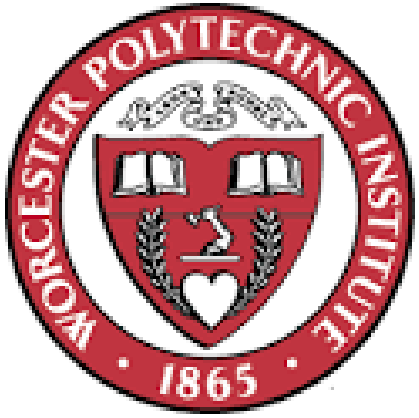
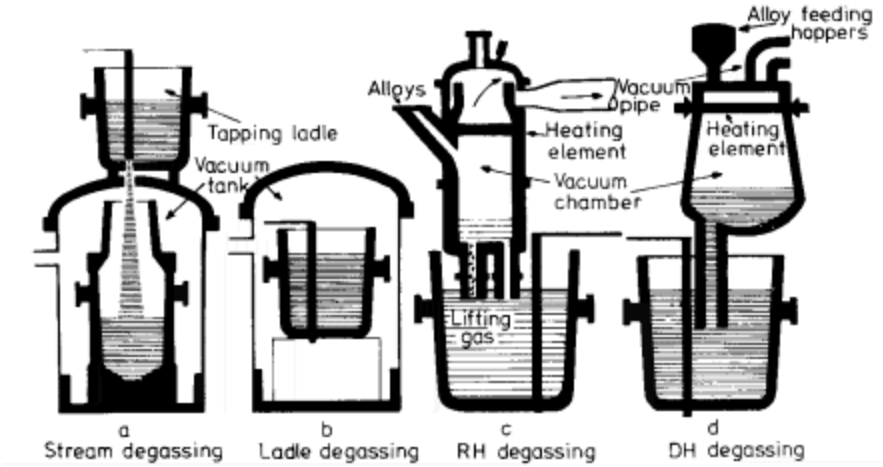
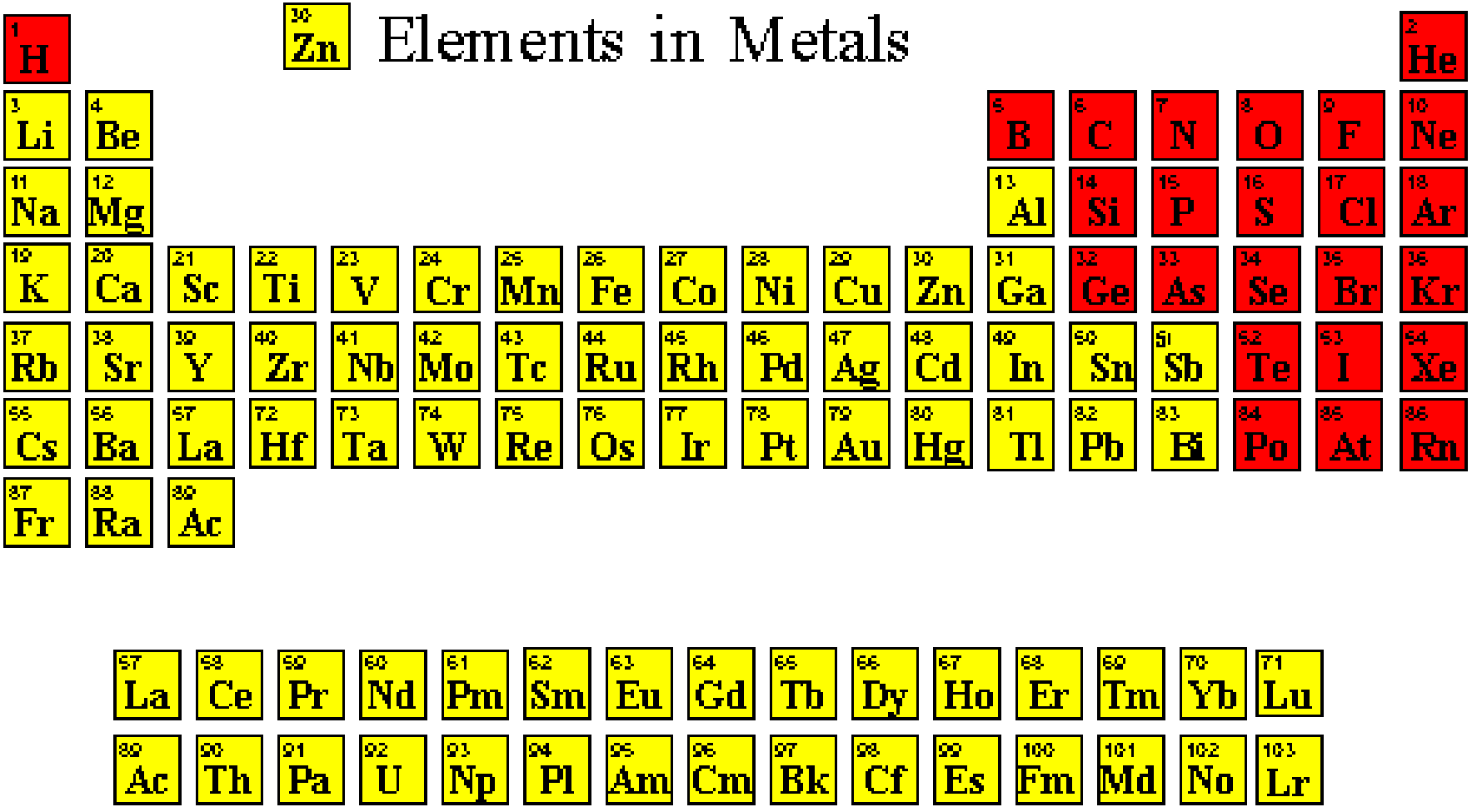


Mathematics and Science in Schools in Sub-Saharan Africa

MATERIAL SCIENCE

Introduction to
METALS

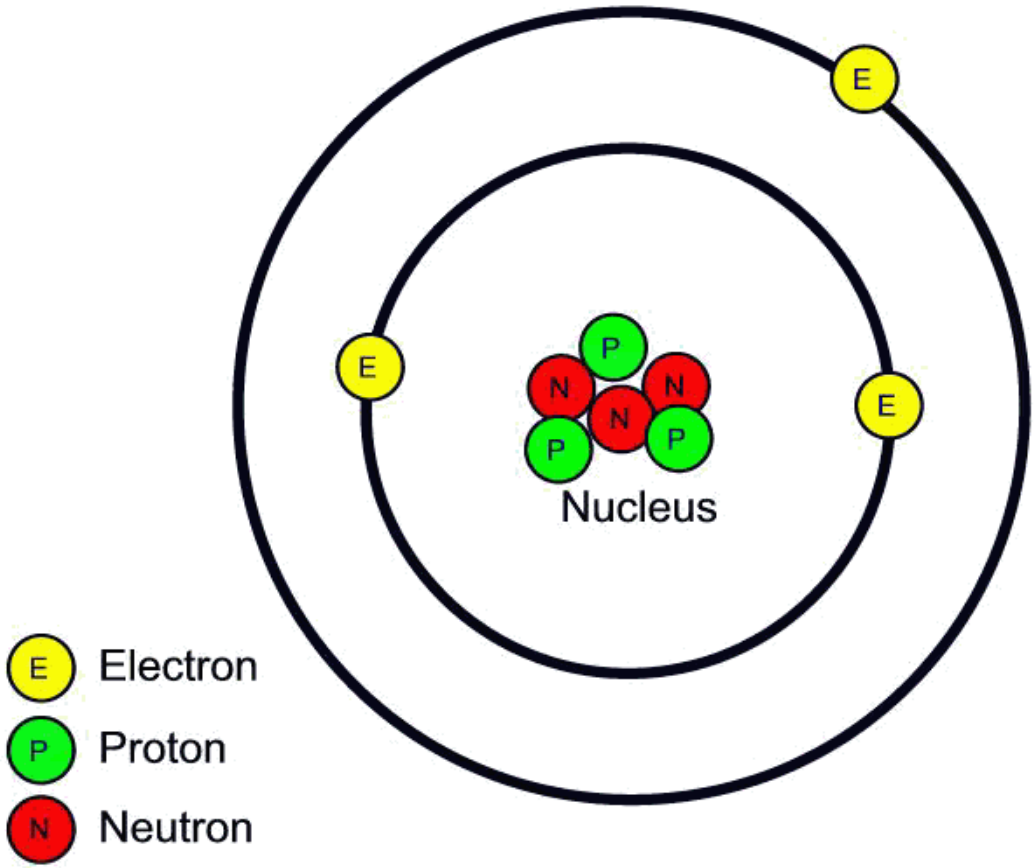



30 Zn
Elements in Metals
1 H
2 He
3 Li
4 Be
5 B
6 C
7 N
8 O
9 F
10 Ne
11 Na
12 Mg
13 Al
14 Si
15 P
16 S
17 Cl
18 Ar
19 K
20 Ca
21 Sc
22 Ti
23 V
24 Cr
25 Mn
26 Fe
27 Co
28 Ni
29 Cu
30 Zn
31 Ga
32 Ge
33 As
34 Se
35 Br
36 Kr
37 Rb
38 Sr
39 Y
40 Zr
41 Nb
42 Mo
43 Tc
44 Ru
45 Rh
46 Pd
47 Ag
48 Cd
49 In
50 Sn
51 Sb
52 Te
53 I
54 Xe
55 Cs
56 Ba
57 La
72 Hf
73 Ta
74 W
75 Re
76 Os
77 Ir
78 Pt
79 Au
80 Hg
81 Tl
82 Pb
83 Bi
84 Po
85 At
86 Rn
87 Fr
88 Ra
89 Ac
57 La
58 Ce
59 Pr
60 Nd
61 Pm
62 Sm
63 Eu
64 Gd
65 Tb
66 Dy
67 Ho
68 Er
69 Tm
70 Yb
71 Lu
89 Ac
90 Th
91 Pa
92 U
93 Np
94 Pl
95 Am
96 Cm
97 Bk
98 Cf
99 Es
100 Fm
101 Md
102 No
103 Lr

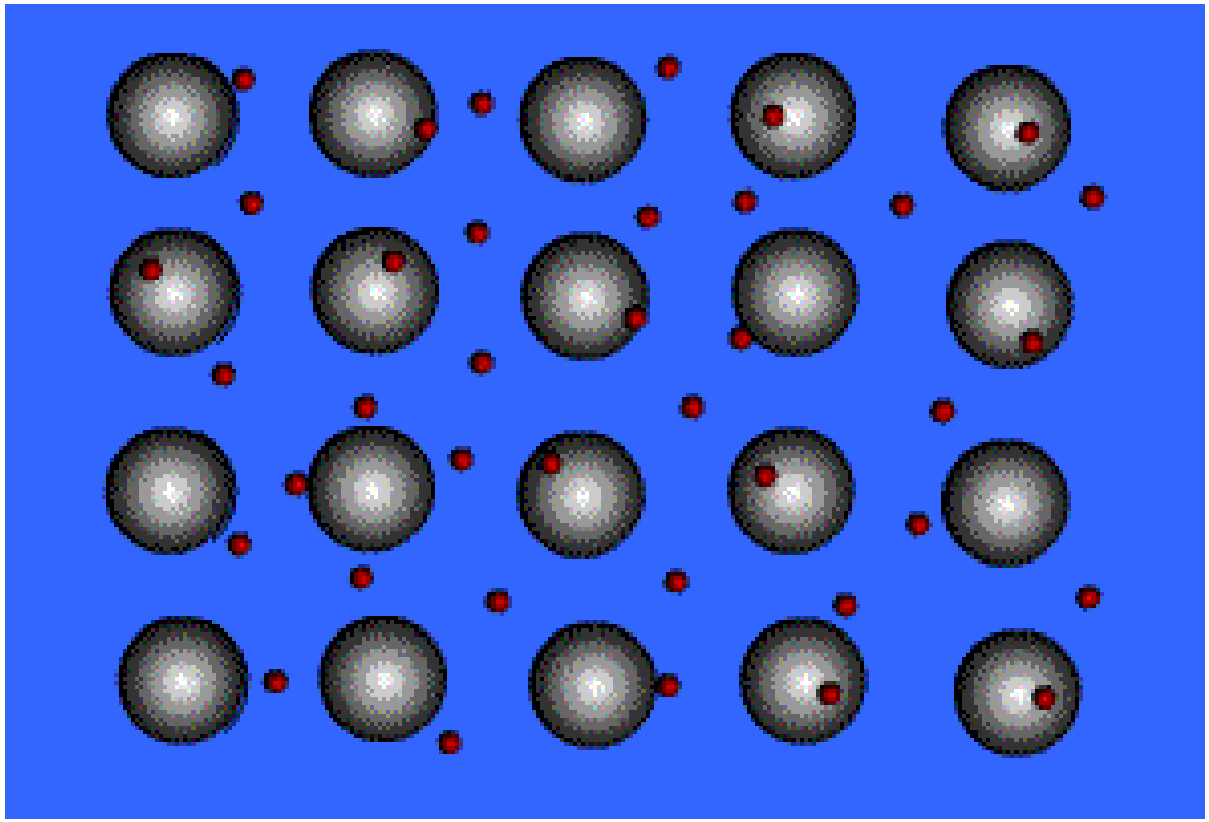
World Stability

Stock Market

Atomic Structure



Metallic Bonding



“Sea of Electrons”

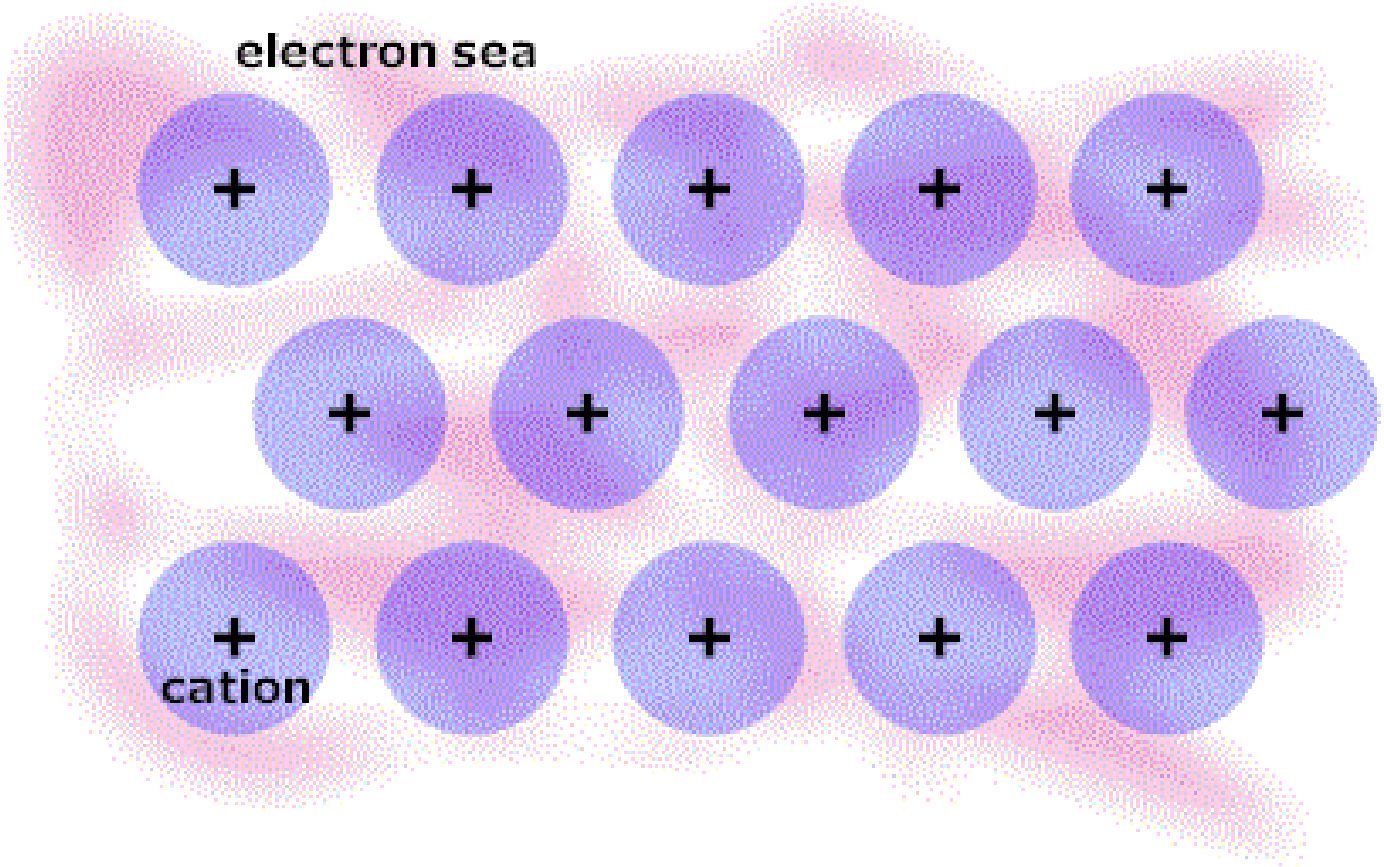
Properties of Metals

Metals are strong.

Properties of Metals

Metals have a lustrous look when polished.

Properties of Metals

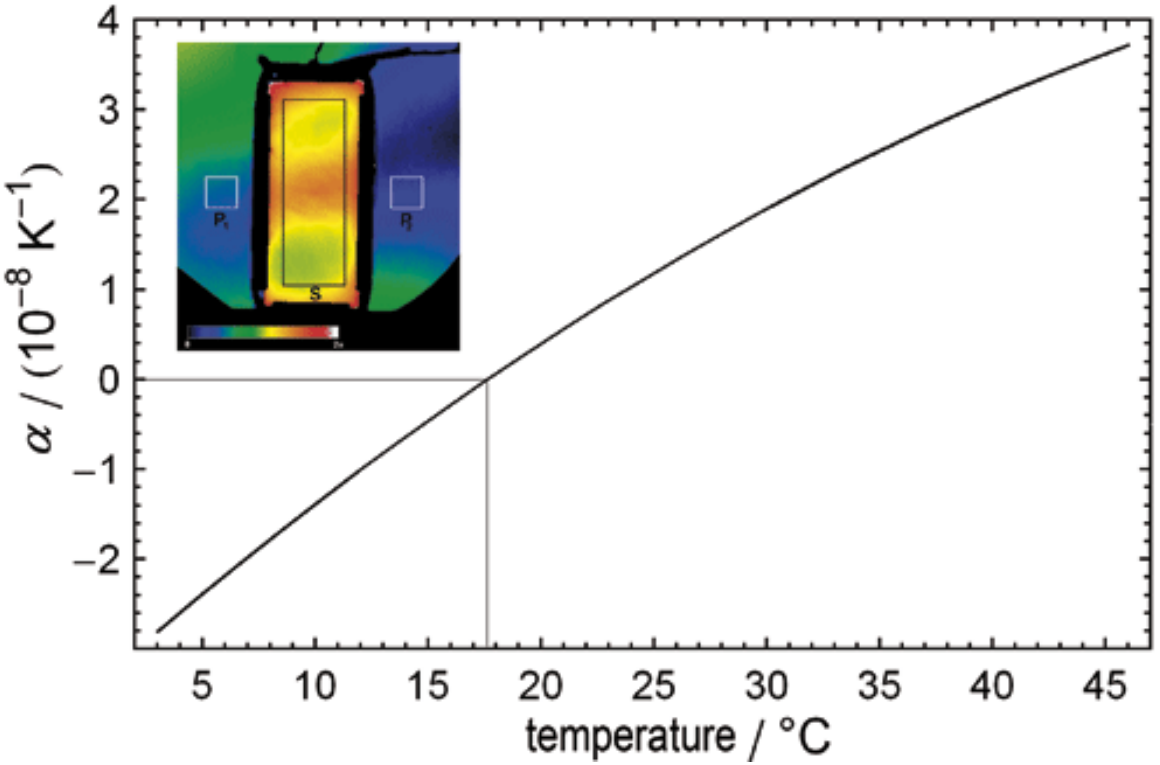


Metals are flexible.

Properties of Metals

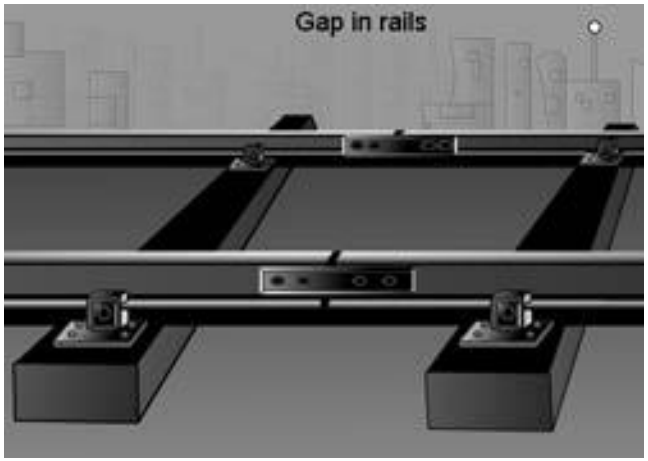
Metals are malleable.

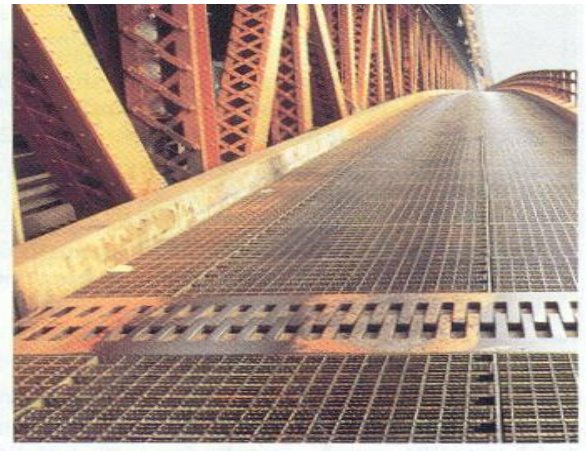
Properties of Metals



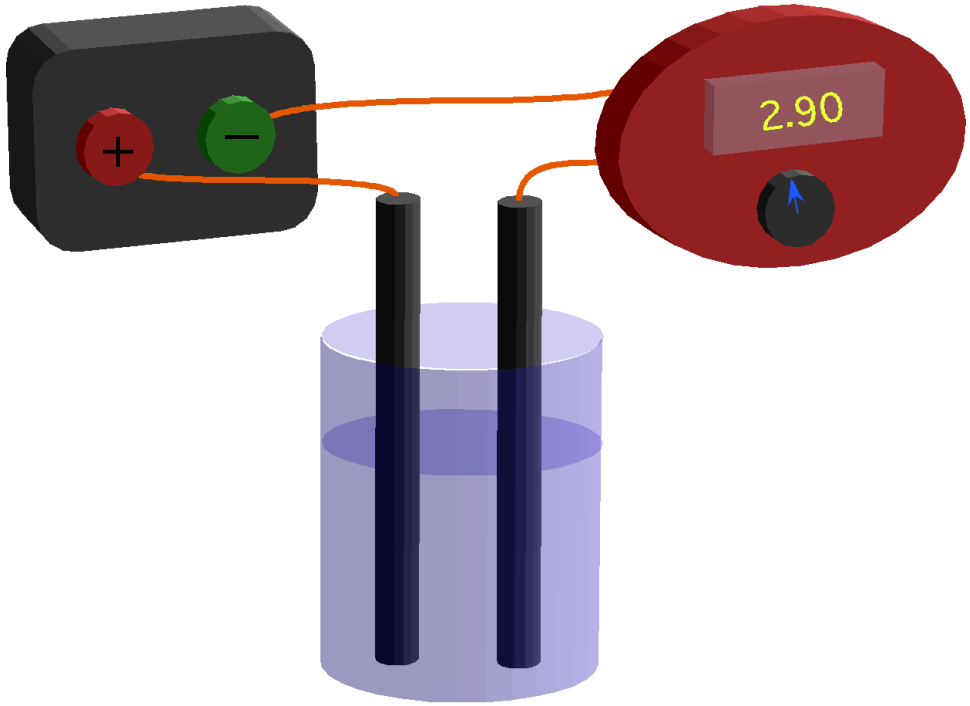
Metals expand when heated.

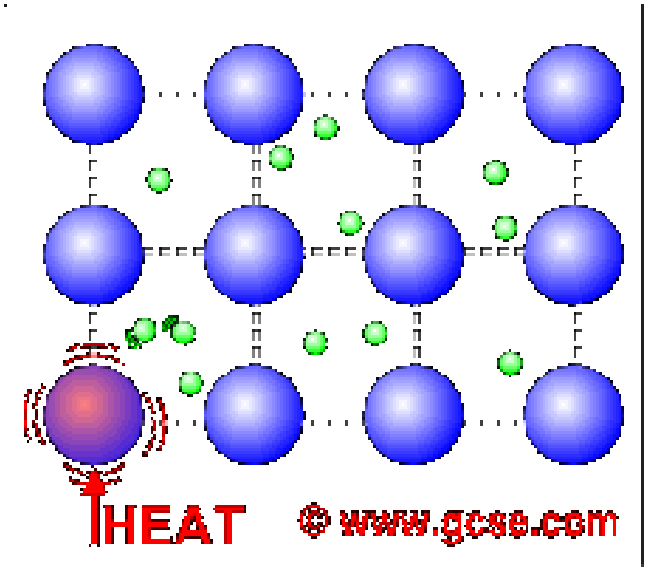
Thermal Expansion





Properties of Metals





Metals have a very high conductivity rate of heat and electricity.

Commercial Applications

Copper

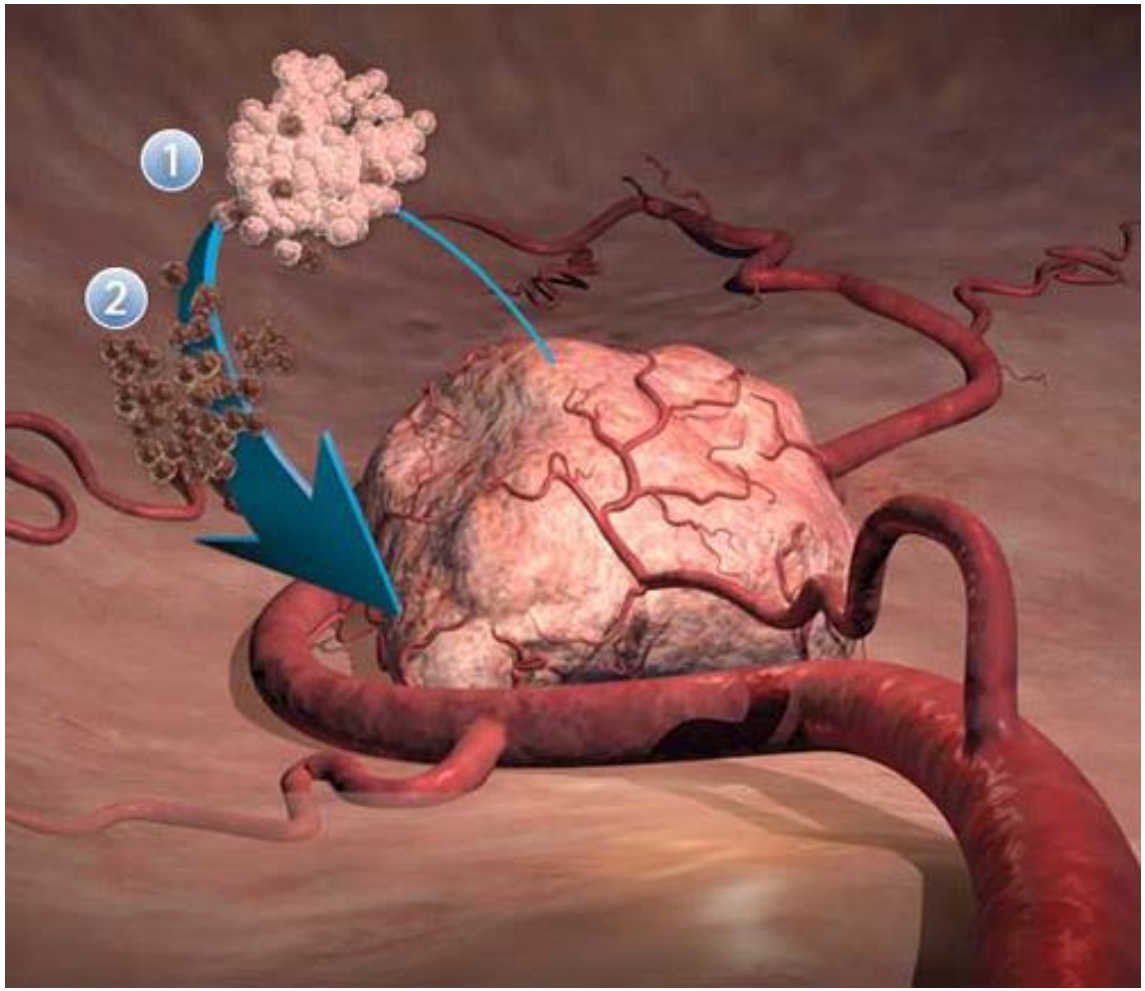
Aluminum

Cast Iron

Steel

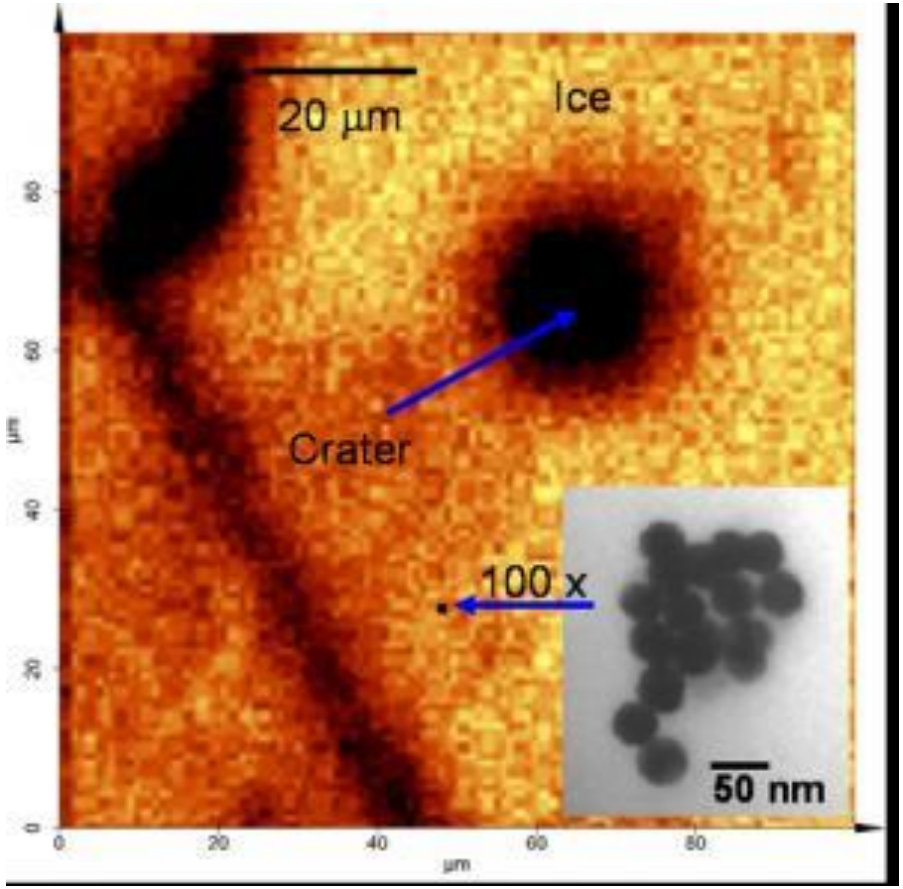
Cookware

Medical Applications



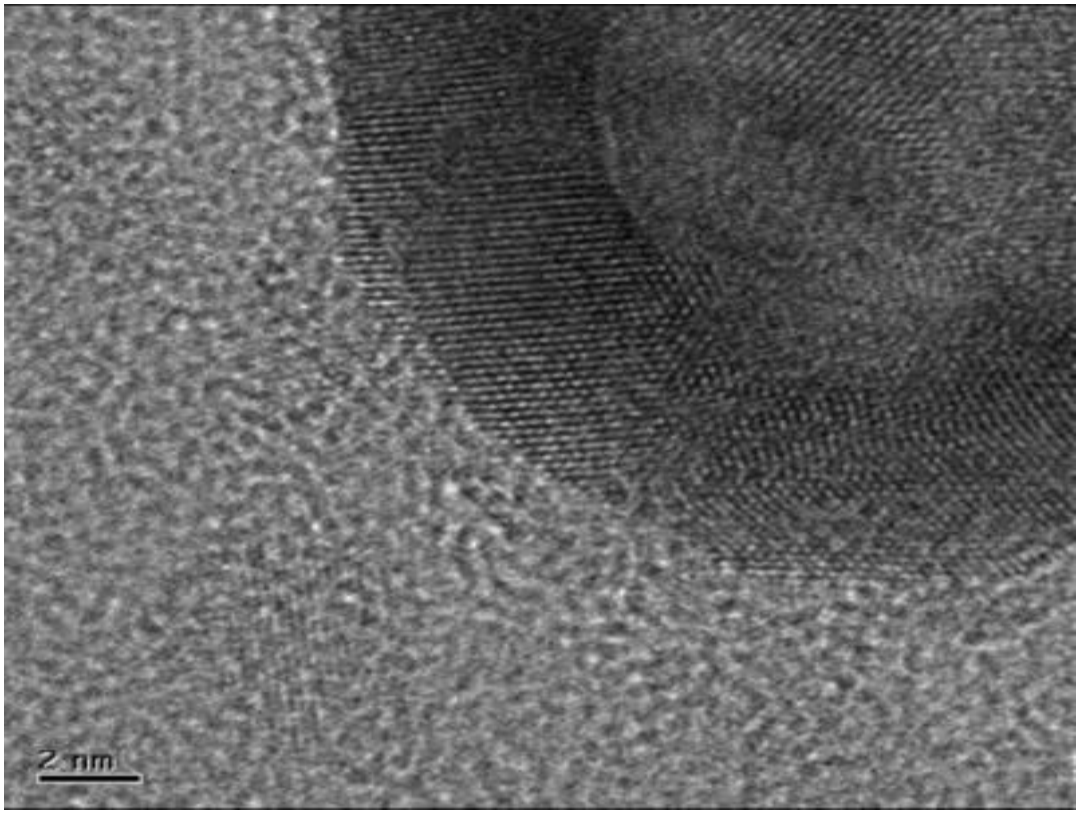
Using laser light, Ohio University scientists uses gold nanoparticles to kill cancer tumors.

Medical Applications



Metal nanoparticles, such as gold, can heat an area up to 1,000 times its size.

Medical Applications



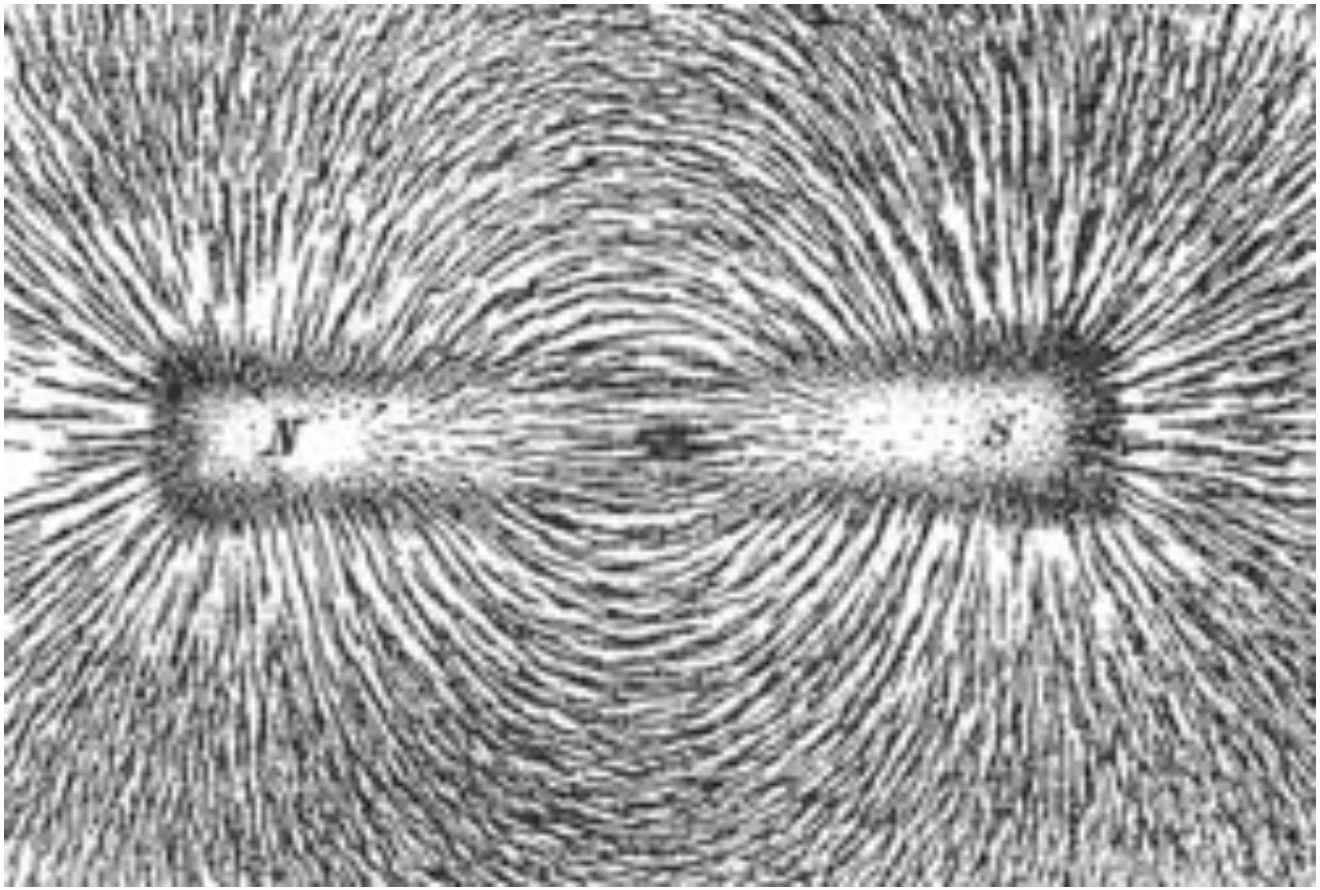
A short peptide is attached to the nanospheres of gold that enabled them to bind to tumor cells.

Medical Applications

Using a near-infrared light from a laser, heat the gold nanospheres and selectively kill the cancer cells to which the particles were bound.

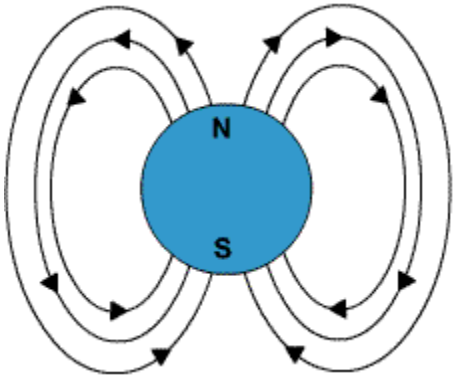
Electrical Applications

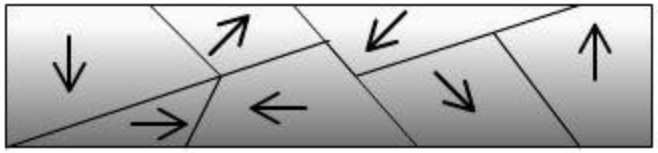
Properties of Metals

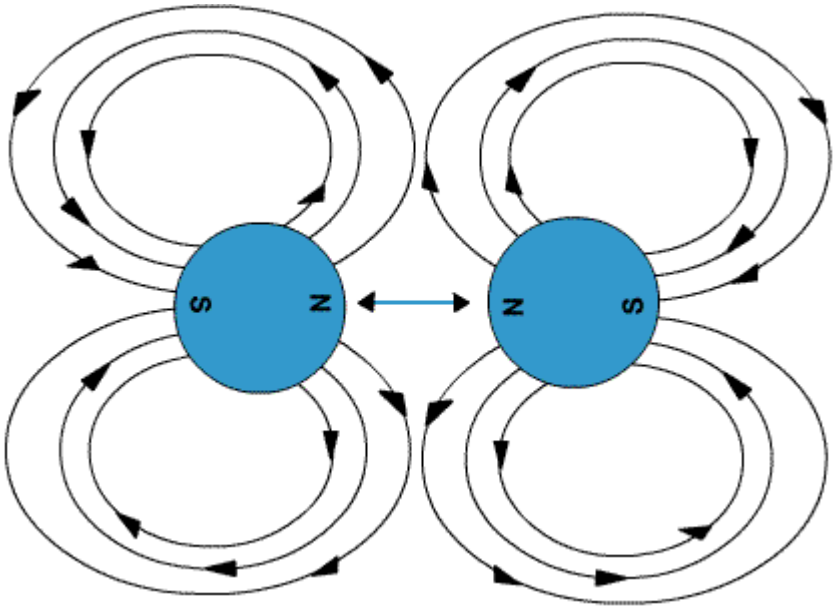


Certain metals can be magnetic.

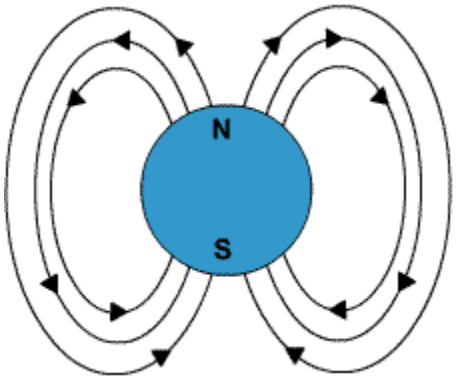
Non-Magnetic Metals

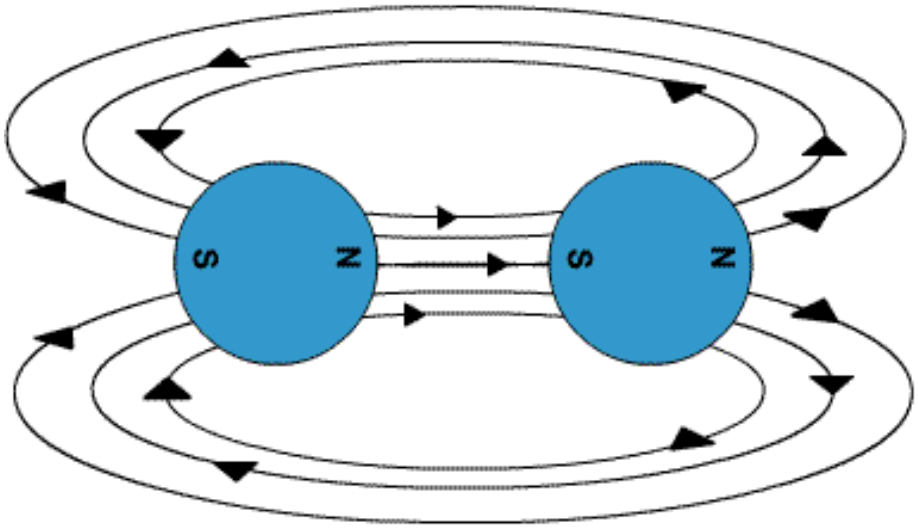


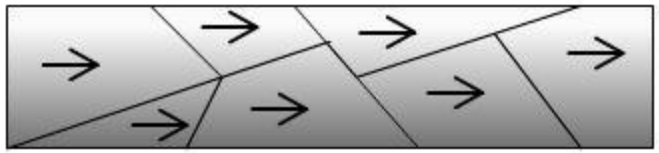




Magnetic Metals







Properties of Metals

Metals are crystalline in structure.

Crystal Structures of Metals

- Aluminum FCC
- Cadmium HCP
- Chromium BCC
- Cobalt HCP
- Copper FCC
- Gold FCC
- Iron BCC
- Lead FCC
- Magnesium HCP
- Nickel FCC
- Niobium BCC
- Platinum FCC
- Polonium Cubic
- Silver FCC
- Titanium HCP
- Vanadium BCC
- Zinc HCP
- Zirconium HCP

Disadvantages of Metals

Metals corrode!

Unit #1: History of Metals

Metallurgy

Metallurgy is one of the oldest applied sciences.

The history of metals is closely linked to that of coins and gemstones.

Metallurgy

As early as 3400 B.C., at the beginning of the historical period, the Egyptians had an intimate knowledge of gold, copper ores and of processes of extracting metals.

Metallurgy

Metals were also known to the Mesopotamians, Greeks and the Romans.

Native Metals

Copper

Gold

Mercury

Silver

Native Metals

Iron

Iron was available to the ancients in small amounts from meteors.

Native iron is easily distinguishable because it contains 6-8% nickel.

Copper Age (~4000 B.C.)

The first metal to be used was copper.

Copper Age (~4000 B.C.)

The first tools, implements & weapons were made from copper.

Copper Age (~4000 B.C.)

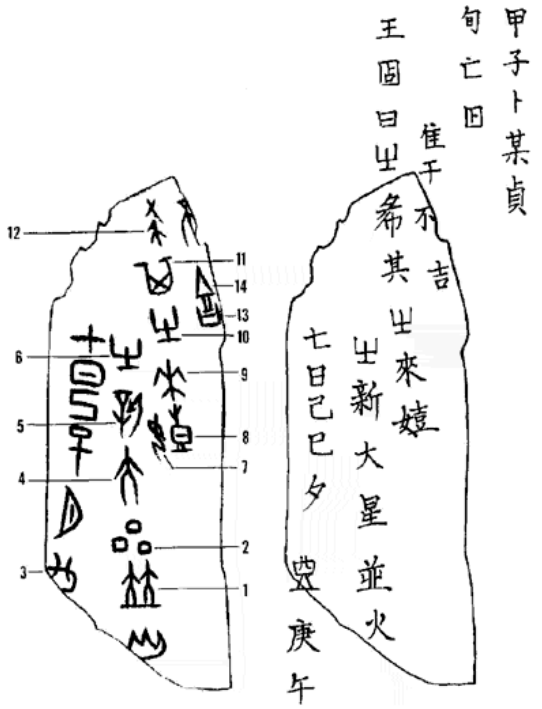
The oldest known casting in existence, a pure copper frog, was cast in Mesopotamia.

Bronze Age (~3000 B.C.)

Bronze was the first alloy used.

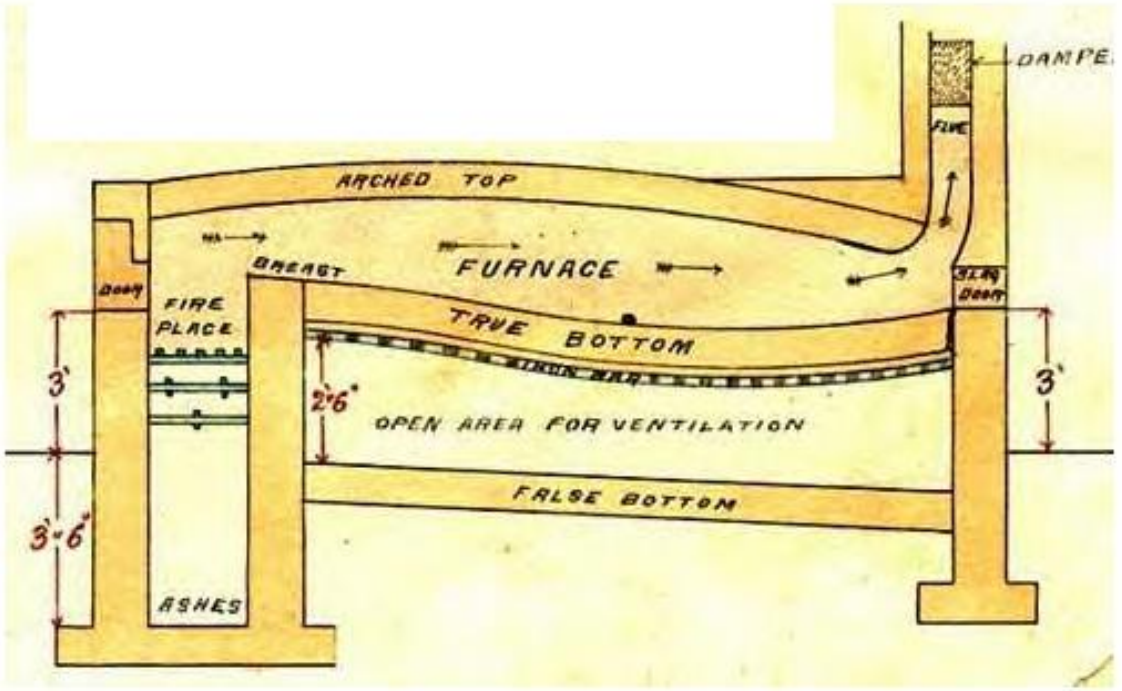
Bronze = Copper & 5-10% Tin

Bronze Age (~3000 B.C.)



New discoveries near Ban Chiang, Thailand, indicate that bronze technology was maybe known there as early as 4500 BC!

Iron Age (~2000 B.C.)

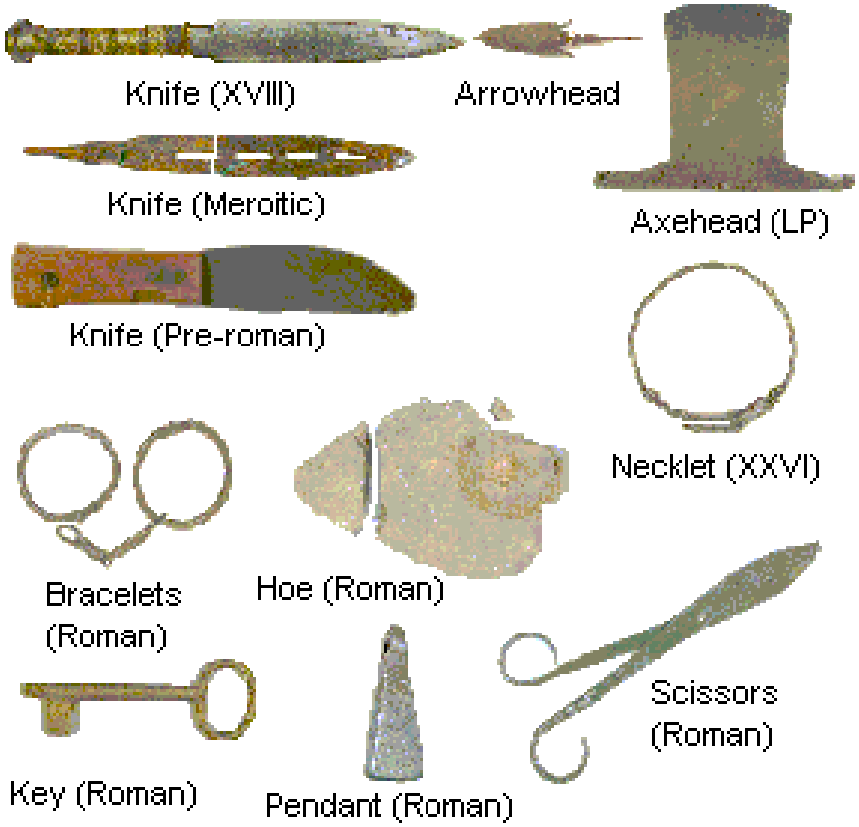


Iron smelting began in Egypt.

Process of Iron Smelting

A mixture of iron and oxide impurities is heated to about 1,500° C. Molten iron is drawn off on one side, and slag (waste) on the other

Iron Age (~2000 B.C.)



Iron weapons revolutionized warfare and iron implements did the same for farming.

Iron Pillar ~ 400A.D.

This iron pillar dating to 400 A.D., remains standing today in Delhi, India. Corrosion to the pillar has been minimal a skill lost to current ironworkers.

Cast Iron (~800)

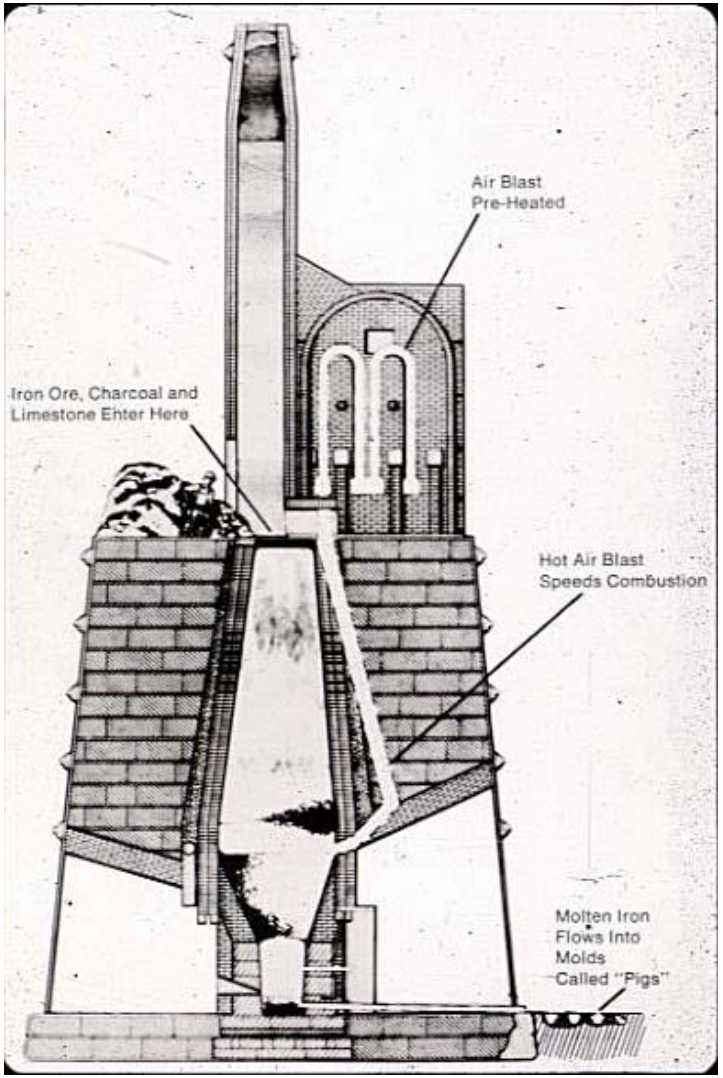
Chinese were the first in the production of cast iron.

Cast Iron (~800)

Molten iron is "cast" into forms made of sand.

Steel (~500)

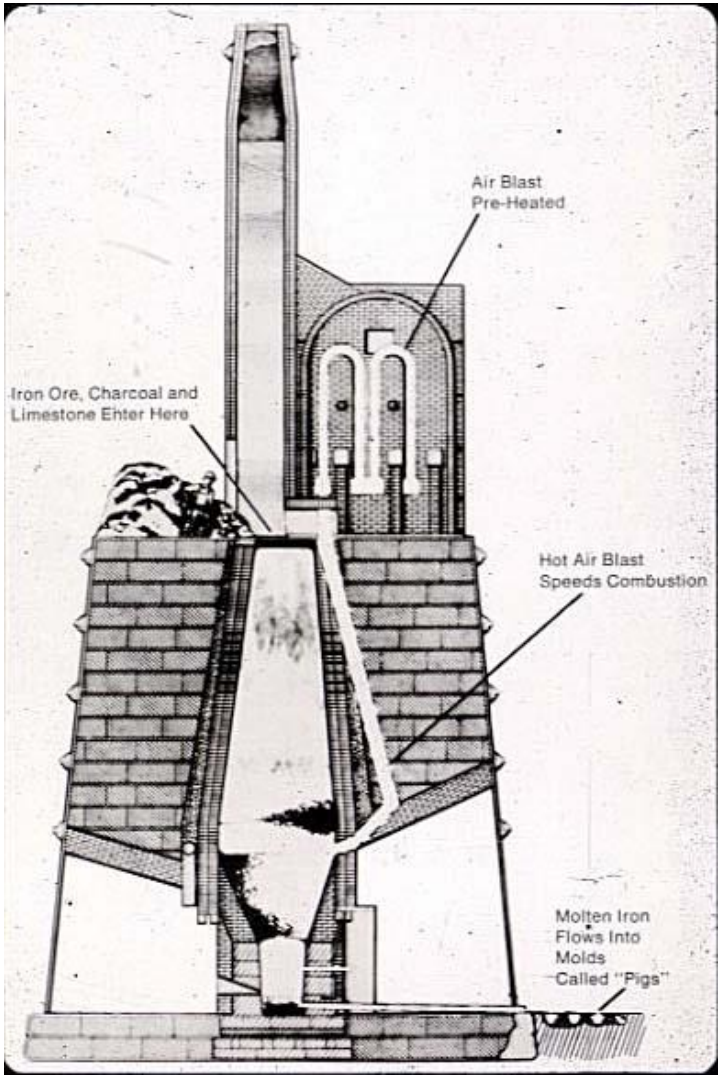
How To Smelt Iron?



Wood

Wood was needed as timber and it takes too much wood so smelt iron.

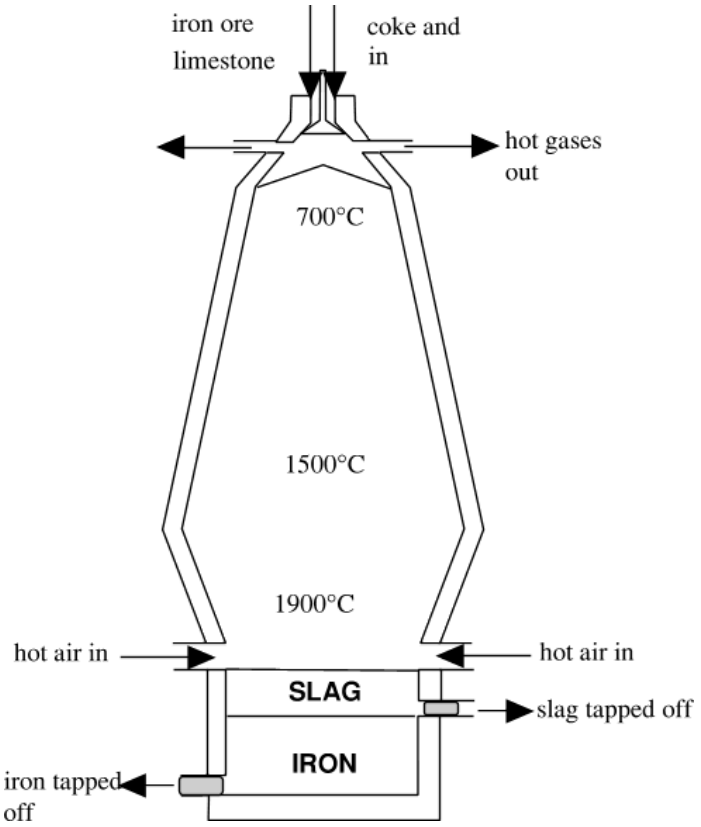
How To Smelt Iron?



Coal

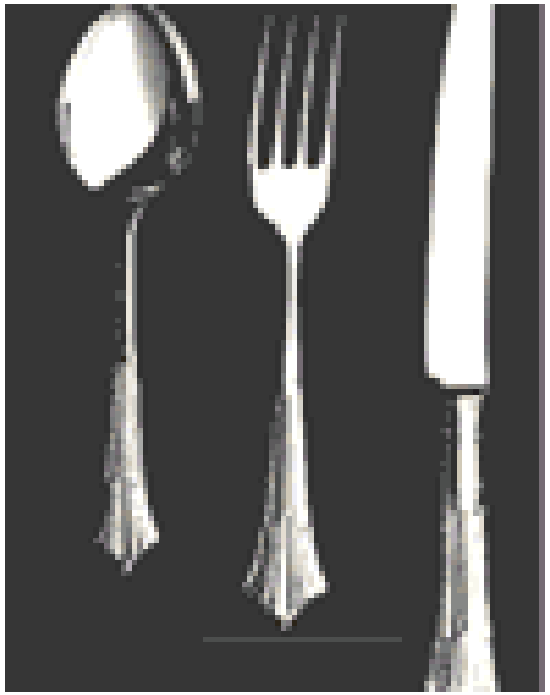
Although cheap and plentiful, coal contained sulphur that made the iron too brittle to be of any use.

