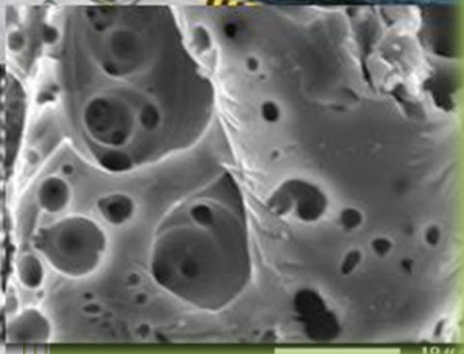
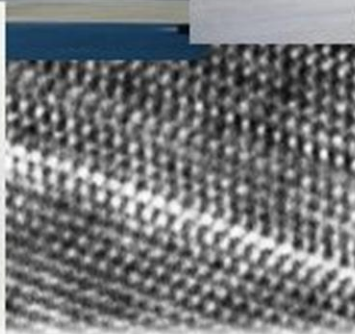


Strojništvo

Materiali



Simona Vincelj



Strojništvo

Materiali – M1



POVZETEK

Gradivo opisuje materiale in njihove lastnosti. Predstavljeni so začetki obdelovanja materialov in postopki, ki jih pri oblikovanju uporabljamo danes. Gradivo predstavi delitev materialov v kovine in nekovine, njihove splošne lastnosti in opis tistih, ki se uporabljajo najpogosteje. Podrobneje so predstavljeni različni načini in postopki oblikovanja in združevanja.

V slovnичnem delu so predstavljeni členi v angleščini (a, an, the) in njihova uporaba ter stopnjevanje pridevnikov.

Gradivo opisuje tudi materiale in tehnologijo prihodnosti in dopušča uporabo domišljije.

Ključne besede: materials, metals, non-metals, malleability, ductility, brittleness, plasticity, elasticity, toughness, hardness, strength, plain carbon steel, cast iron, iron, ferrous metals, alloy steels, non-ferrous metals, aluminium, alloys, copper, titanium, polymers, ceramics, composite materials, shaping, casting, forging, sheet metal forming, material removal processes, smart materials.

Avtorica: Simona Vincelj

Recenzent: Tjaša Ogrizek

Lektorica: Simona Tadeja Ribič

Datum: junij 2012

CIP –



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PROPERTIES OF MATERIALS (Lastnosti materialov)



Odgovorite na spodnja vprašanja.

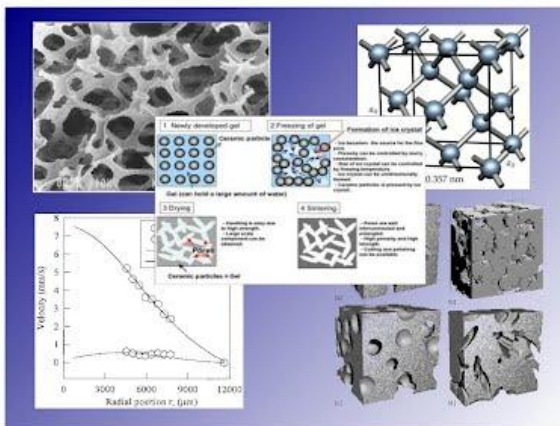
- Can you mention some of the properties which characterise each material?
- Do you know the difference between mechanical and electrical properties of materials?
- Name some of the chemical properties of materials.



Mechanical properties of materials (Mehanske lastnosti materialov)

When studying materials and especially when selecting materials for a project / design, it is important to consider their properties, which can be classified in 4 groups:

- mechanical** (strength, hardness, toughness, elasticity, plasticity, brittleness, ductility and malleability)
- thermal** (conductivity, expansion, melting point)
- electrical** (conductivity, magnetism, resistivity)
- chemical** (atomic volume, density, corrosion, resistance, flammability)



Slika 1: Lastnosti materialov.

Vir: <http://www.induceric.com> (24.6.2012)

Strength, hardness, toughness, elasticity, plasticity, brittleness, ductility and malleability are **mechanical properties** used as measurements of how materials behave under a load. These properties are described in terms of the types of force or stress that the metal must withstand.

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Mechanical Properties of Metal / Alloys

<u>TOUGHNESS</u>	<u>BRITTLENESS</u>	<u>DUCTILITY</u>	<u>MALLEABILITY</u>	<u>CORROSION RESISTANCE</u>
Copper	White Cast Iron	Gold	Gold	Gold
Nickel	Gray Cast Iron	Silver	Silver	Platinum
Iron	Hardened Steel	Platinum	Aluminum	Silver
Magnesium	Bismuth	Iron	Copper	Mercury
Zinc	Manganese	Nickel	Tin	Copper
Aluminum	Bronzes	Copper	Lead	Lead
Lead	Aluminum	Aluminum	Zinc	Tin
Tin	Brass	Tungsten	Iron	Nickel
Cobalt	Structural Steels	Zinc		Iron
Bismuth	Zinc	Tin		Zinc
	Monel	Lead		Magnesium
	Tin			Aluminum
	Copper			
	Iron			

* Metals/alloys are ranked in descending order of having the property named in the column heading

Slika 2: Mehanske lastnosti kovin in zlitin. Vir: <http://www.tpub.com/steelworker1/2.htm> (24.6.2012)

Common types of stress are **compression, tension, shear, torsion, bending** and **impact**, or a combination of these stresses, such as **fatigue**.

- Compression stresses develop within a material when forces compress or crush the material.
- Tension (or tensile) stresses develop when a material is subject to a pulling load.
- Shearing stresses occur within a material when external forces are applied along parallel lines in opposite directions.
- Torsion stress occurs when a material is subject to a twisting force.
- Bending stress develops when it is subject to a combination of tension and compression loads.
- Impact stress occurs when a material is under a force applied gradually and maintained over a long period.
- Fatigues is often measured in mechanical structures and is referred to as the ability to resist repeated cycles of combined stresses such as tension and bending.

Strength

Strength is the property that enables a metal to resist deformation under load without breaking, bending, shattering or deforming.

- Tensile strength is a measurement of the resistance to being pulled apart when placed in a tension load.

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- Fatigue strength is the ability of material to resist various kinds of rapidly changing stresses.
- Impact strength is the ability of a metal to resist suddenly applied loads.

Hardness

Hardness is the property of a material to resist permanent indentation. Because there are several methods of measuring hardness, the hardness of a material is always specified in terms of the particular test that was used to measure this property.

Toughness

Toughness is the property that enables a material to withstand shock and to be deformed without rupturing. Toughness may be considered as a combination of strength and plasticity.

Elasticity

When a material has a load applied to it, the load causes the material to deform. Elasticity is the ability of a material to return to its original shape after the load is removed. Theoretically, the elastic limit of a material is the limit to which a material can be loaded and still recover its original shape after the load is removed.

Plasticity

Plasticity is the ability of a material to deform permanently without breaking or rupturing. This property is the opposite of strength. By careful alloying of metals, the combination of plasticity and strength is used to manufacture large structural members. For example, should a member of a bridge structure become overloaded, plasticity allows the overloaded member to flow allowing the distribution of the load to other parts of the bridge structure.

Brittleness

Brittleness is the opposite of the property of plasticity. A brittle metal is one that breaks or shatters before it deforms. White cast iron and glass are good examples of brittle material. Generally, brittle metals are high in compressive strength but low in tensile strength.

Ductility

Ductility is the property that enables a material to stretch, bend, or twist without cracking or breaking. This property makes it possible for a material to be drawn out into a thin wire.

Malleability

Malleability is the property that enables a material to deform by compressive forces without developing defects. A malleable material is one that can be stamped, hammered, forged, pressed, or rolled into thin sheets.

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VAJE

1 V besedilu poiščite angleške izraze za naslednje slovenske besede.

- a. trdota
- b. odpornost
- c. krhkost
- d. trdnost
- e. obnašanje
- f. utrujenost
- g. rezanje
- h. sposobnost deformacije

2 V besedilu poiščite slovenske izraze za naslednje angleške besede.

- a. load
- b. bend
- c. crush
- d. sheet
- e. twist
- f. shatter
- g. flex
- h. shape

3 Izberite pravilno rešitev

1 Compression stresses develop when a material is subject to

- a. a pulling load.
- b. a crushing force.
- c. sliding forces.

2 A hard material

- a. doesn't resist scratching.
- b. is affected by penetration.
- c. resists surface abrasion.

- 3 A tough material
 - a. withstands shocks.
 - b. easily brakes.
 - c. can easily bend.

- 4 A brittle metal
 - a. deforms without breaking
 - b. breaks before it deforms
 - c. bends without cracking

- 5 Strength is
 - a. the property of metal to resist deformation.
 - b. the ability of material to resist abrasion.
 - c. the property of material to deform without breaking.



LOAD and STRESS

A load is an external force acting on a body.

A stress is an internal force in a body that resists the tendency of an external force to change its shape.

4 Odgovorite na spodnja vprašanja

- a. What are the most common types of stress?

- b. What kind of properties do solid materials have?

- c. What is fatigue strength?

- d. What does plasticity refer to?

- e. What is the difference between hardness and toughness?

- f. What kind of property is ductility?

- g. When can you say that a material is brittle?

- h. What are the properties of a malleable material?



METALS (Kovine)



1. Odgovorite na spodnja vprašanja.

- What do you know about materials and different types of materials?
- What are the most common metals?
- What metals are largely employed in engineering?
- What is an alloy?



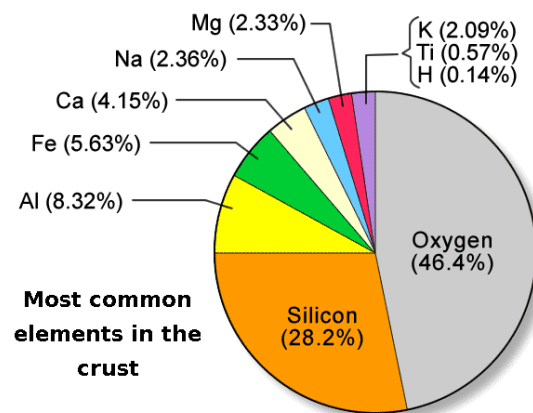
Metals: general characteristics – Splošne lastnosti kovin

2. V slovarju poiščite pomen spodnjih besed in dopolnite besedilo.

non-ferrous • semi-metals • high • substances • consisting • properties • defined • mixed • carry out • malleable • classified • employed • ores • conductors • components

Natural elements are usually _____ into four main groups: metals, non-metals, noble gases and _____. Metals and non-metals (plastic, ceramics) are the engineering materials mostly _____ in the manufacturing of finished products and mechanical engineers are expected to have a complete knowledge of their _____ and processing methods in order to choose the best solution for the task they have to _____.

As regards the metallic elements, they form less than 25% of the Earth's crust: aluminium, iron, calcium, sodium, potassium and magnesium are the most common ones. The majority are extracted from their _____ and are in combination _____ with other _____, such as carbonates, sulphides, oxides, while only a few metals (silver, platinum, gold and copper) can be found free in nature.



Slika 3: Zemeljska skorja.

Vir: <http://www.suu.edu/faculty> (25.6.2012)

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The properties of metal vary greatly but, in general, they can be _____ as hard, strong, _____, ductile, or fusible materials. They are good _____ of heat and electricity; they have high density as well as _____ melting points.

From the chemical point of view, metals are classified as “pure metals” and “alloys”. The former are metals _____ of one type of atom (e.g. aluminium, copper), while the latter are metallic substances consisting of two or more different types of atoms. In other words, alloys are compounds made up of two or even more _____ at least



one of which is a metal: bronze and brass are alloys consisting of two metals (copper + tin; copper + zinc), while steel is an alloy consisting of a metal and a non-metal (iron + carbon).

In industry, metals are often _____ together to form alloys and improve their original properties, and are usually classified as either “ferrous” or “_____”, according to whether they contain iron or not.

Slika 4: Meteoroid.

Vir: <http://astro.wsu.edu/worthey/astro/html/im-meteor/classif.html> (25.6.2012)

3. Ponovno preberite besedilo in odgovorite na vprašanja.

a. How are natural elements usually grouped?

b. Which are the most widely used engineering materials?

c. What are the main properties of metals?

d. What do “pure metals” consist of?

e. What are alloys? What do they consist of?

f. How are metals classified in industry?

Učno gradivo je nastalo v okviru projekta Munus 2. Njegovo izdajo je omogočilo sofinanciranje Evropskega socialnega sklada Evropske unije in Ministrstva za šolstvo in šport.



Ferrous metals (Magnetne kovine)

The term 'ferrous' comes from a Latin word *ferrum*, meaning 'containing iron'. Hence, ferrous metals are all those metals that contain iron. Ferrous metals may contain small amounts of other elements such as carbon or nickel, in a specific proportion, that are added to achieve the desired properties. All the ferrous metals are generally magnetic and have high tensile strength.

Iron

Silvery and magnetic, iron has limited applications in its pure form. It is therefore mixed with carbon and other elements to improve its original characteristics and form widely-used alloys.

Cast iron



Hard but brittle, neither malleable nor ductile, cast iron contains from 2% to 4% carbon. It is widely used for low-stress components and greatly appreciated for its low cost. It varies a lot according to the form of carbon it contains and it is usually classified as “white iron” or “grey iron”. “Ductile iron” is a new variety of grey iron, very tough and strong.

Slika 5: Izdelek iz litega železa.

Vir: <http://metallurgyfordummies.com/cast-iron/> (26.6.2012)

Plain carbon steel

These are metal alloys usually classified as “mild steel”, “medium carbon steel” or “high carbon steel”, according to the quantity of carbon they contain. As the percentage of carbon increases, steel becomes harder, stronger, less ductile and more difficult to weld, while the melting-point and the resistance to temperature decrease.



Slika 6: Proizvodnja jekla. Vir: <http://www.springsteel-strip.com/annealedspringsteelstrip.html> (26.6.2012)

Učno gradivo je nastalo v okviru projekta Munus 2. Njegovo izdajo je omogočilo sofinanciranje Evropskega socialnega sklada Evropske unije in Ministrstva za šolstvo in šport.

Alloy steels

Alloy steels contain carbon and alloying elements improving their properties. Stainless steels and tool steels are the most widely known types: chromium and nickel are added to the former in order to increase durability and resistance to rust or corrosion. The latter contain tungsten, molybdenum and other alloying elements which give them very high strength, hardness and wear resistance.

High-strength low-alloy steels

HSLA steels are cheaper than regular alloy steels because they contain smaller amounts of the alloying elements; furthermore, they are also stronger and lighter.



VAJE

1. Ugotovite ali so spodnje trditve pravilne (T) ali napačne (F).

	T	F
a. Pure iron finds few applications.	—	—
b. Iron's characteristics cannot be improved.	—	—
c. Cast iron is relatively cheap.	—	—
d. The form of carbon is important in cast iron.	—	—
e. Plain carbon steels consist mainly of carbon and iron.	—	—
f. The carbon content affects the properties of the alloys.	—	—
g. The higher the carbon content, the stronger the steel.	—	—
h. High carbon steels are very ductile and easy to weld.	—	—

2. Smiselno povežite dele stavkov.

a. Tungsten is added	___ 1. to resist corrosion.
b. When resistance to corrosion is needed	___ 2. alloy steels are not cheap.
c. Steel has different classifications	___ 3. according to the carbon content.
d. Chromium is added	___ 4. HSLA steels often replace alloy steels.
e. Because of the alloying elements	___ 5. to improve hardness.
f. Exceptionally light, strong and rather convenient,	___ 6. stainless steels are employed.

3. Odgovorite na vprašanja.

a. What do alloy steels consist of?

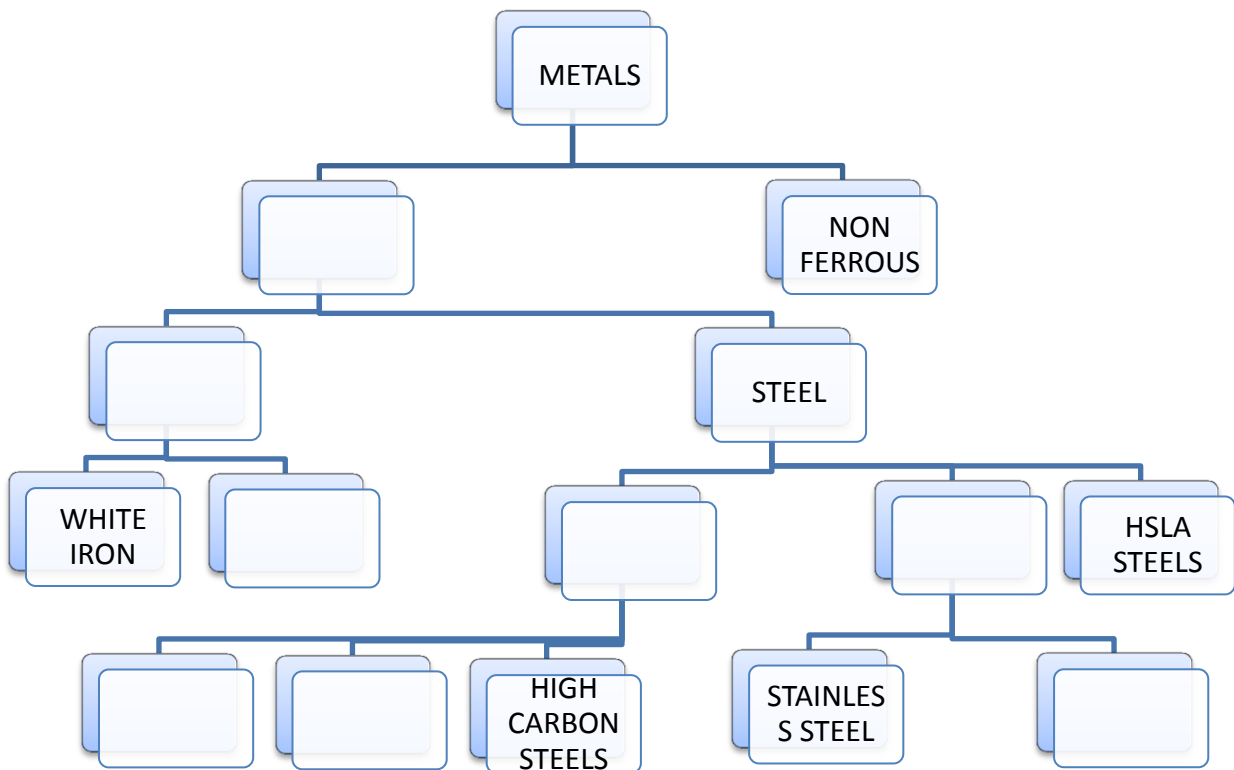
b. What are stainless steels used for?

c. Which properties do tungsten, molybdenum, chromium and nickel improve?

d. Why are tool steels employed for wear-intensive machinery?

e. Which advantages do HSLA steels offer?

4. Dopolnite spodnji diagram, glede na to, kar ste prebrali o kovinah.





Non-ferrous metals (Nemagnetne kovine)

In metallurgy, a non-ferrous metal is a metal that is not ferrous, that is, any metal, including alloys, that does not contain iron in appreciable amounts. Generally more expensive than ferrous metals, non-ferrous metals are used because of desirable properties such as low weight (e.g., aluminium), higher conductivity (e.g., copper), non-magnetic property or resistance to corrosion (e.g., zinc). Some non-ferrous materials are also used in the iron and steel industries. For example, bauxite is used as flux for blast furnaces, while others such as wolframite, pyrolusite and chromite are used in making ferrous alloys.

Important non-ferrous metals include aluminium, copper and the alloys brass, lead, nickel, tin, titanium, and zinc. Precious metals such as gold, silver and platinum are also classified as non-ferrous. Exotic or rare metals such as cobalt, mercury, tungsten, arsenic, beryllium, bismuth, cerium, cadmium, niobium, indium, gallium, germanium, lithium, selenium, tantalum, tellurium, vanadium, and zirconium are also non-ferrous. They are usually obtained through minerals such as sulfides, carbonates, and silicates. Non-ferrous metals are usually refined through electrolysis.

Izpišite vse omenjene nemagnetne kovine in poiščite slovenski pomen besed v slovarju.

angleško	slovensko

angleško	slovensko

Aluminium and its alloys

Obtained from bauxite, aluminium is the third most abundant element on Earth and combines easily with oxygen and other common elements in nature. It has many industrial applications because it is hard, strong and light, easily machinable and resistant to corrosion. An excellent conductor of heat and electricity, it is easily recyclable and non-toxic: it is used in the aerospace, shipbuilding, food processing industries, in medical and chemical equipment and many other fields. Aluminium alloys are even stronger and lighter and can undergo almost all the metalwork processes.



Slika 7: Aluminij. Vir:
<http://ralf2006.en.busytrade.com/products/info/>
 (26.6.2012)

Copper and its alloys

Reddish, ductile, a good conductor of electricity and heat, copper strongly resists corrosion and is useful for both ornamental and practical applications. It is commercially produced mainly to supply the electrical industries, to make water pipes and to form technologically important alloys such as brasses (copper + zinc), bronzes (copper + tin) and cupro-nickels (copper + nickel). These alloys are much stronger, harder and tougher than copper itself.

Titanium and its alloys



Titanium and its alloys are light, very strong with extremely high corrosion resistance, a high melting point and good creep resistance. They are suitable for aerospace applications, food processing, chemical and bio-engineering applications, surgical and dental implants.

Slika 8: Izdelki iz titana.
 Vir: <http://www.tradekey.com> (26.6.2012)



VAJE

1. Smiselno povežite dele stavkov.

- | | |
|-------------------------|---------------------------------------|
| a. Aluminium usually | ___ 1. a wide range of applications. |
| b. Bauxite is | ___ 2. occurs in compounds.. |
| c. Aluminium alloys are | ___ 3. the most common aluminium ore. |
| d. Aluminium alloys fin | ___ 4. very strong and light. |

2. V besedilu poiščite sopomenke za naslednje izraze.

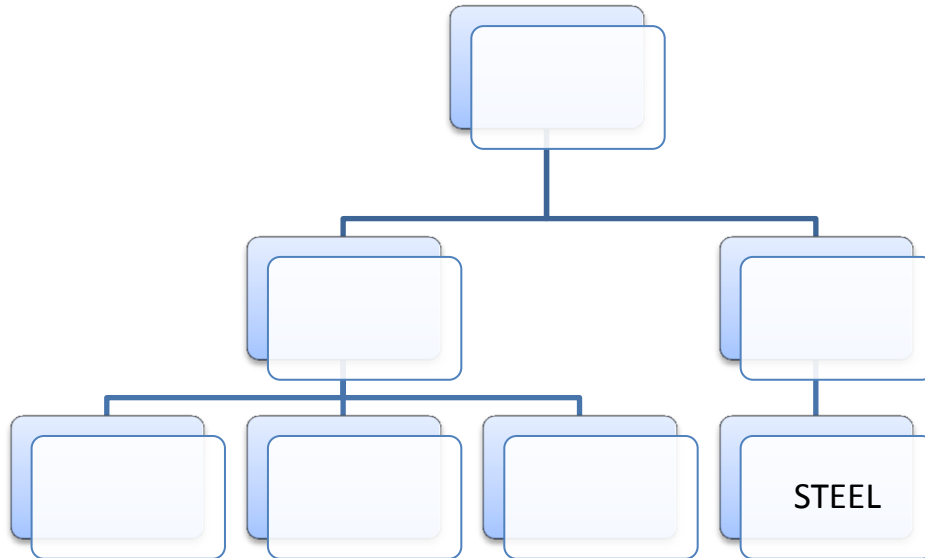
- a. more than enough
- b. mixes together
- c. recovered
- d. can be used again

3. Dopolnite razpredelnico z manjkajočimi podatki.

NON-FEROUS METALS	PROPERTIES	USES
ALUMINIUM		<ul style="list-style-type: none"> - mixed with other metals to form alloys; - aircraft, shipbuilding industry; - food processing industry; - chemical-medical equipment;
	<ul style="list-style-type: none"> - reddish, ductile, malleable; - good conductor of heat and electricity; - highly resistant to corrosion 	
		<ul style="list-style-type: none"> - food-processing industries - chemical and bio-engineering applications - surgical implants

4. Doplnite diagram s spodnjimi besedami.

copper-based metals • ferrous metals • titanium-based metals • metals
• aluminium-based metals • non-ferrous metals





Grammar spot: The article (člen)

V angleščini pred večino samostalnikov stojijo določni ali nedoločni členi.

Definite article (določni člen): "THE"

Uporabljamo ga za vse tri spole, za samostalnike v ednini in množini.

Uporabljamo ga:

- ko govorimo o ljudeh oz. stvareh, ki so našemu sogovorniku že poznani/poznane, torej se zaveda natančno koga/kaj mislimo, čeprav jih v tem trenutnem pogovoru še nismo omenili

Kje je kuhinja? Where is the kitchen?

(Naš sogovornik ve, točno katero kuhinjo imamo v mislih.)

- ko govorimo o ljudeh oz. stvareh, ki smo jih našemu sogovorniku v tem trenutnem pogovoru že omenili

Kupil sem jabolko. Bilo je gnilo. I bought an apple. The apple was rotten.*

(Sogovornik ve, katero jabolko je bilo gnilo.)

*V prvem stavku ne smemo uporabiti the, saj sogovorniku pove le to, da smo kupili eno jabolko, ne pa točno katero.

- ko govorimo o geografskih točkah zemlje, rekah, oceanih, morjih...

<i>ekvator</i>	<i>the equator</i>
<i>Amazonka</i>	<i>the Amazon</i>
<i>Atlantik</i>	<i>the Atlantic</i>

- ko govorimo o določenem samostalniku za katerega vemo, da obstaja samo en takšne vrste

<i>sneg</i>	<i>the snow</i>
<i>sonce</i>	<i>the sun</i>

- ko govorimo o tem, da je neka oseba ali neka stvar najboljša, najlepša, največja ipd.

On je najboljši! He is the best!

- pred vrstilnimi števnik

<i>prvi</i>	<i>the first</i>
<i>peti</i>	<i>the fifth</i>

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Indefinite article (nedoločni člen): “A” ali “AN”

Nedoločni člen ima dve obliki, in sicer a ter an. Nanaša se na nekaj, kar našemu sogovorniku ni znano. Uporabljamo ga za moški, ženski in srednji spol, vendar samo v ednini.

Uporabljamo ga:

- pred samostalniki, ki predstavljajo nekaj oz. nekoga, ki ga v tistem pogovoru, pismu ipd. omenjamo prvič

Včeraj sem prebral članek.

I read an article yesterday.

- pred samostalniki, ki označujejo poklice

Jaz sem mizar.

I am a carpenter.

- pred samostalniki, ki označujejo narodnost

On je Italijan. He is an Italian.

On je Norvežan. He is a Norwegian.

»AN« se uporablja, če se beseda, pred katerim stoji, začne s samoglasnikom, torej a, e, i, o, u:

an apple, an eye, an Indian, an ocean, an undersecretary.

Upoštevati pa moramo, da je glas (izgovorjava) pomembnejši od črkovanja. V naslednjih dveh primerih sta začetni črki res enaki (u, samoglasnik), a se izgovarjata drugače.

dežnik an umbrella

univerza a university

ura an hour

Kot primer uporabe členov preberite spodni sestavek:

A man and a woman were walking in Oxford Street. The woman saw a dress that she liked in a shop. She asked the man if he could buy the dress for her. He said: "Do you think the shop will accept a cheque? I don't have a credit card."

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No article

Členov ne uporabljamo:

- ko se pogovarjamo o splošnih stvareh in o športu
Živali so zelo zanimive. Animals are very interesting.
Njegov nečak igra tenis. His nephew plays tennis.

- ko se pogovarjamo o samostalnikih, ki so neštevni
Potrebujem informacije o ... I need information about ...

- ko govorimo o dnevih, mesecih, praznikih
Danes je petek. Today is Friday.
Rodila sem se septembra. I was born in September.
Kaj je božič? What is Christmas?

- pred imeni držav
Španija Spain
Bil sem na Kitajski. I was in China.



VAJE

1 Dopolnite z *a/an, the* ali pustite prazno.

- a. Iron is on of most abundant elements in nature.
- b. alloy is compound made up of two or more substances, one of which at least is metal.
- c. mechanical engineers need exhaustive knowledge of materials they choose.
- d. Tensile strength is measurement of resistance to being pulled apart.
- e. aluminium has relatively low melting point and it is excellent conductor of heat and electricity.
- f. Less than 25% of Earth's crust is formed of metals.
- g. atoms of pure metal are all alike.
- h. composite materials combine best properties of their constituents.

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2 Dopolnite z *a/an, the* ali pustite prazno.

- I love living in this _____ city.
- Generally speaking, _____ boys are physically stronger than girls.
- Bill enjoys reading _____ mystery novels.
- _____ girl that I told you about is standing over there.
- Where did you go last night? We went to _____ restaurant that you recommended.
- He is _____ really good person.
- My brother is _____ expert at fixing cars.
- _____ Paris is a beautiful city.
- My _____ teacher's name is William.
- We got our son _____ dog for Christmas.

3 Dopolnite zgodbo. Uporabite *a/an* ali *the*.

. . . . man decided to rob bank in the town where he lived. He walked into bank and handed note to one of cashiers.
. . . . cashier read note, which told her to give man some money. Afraid that he might have gun, she did as she was told.
. . . . man then walked out of building, leaving note behind. However, he had no time to spend money because he was arrested same day. He had made mistake. He had written note on back of envelope. And on other side of envelope was his name and address. This clue was quite enough for detectives on the case.

4 Dopolnite pogovore. Vstavite *a/an* ali *the*.

- Mike: I'm going out for walk. Have you seen my shoes?
Harriet: Yes, they're on floor in kitchen.
- Melanie: Would you like tomato? There's one in fridge.
David: Oh, yes, please. I'll make myself cheese and tomato sandwich.

- c. Sarah: If you're going into city centre, can you post these letters for me?
Mark: Yes, I'll take them to main post office.
- d. Rita: I've got problem with my phone bill. Can I see someone about it?
Receptionist: Yes, go to fifth floor. lift is along the corridor.
- e. Tom: I didn't know Melanie had dog.
David: It isn't hers. She's just taking it for a walk while owner is away.
- f. Vicky: I've got headache. I've had it all day.
Rachel: Why don't you go to health centre? It's open until six.
- g. Andrew: Guess what. I found £50 note on the pavement this morning.
Jessica: You really ought to take it to police station, you know.



PONOVIMO

Mechanical properties of materials

1 The quality that is required from any material depends on its use: it's obvious that wires and springs can't be manufactured out of the same metal as the former must possess ductility and the latter elasticity. Aluminium will certainly not do for a drill but is advisable for electricity. Thus a designer must estimate the loads that a piece will carry and determine which material, shape and size is best suited.

2 External forces can effect solid materials in different ways, but basically their effects can be divided into three categories: compression, tension and shear. A material is said to be stressed when an external force tends to cause it to change shape. Sometimes the force applied is so strong that the shape is actually permanently altered: the piece is said to be strained i.e. distorted.



Slika 9: Vzmet. Vir:

<http://www.precisealloys.net> (5.7.2012)

3 Tests performed on specimens enable to determine their mechanical properties. Hardness, for instance, is measured by applying a constant vertical load onto a test area (Brinell test). Tensile tests are carried out by exerting a progressively increased load to a specimen, until elongation and finally fracture happens. It's also possible to determine how tough a material is by means of an Izod test : a pendulum hits the specimen with a given kinetic energy at a given speed, and the energy absorbed in bending the specimen indicates its toughness.

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4 The natural properties of materials can sometimes be widely altered by various treatments. Thus corrosion, which attacks metals in particular, can be reduced by applying paint or by electrical treatment such as electro-plating. Metallic elements can also be added so as to improve the original properties: nickel added to steel increases toughness and ductility, whereas brass (a copper and zinc alloy) is much stronger than copper though less ductile.



Slika 10: Korozija. Vir:

<http://www.precisalloys.net> (5.7.2012)

5 The properties of ferrous metals depend on the amount of carbon that they contain. Cast iron contains approximately 3% carbon whereas in steel the proportion ranges from 0.1 to 1.5%. Depending on the exact percentage of carbon and of various other metals which have been added, alloy steel can exhibit such different properties as ductility, hardness, elasticity or plasticity.

6 Moreover, heating metals, either during or after shaping, provides them with new physical or mechanical properties: atoms are arranged as 3-D shapes (called crystals) which determine the properties. When heated, the structure of some crystals (especially iron) is changed, thus resulting in different properties. The basic operation consists in heating steel (for instance) up to a determined temperature and cooling it down more or less slowly depending on the result to be achieved.

Odgovorite na vprašanja.

1 - When choosing a material, what must a designer always think about?

- According to the text, which properties should wires possess? What about springs?
- What can aluminium be used for?
- As a result, how does a designer choose a material?

2 - What are the effects of external forces on materials ?

- What is the definition of 'stress'?
- What has caused a piece to be strained?

3 - List the tests mentioned in the paragraph.

- What are these tests for ?

4 - How can metals be supplied with new properties ?

- Which basic operations must then be carried out?
- Explain briefly the relationship between the properties and the chemical structure of a metal.

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NON-METALS (Nekovine)



1. Odgovorite na spodnja vprašanja.

- Can you mention some non-metallic materials?
- Do you often use objects made of plastic materials? Think of some examples.
- What do you know about ceramics?
- What are composite materials? Do you know some of their application?



Polymers – Polimeri

Polymers are both natural (e.g. proteins, cellulose, rubber) and synthetic substances: they are carbon-based chemical compounds characterized by very large molecules, (monomers) linked together. Synthetic polymers are generally derived from oil and are usually referred to as “plastic” materials.

Easily formed into shape, stiff, light and durable, plastics are also poor conductors of heat and electricity, with low density and a low melting point. They have many different applications: from optical components to telecommunications equipment, from food storage to adhesives, from architectural elements to car parts, clothing, ski boots and safety helmets.



Slika 11: Polimeri.

Vir: <http://www.sonneborn.com> (5.7.2012)

According to their chemical and structural bonds, plastics are usually classified as thermoplastics or thermosettings. The former soften or melt when heated and harden when cooled: in particular, they can undergo reheating processes in order to be reshaped into a new form. The latter, on the contrary, cannot undergo reheating processes: they become permanently hard and rigid when heated.

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Elastomers are polymers whose main quality is that of returning to their original shape after deformation: most of them are synthetic and play a fundamental role in the production of tyres.

Ceramics – Keramika



Slika 12: Keramika

Vir: <http://homes-n-gardens.blogspot.com>
(5.7.2012)

Ceramics are inorganic, on-metallic substances produced using clay and other minerals from Earth or chemically processed powders, hardened firing at high temperatures, through sintering.

In general, they are classified as “traditional” and “advanced”.

Porcelain, pottery, tiles, bricks are a few examples of traditional ceramics. Advanced ceramics have a huge variety of applications: they are employed for wear-resistant and heat-resistant machinery, cutting tools, engine components. They are also used in surgery for making artificial joints.

Composite materials – Sestavljeni materiali

Composite materials are formed by combining two or more materials that have quite different properties. The different materials work together to give the composite unique properties, but within the composite you can easily tell the different materials apart – they do not dissolve or blend into each other as happens with alloys or chemical compounds.

Most composites are made up of just two materials. One material, called the matrix or binder, surrounds and binds together a cluster of fibres or fragments of a much stronger material, the reinforcement. The use of plastic or polymers in the matrix explains the name “reinforced plastics” commonly given to composites. Ceramics, carbon and metals are also used as the matrix for some highly specialised purposes.

Glass fibres are by far the most common reinforcement, although many advanced composites now use fine fibres or pure carbon. Carbon fibres are much stronger and lighter, but they are also more expensive.



Slika 13: Izdelek iz sestavljenih materialov.

Vir: <http://www.chinatraderonline.com> (5.7.2012)

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The greatest advantage of composite materials is strength and stiffness combined with lightness. Composites are also less likely than metals to break up completely under stress, as they withstand heat and corrosion and are very durable.

Another advantage is that they are flexible and can be moulded into complex shapes. The downside of composites is usually the cost, as the raw materials are expensive.

Composites will never totally replace traditional materials like steel, but in many cases they are just what we need.



VAJE

1 Ugotovite ali so spodnje trditve pravilne (T) ali napačne (F).

	T	F
a. Polymers occur in nature .	—	—
b. Polymers are substances whose molecules are composed of a large number of repeating units.	—	—
c. Synthetic polymers are made from coal.	—	—
d. The form of carbon is important in cast iron.	—	—
e. Elastomers have nothing in common with plastics.	—	—
f. The materials commonly called plastics are synthetic polymers.	—	—

2 Ugotovite ali so spodnje trditve pravilne (T) ali napačne (F).

	T	F
a. Composite materials can be formed exclusively of two materials.	—	—
b. It is difficult to tell apart the different materials the composite is made of.	—	—
c. The two materials of a composite do not blend into each other.	—	—
d. The reinforcement surrounds and binds the matrix together.	—	—
e. Pure carbon fibres are not as strong as glass fibres but they are less expensive.	—	—
f. Polymers can be used both for the matrix and the reinforcement.	—	—



Grammar spot: Comparison of adjectives

(stopnjevanje pridevnikov)

V angleščini pridevike stopnjujemo podobno kot v slovenščini. Kot slovenščina, angleščina pozna tri stopnje:

- osnovnik (adjective)
- primernik (comparative)
- presežnik (superlative)

Angleščina je podobna slovenščini tudi v tem, da stopnjuje na dva načina:

- z obrazili : new (nov)
 newer (novejši)
 the newest (najnovejši)

- opisno : interesting (zanimiv)
 more interesting (bolj zanimiv)
 the most interesting (najbolj zanimiv)

Stopnjevanje z obrazili -er/-est

Ta način uporabljamo z naslednjimi pridevniki:

- pridevniki, ki imajo en zlog:

clean	cleaner	cleanest
cheap	cheaper	cheapest

- dvozložnimi pridevniki, ki se končajo na črke "y", "er", "le", "ow":

dirty	dirtier	dirtiest
clever	cleverer	cleverest
simple	simpler	simplest
narrow	narrower	narrowest

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Posebnosti pri črkovanju:

large	larger	largest	če se pridevnik že konča na “-e”
big	bigger	biggest	pri kratkih pridevniki se soglasnik podvoji
sad	sadder	saddest	
happy	happier	happiest	“-y” se spremeni v “-i” (ker je pred “-y” soglasnik)

Stopnjevanje z “more / the most”

difficult - **more** difficult - (the) **most** difficult

Na ta način se stopnjujejo vsi pridevniki z dvema ali več zlogi.

Izjeme

good	better	best	
bad	worse	worst	
much	more	most	se uporablja z neštevnimi smostalniki
many	more	most	se uporablja s števnimi smostalniki
little	less	least	
little	smaller	smallest	

Ostali načini primerjanja

Enakost dveh pojmov izražamo z “as ... as”

➤ A=B

Our car is as fast as Peter's car.

➤ A > B

John's car isn't as fast as our car. (A < B)

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VAJE

- 1 Na sliki vidite sedem različnih materialov. Primerjajte jih med sabo tako, da uporabite pridevnike v okvirčku. Napišite čimveč primerjav.



Slika 14: Različni materiali. Vir: <http://www.ndt-ed.org> (5.7.2012)

hard • ductile • corrosion resistant • strong • light • expensive

Primer: *Cast iron is harder than aluminium.*

2 Primerjajte steklenice na slikah. Uporabite vse tri oblike stopnjevanja.



plastic bottle



glass bottle



vacuum bottle

Primer:

The plastic bottle is softer than the glass bottle.

The glass bottle isn't as light as the plastic bottle.

The vacuum bottle is the most expensive.

3 Poudarjene pridevnike iz prvega stavka postavite v pravilno obliko v drugem stavku.

- a. This is a **nice** cat. It's much _____ than my friend's cat.
- b. Here is Emily. She's six years **old**. Her brother is nine, so he is _____.
- c. This is a **difficult** exercise. But the exercise with an asterisk (*) is the _____ exercise on the worksheet.
- d. He has an **interesting** hobby, but my sister has the _____ hobby in the world.
- e. In the last holidays I read a **good** book, but father gave me an even _____ one last weekend.
- f. School is **boring**, but homework is _____ than school.
- g. Skateboarding is a **dangerous** hobby. Bungee jumping is _____ than skateboarding.
- h. This magazine is **cheap**, but that one is _____.
- i. We live in a **small** house, but my grandparents' house is even _____ than ours.
- j. Yesterday John told me a **funny** joke. This joke was the _____ joke I've ever heard.



SHAPING MATERIALS (Oblikovanje materialov)



Odgovorite na spodnja vprašanja.

- Can you list some metalworking methods?
- What is the oldest one?
- Which factors would you take into consideration before choosing a metalworking process?



Casting (Vlivanje)

Casting is a manufacturing process by which a liquid material is usually poured into a mould, which contains a hollow cavity of the desired shape. When it hardens it takes the form of the cavity.

Sand casting is the oldest and best-known technique, based on the three fundamental steps of any casting process: moulding, melting and casting. It employs temporary, non-reusable moulds and relies on gravity to force the molten substance into them. It is relatively cheap.



Die, permanent and centrifugal casting employ permanent, reusable moulds made of metal or graphite and exploit pressure, gravity or centrifugal forces to pour the molten metal into the mould. These techniques are suitable for mass production and provide high dimensional accuracy and good surface finish.

Continuous casting is largely used in the steel industry to form long bars which are then cut, processed and shaped according to the requirements.

Slika 15: Vlivanje. Vir: <http://cltad.arts.ac.uk> (5.7.2012)

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Forging (Kovanje)

Forging is the forming of metal by applying compressive forces. It is used to produce large quantities of identical parts.

Cold forging is done at low temperatures and is generally limited to relatively soft metals and plastic materials. Conventional **hot forging**, on the other hand, is done at high temperatures, which make metal easier to shape and less likely to fracture. Iron and its alloys are almost always forged hot.

In modern times, industrial forging is done either with presses or with hammers powered by compressed air, electricity, hydraulics or steam.

In industry, a distinction is made between open- and closed- die forging. In **open-die forging** the material is placed in a die resembling a mould, which is forced to fill by the application of pressure. **Closed-die** forging is more expensive for mass production than casting, but produces much stronger parts, and is used for tools and high strength machine parts.



Slika 16: Kovanje. Vir: <http://www.s-kinc.com>
(5.7.2012)

Other bulk deformation processes (Ostali postopki)

Rolling

A fabricating process in which the metal, plastic, paper or glass is passed through a pair of rollers. In **flat rolling**, the final shape of the product is either a sheet (less than 3 mm thick) or a plate (more than 3 mm thick). In **profile rolling**, the final product may be a round rod or a shaped bar. Rolling is also classified according to the temperature of the metal rolled. If the temperature of the metal is above its recrystallization temperature then the process is termed **hot rolling**; if below, **cold rolling**.

Extrusion

A process by which long straight metal parts can be produced. The cross-sections that can be produced vary from solid round, rectangular, to L or T shapes. Extrusion is done by squeezing the material in a closed cavity through a die using either a mechanical or hydraulic press.

Cold extrusion is the process done at room temperature or slightly elevated temperatures. This process can be used for materials that can withstand the stresses created by extrusion such as lead, tin, aluminium alloys, copper, titanium or steel. **Hot extrusion** is done at fairly high temperatures. Due to the high temperatures and pressures, good lubrication is necessary.

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Drawing

A manufacturing process for producing wires, bars or tubes by pulling on a material until it increases in length. This technique has long been used to produce flexible metal wires by drawing the material through a series of dies of decreasing size. More recently, drawing has been used with molten glass to produce high quality optical fibres.

Sheet metal forming (Oblikovanje pločevine)

Sheet metal forming is a grouping of many complementary processes that are used to form sheet metal parts. One or more of these processes is used to take a flat sheet of ductile metal, and mechanically apply deformation forces that alter the shape of the material.

Sheet metal forming processes include the following: bending, roll forming, spinning, deep drawing, stretch forming.

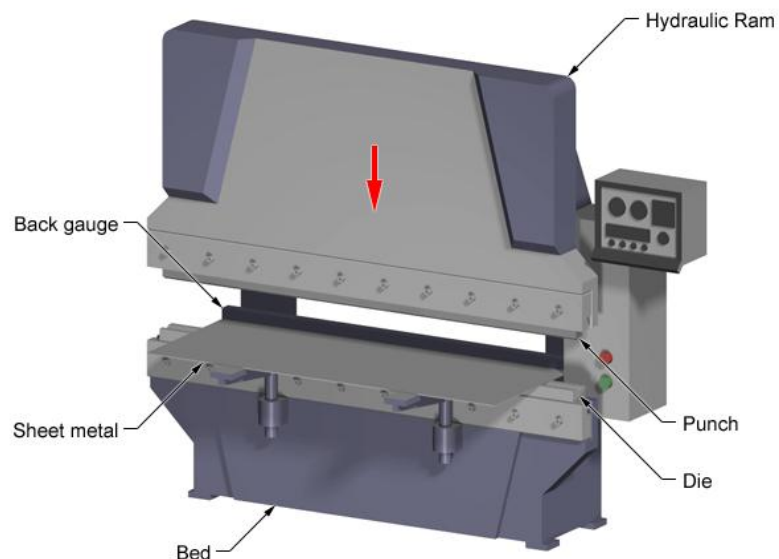
Bending

Bending is a metal forming process in which a force is applied to a piece of sheet metal, causing it to bend at an angle and form the desired shape. A bending operation causes deformation along one axis, but a sequence of several different operations can be performed to create a complex part. Bent parts can be quite small, such as a bracket, or up to 20 feet in length, such as a large enclosure or chassis.

Slika 17: Press brake.

Vir: <http://www.custompartnet.com> (5.7.2012)

A press brake contains an upper tool called the punch and a lower tool called the die, between which the sheet metal is located. The sheet is carefully positioned over the die and held in place by the back gauge while the punch lowers and forces the sheet to bend. In an automatic machine, the punch is forced into the sheet under the power of a hydraulic ram. Bending is typically performed on a machine called a press brake, which can be manually or automatically operated. For this reason, the bending process is sometimes referred to as press brake forming.



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Roll forming

Roll forming is a metal forming process in which sheet metal is progressively shaped through a series of bending operations. The process is performed on a roll forming line in which the sheet metal stock is fed through a series of roll stations. Each station has a roller, referred to as a roller die, positioned on both sides of the sheet.



The shape and size of the roller die may be unique to that station, or several identical roller dies may be used in different positions. The roller dies may be above and below the sheet, along the sides, at an angle, etc. As the sheet is forced through the roller dies in each roll station, it plastically deforms and bends. Each roll station performs one stage in the complete bending of the sheet to form the desired part. The roller dies are lubricated to reduce friction between the die and the sheet, thus reducing the tool wear. The roll forming line can also include other sheet metal fabrication operations before or after the roll forming, such as punching or shearing.

Slika 18: Roll forming. Vir: <http://image.thefabricator.com> (5.7.2012)

Spinning

Spinning, sometimes called spin forming, is a metal forming process used to form cylindrical parts by rotating a piece of sheet metal while forces are applied to one side. A sheet metal disc is rotated at high speeds while rollers press the sheet against a tool, called a mandrel, to form the shape of the desired part.

Spinning is typically performed on a manual or CNC lathe and requires a blank, mandrel, and roller tool. There are two distinct spinning methods, referred to as conventional spinning and shear spinning.



Slika 19: Spojke.

Vir: <http://image.thefabricator.com> (5.7.2012)

Deep Drawing

Deep drawing is a metal forming process in which sheet metal is stretched into the desired part shape. A tool pushes downward on the sheet metal, forcing it into a die cavity in the shape of the desired part.

Deep drawn parts are characterized by a depth equal to more than half of the diameter of the part. These parts can have a variety of cross sections with straight, tapered, or even curved walls, but cylindrical or rectangular parts are most common. Deep drawing is most effective with ductile metals, such as aluminum, brass, copper, and mild steel. Examples of parts formed with deep drawing include automotive bodies and fuel tanks, cans, cups, kitchen sinks, and pots and pans.

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Stretch Forming



Stretch forming is a metal forming process in which a piece of sheet metal is stretched and bent simultaneously over a die in order to form large contoured parts. Stretch forming is performed on a stretch press, in which a piece of sheet metal is securely gripped along its edges by gripping jaws. The tooling used in this process is a stretch form block, called a form die, which is a solid contoured piece against which the sheet metal will be pressed

Slika 20: Strech forming.

Vir: <http://aluminium.matter.org.uk> (5.7.2012)



VAJE

1 PAIR WORK. Odgovorite na naslednja vprašanja.

- a. How is casting carried out?
- b. Can you name some different casting techniques?
- c. What are the main elements the differentiate casting processes?
- d. What kind of process is forging?
- e. How is it done nowadays?
- f. Is forging more expensive than casting?
- g. Why is sheet metal forming very important in modern metalworking industries?
- h. What is the aim of bending?
- i. What is roll forming? How is it carried out?

2 Dopolnite razpredelnico.

SHEET FORMING PROCESS	AIM	HOW
	Causing metal sheets to curve.	Using a punch to force a metal sheet into a die.
DEEP DRAWING		
	Shaping and finishing blank metals.	
		Putting the heated metal sheet around a die, with a load stretching it until cooling occurs.
ROLL FORMING		

3 PAIR WORK. Kateri postopek bi uporabili v naslednjih situacijah? Tvorite kratke dialoge.

- You want to produce 2 mm thick sheets.
- You need to produce 4 mm thick plates.
- You want to obtain round rods.
- You want to produce bars of different shapes.
- You want to produce flexible metal wires.
- You need to produce high-quality optical fibres.

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4 Dopolnite razpredelnico.

PROCESS	PROCEDURE	METHODS	FINAL PRODUCT
Rolling	Material is passed through a pair of rollers.	- Sheets / plates - . - . -	- Sheets / plates -
Extrusion			
Drawing			



Material removal processes (Postopki odstranjevanja materiala)

Turning

Turning is one of the basic machining processes and is performed on a machine called a lathe in which the tool is stationary and the part is rotated.

Drilling

Drilling is one of the most common operations in a workshop and is carried out by different types of drills which are commonly used both in woodworking and metalworking.



Slika 21: Horizontalni vrtalni stroj. Vir: <http://www.inkos.si> (7.7.2012)

Učno gradivo je nastalo v okviru projekta Munus 2. Njegovo izdajo je omogočilo sofinanciranje Evropskega socialnega sklada Evropske unije in Ministrstva za šolstvo in šport.

Milling

Milling is a process of removing material by feeding a workpiece past a rotating multiple tooth cutter or endmill. The workpiece is usually held in a vise and placed on a movable table so that any type of surface can be worked and complex forms can be obtained. Rotation speed, cutting depth and cutting speed are the most important factors in any milling process.

Grinding

Grinding is a process of removing material from a surface by rubbing is against an abrasive rotating wheel or moving belt. It is commonly employed when good surface finish and great dimensional accuracy are required, for machining hard materials or sharpening cutting tools.



PONOVIMO

1 Tukaj je nekaj najpomembnejših besed, ki ste jih srečali v tem poglavju.

Hot forging – cold forging – open die forging – closed die forging – rolling – extrusion – drawing – sheet – plate – die – mould – harden – melting – core – spinning – bending – roller – deep drawing – forming – vise – grinding – rotation speed – milling – worktable – lathe – drilling – turning – abrasive

Uporabite nekaj zgornjih besed in dopolnite stavke.

- a. The hollow form which imparts its shape to a fluid or soft substance is called
- b. Inner holes or cavities are formed in casting by using
- c. Pressure forces the molten metal into a metallic mould in
- d. A is a device used for holding a machine tool component rigid.
- e., cutting depth and speed are the most important factors in milling.
- f. wheels are employed in grinding.
- g. Sheet metal is one of the most important metalworking processes.
- h. is one of the basic machining processes and is performed on a machine called lathe.
- i. is a fabricating process in which the metal, plastic, paper or glass is passed through a pair of rollers.
- j. Is a process by which long straight metal parts can be produced.

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2 Dopolnite razpredelnico z manjkajočimi podatki.

METALWORKING PROCESS	AIM
	To finish the surface of a work piece, to have dimensional accuracy, to machine hard materials, to sharpen cutting tools.
CASTING	
	To create flat surfaces, to make curved and angular shapes.
	To modify the shape of the object without removing any material used to produce large quantities of identical parts.
EXTRUSION	
	To produce a sheet, a plate, a round rod or a shaped bar.
SHEET METAL FORMING	
	To produce a wire, a bar or a tube by pulling on a material until it increases its length.

3 READING: Smart materials

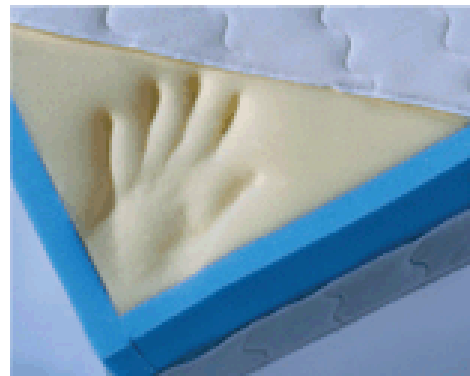
Smart – or shape memory – materials are an invention that has changed the world of engineering. There are two types: metal alloys and plastic polymers. The metal alloys were made first and are usually an expensive mixture of titanium and nickel.

Shape memory materials are called “smart” because they react to changes in their environment, for example:

- Plastic that return to their original shape when the temperature changes. One use is in surgery where plastic threads “remember” the shape of a knot, react to the patient’s body temperature and make themselves into stitches.
- Metal alloys that have a “memory” and can return to their original shape. They are used in medical implants that are compresses so they can be put inside the patient’s body through a small cut. The implant then expands back to its original shape. More everyday uses are for flexible spectacle frames and teeth braces.
- Solids that darken in sunlight, like the lenses in some sunglasses.
- Liquid crystals that change shape and colour. These have been used in climbing ropes that change colour if there is too much strain and weight on them.

Slika 22: Spominska pena.

Vir: <http://www.pu2pu.com> (7.7.2012)



The future of these materials and their possible uses is limited only by human imagination. One clever idea is that if cars were made of smart metal, a minor accident could be repaired by leaving the car in the sun!

Ponovno preberite besedilo in izberite pravilne odgovore.

1. Smart materials change when...
 - a. the weather changes.
 - b. something affects them.
 - c. the light is switched on.
2. Plastic threads are used for
 - a. sewing.
 - b. stitching.
 - c. knitting.

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3. Medical implants made from shape memory alloys are good because
 - a. they save lives.
 - b. they change colour.
 - c. they are easy to put in.

4. Climbing ropes with liquid crystals change colour to
 - a. warn you.
 - b. amuse you.
 - c. make you heavy.

4 Na spletu poiščite več informacij o :

- a. Three –dimensional object manufacturing
- b. Laser beam machining
- c. Smart materials



MEDPREDMETNO POVEZOVANJE

Povezava s slovenščino:

- izdelava dvojezičnega slovarja strokovnih izrazov
- prevajanje
-

Povezava s praktičnim poukom:

- primere iz prakse znajo povedati v angleščini
- poznajo strokovne izraze v angleščini

Povezava s strokovnimi predmeti (Tehniško komuniciranje, Lastnosti materialov, primarno oblikovanje in preoblikovanje, Spajanje gradiv in toplotna obdelava)



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