sources –*

There are many heavy metals in our _____ both naturally and from pollution. The term "heavy metal" applies to a _____ of metals with similar _____properties. Some of these, including copper, iron and zinc, play important roles in _____ bodies. Others have no known benefit for health. Examples of these are lead, which is found in paint in old homes as well as many other _____, arsenic, which can be found in well water and wood products, and mercury, which can build up in fish that we eat. At very high levels, most _____ metals can cause health problems. People may be exposed to small amounts of heavy metals through food, water, air, and commercial _____. People can also be exposed in their workplace, as several industries use or produce these metals. Each metal is different in where it is _____ and how it behaves in our bodies. Exposure alone does not mean that it is causing any disease or harm. The symptoms of chronic heavy metal _____ can be severe, but are often less obvious and develop much more slowly over time than the symptoms caused by acute exposure. People feel very _____, vomit, they have high temperature, sweat, also with high anemia. People tend to be pale.

Task 6. Complete the classification of metals.



Task 7. Now, discuss the classification of metals according to the table above.

Task 8. Translate the bold type vocabulary from the text into your language.

Task 9. Metals and alloys test.

1. **Why can copper be extracted by heating copper ore with carbon?**
A. Copper is more reactive than carbon.
B. Copper is purified using electricity.
C. Copper is less reactive than carbon.
2. **What is the cathode (negative electrode) made of when copper is purified by electrolysis?**
a. impure copper b. pure copper c. graphite
3. Copper and zinc make an alloy called A. solder B. amalgam C. brass
4. Why are alloys likely to be harder than pure metals?
A. Because layers of atoms can slide over each other easily.
B. Because layers of atoms cannot slide over each other easily.
C. Because their atoms are denser and harder than those of pure metals.
5. **Nitinol is a smart alloy made of nickel and titanium. What is its key property?**
A. After bending, it returns to its original shape when magnetised or electricity is passed through it.
B. After bending, it returns to its original shape when cooled down.
C. After bending, it returns to its original shape when heated or electricity is passed through it.
6. Rust is formed from iron and which other element? hydrogen - nitrogen - oxygen - sulphur
7. Which of these metals is a liquid at room temperature? beryllium -lithium -mercury -osmium
8. Which of the metals can be found in a pure state in nature? lithium -iron -gold -aluminium
9. In its simplest form, bronze is an alloy of copper and tin - copper and zinc
- copper, zinc, and nickel -copper, tin, and lead
10. The ability of a metal to be drawn into wire is a measure of ductility - hardness - malleability - strength
11. Metals are generally good thermal and electrical conductors. True - False
12. Most metals have A. high electronegativities B. low electronegativities C. small atomic radii D. high ionization energies
13. Metals which burn on exposure to air are best stored under water - under alcohol - under vinegar - under kerosene
14. Galvanized metals are covered with a thin sheet of chromium - copper - tin - zinc
15. The metals having the largest atomic radii within their period of the Periodic Table are the alkali metals - alkaline earth metals - rare earth metals - transition metals

Writing. Try to revise the topic in your own words.

UNIT 3 ALLOYS

The best way to think of an alloy is as a material that is made up of at least two different chemical elements, one of which is a metal. The most important metallic component of an alloy (often representing 90 percent or more of the material) is called the main metal, the **parent metal**, or the **base metal**. The other components of an alloy (which are called **alloying agents**) can be either

metals or non-metals and they are present in much smaller quantities (sometimes less than one percent of the total). An alloy can sometimes be a **compound** (the elements it is made of are **chemically bonded** together). It is usually a **solid solution**. People make and use alloys because metals do not have exactly the right properties for a particular job.

STEEL

Strictly speaking, steel is just another type of **iron alloy**, but it has a much lower carbon content than cast and wrought iron and other metals are often added to give it extra properties. Steels fall into the following groups: **carbon steels, alloy steels, tool steels, stainless steels** and **high-speed steels**.

CARBON STEEL

Carbon steel is just basic, ordinary steel. Steels with about 1–2 percent carbon are called **carbon steels** and they tend to be hard and brittle. Steels with less than one percent carbon are known as **low-carbon steels** and like wrought iron, are softer and easier to shape. A lot of everyday items are made of carbon steels, from car bodies and warship hulls to steel cans and engine parts.

ALLOY STEEL

As well as iron and carbon, alloy steels contain one or more other elements, such as **chromium, copper, manganese, nickel, silicon,** or **vanadium.** In alloy steels, these extra elements make the difference and provide some important additional feature or improved property compared to ordinary carbon steels. Alloy steels are generally stronger, harder, tougher, and more durable than carbon steels.

TOOL STEEL

Tool steels are especially **hard alloy steels** used to make tools, dies, and machine parts. They are made of iron and carbon with added elements such as **nickel, molybdenum,** or **tungsten** to give extra hardness and **resistance to wear**. Tool steels are also toughened up by a process called **tempering**, in which steel is first heated to a high temperature, then cooled very quickly, then heated again to a lower temperature.

STAINLESS STEEL

The steel you probably see most often is stainless steel—used in household cutlery, scissors, and medical instruments. Stainless steels contain a high proportion of **chromium** and **nickel**, are very resistant to corrosion and other chemical reactions, and are easy to clean, polish, and sterilize.

HIGH-SPEED STEEL

High-speed steel is an alloy of steel which may consists of either of the following metals: **tungsten, cobalt, molybdenum or chromium.** High-speed steel is probably the toughest of all the types. The term high speed is given to it due to the fact that it has the ability to cut the metals. And that is the reason it is used in the making of drills and tools and power saws. The hardness and rigidity of high-speed steel depends on the metal used in the making of the alloy and its percentage of composition in it. Basically, this steel is used in the making of **machine tools** to cut other metals.

There are some other types of steels like: