

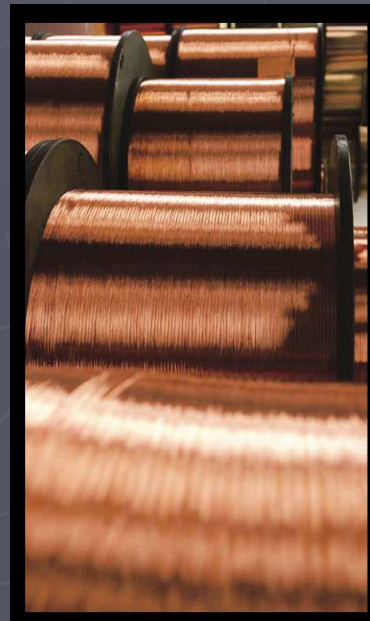
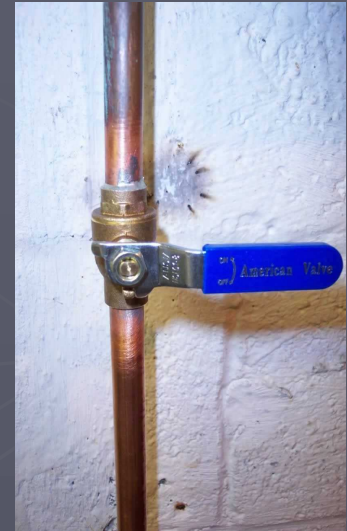
Copper (Cu)

Josep Poch March 07



Copper: properties and uses

- ▶ Copper is a reddish-coloured metal, with a **high electrical and thermal conductivity**
- ▶ **50%** of the copper world production is for **electrical wiring**. Only silver is a better conductor
- ▶ Other main applications are: **plumbing, heating, roofing, machinery** and **coins**



Copper: Mankind's First Metal

- ▶ Copper is **soft** and **easy to smelt** (melting point: 1085 °C)
- ▶ It is found in nature as a **native metal**
- ▶ It was the **first metal** used by mankind to make tools, weapons, sculptures...
- ▶ It started to be used by **6700 BC**

Copper
axe found
in Italy
(2200 BC)



Copper knives, Wessex (UK) 2300 BC



Where does it come from?

- ▶ Copper was named from the Greek word *kyprios* (the Island of **Cyprus**) where copper deposits were mined by the ancients
- ▶ It is **1000 times less abundant than iron**, so minerals with a **low content** of Cu must be used

year	% of Cu
1850	20%
1920	1.5%
1990	0.7%

Content of Cu (%) of minerals used for industrial purposes

Island of Cyprus



Where does it come from?

- ▶ The main ores of copper are **Chalcocite** and **Chalcopyrite**



- ▶ The **main supplier** is **Chile** (16% of world's production) followed by the USA, former USSR and Canada



Left:
Escondida,
Chile's
largest
copper
mine. Right:
chalcopyrite

From ore to copper

- ▶ **Copper mines** are only set up where there is more than **5kg of copper per tonne of rock** (0.5% by mass). Ideally, the figure should be closer to 2%
- ▶ We're in **no danger of running out** of copper. Known worldwide resources are very large
- ▶ Copper's **recycling rate** is higher than that of any other engineering metal

From ore to copper



Ore

Grinding

The ore is **crushed** into **powder**

Concentrating

The ore is **enriched**.
Unwanted material (**gangue**) is **removed**

Roasting

The ore is **heated** in air (700°C) to **remove sulphur**

Electrolytic refining

The copper is **purified to 99.99%** by electrolysis

Furnace

Air is blown forming **blister copper** (almost pure)

Smelting

It is **heated to 1200 °C** and melts. Some **impurities** are **removed as slag**



Copper corrosion

- ▶ Copper corrodes over a long period of time by forming green carbonate in humid air

Background: corroded copper roof
Right: new copper dome



Alloys: bronze and brass

► Copper alloys:

- Brass: copper + zinc (Zn)
- Bronze: copper + any other metal except zinc, though average bronze is made from copper + tin (Sn)

Left: knob made of brass. Right: ancient Greek bronze helmet



Brass (Cu + Zn)

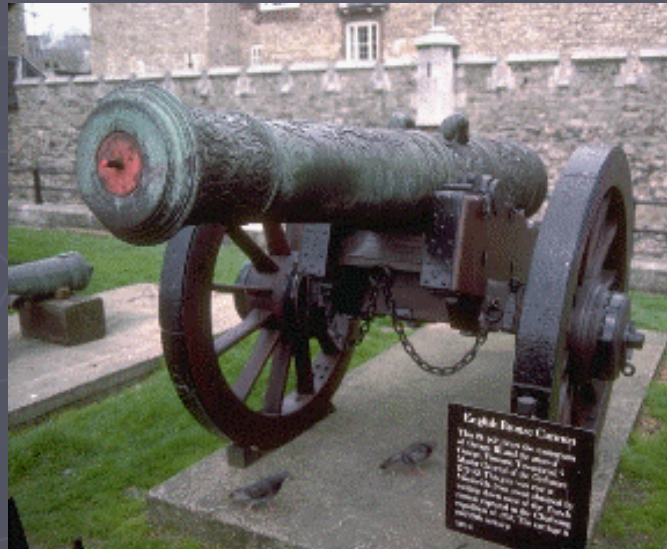
- ▶ Brass has a **yellow colour**, similar to gold
- ▶ The amount of **Zn** varies from **5% to 45%**
- ▶ The **more Zn** it contains, the **tougher** and **more brittle** it gets



Brass has many uses. From left to right: door in Morocco, engraved plate, water tap and trumpet

Bronze (Cu + ...)

- ▶ Bronze was the **first alloy** used by mankind
- ▶ The **first bronze** was made from **copper and tin** (Cu + Sn) around 3000 BC
- ▶ It was typically 60% copper and 40% tin



Charioteer from Delphi (c470 BC), cast bronze , a cannon and a bell (traditional uses of bronze)

Bronze (Cu + ...)

- ▶ Tin improves the **mechanical properties** of Cu, improves **bronze fluidity** (cast bronze) and makes bronze more **resistant to corrosion**
- ▶ Other metals used to make bronze:
 - **Aluminium** (Al): turbine **axis**
 - **Nickel** (Ni): electrical **resistances**
 - **Beryl** (Be): **gears**

Gear and
electrical
resistance





Chuquicamata copper mine,
Chile