Abraham Darby



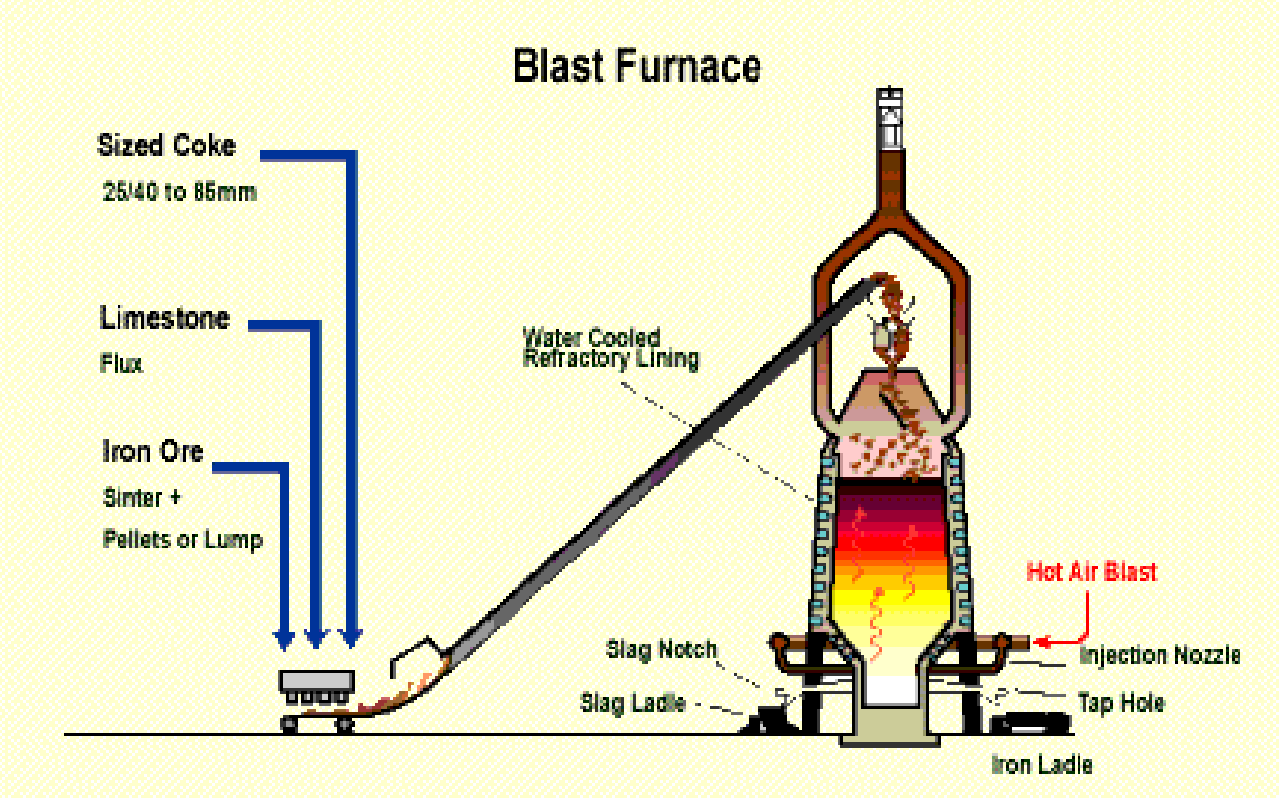
In 1709, Abraham Darby finally succeeded in smelting iron with coke.

1750



Steel becomes the world’s most used material.

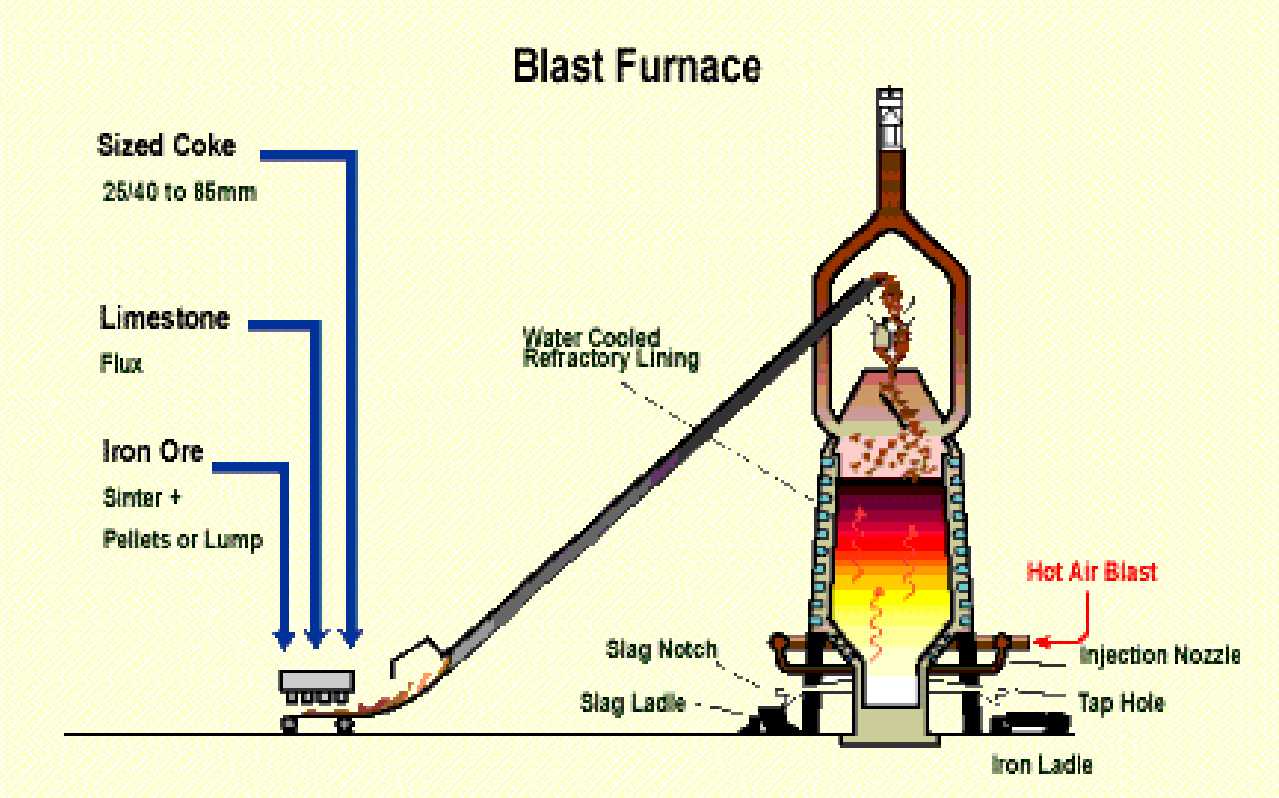
Steel Production Today



Step 1:

$$Fe_2O_{3(s)} + 3CO_{(g)} = 2Fe_{(l)} + 3CO_{2(g)}$$

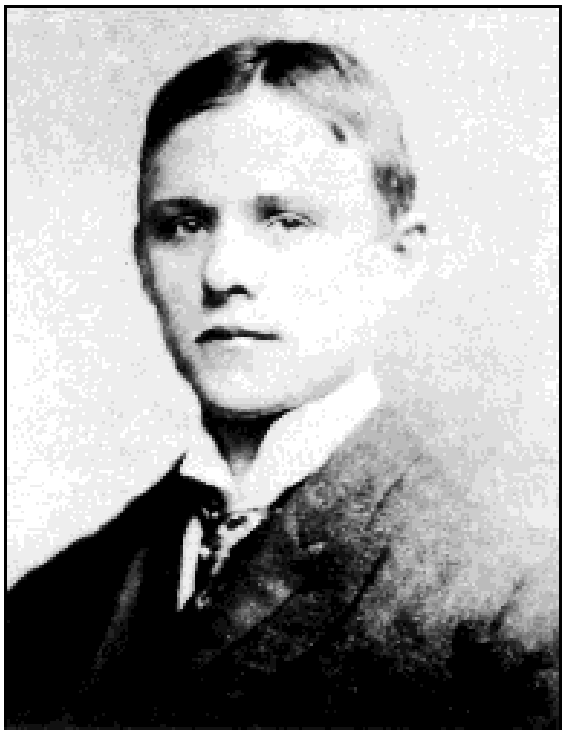
Steel Production Today



Step 2:

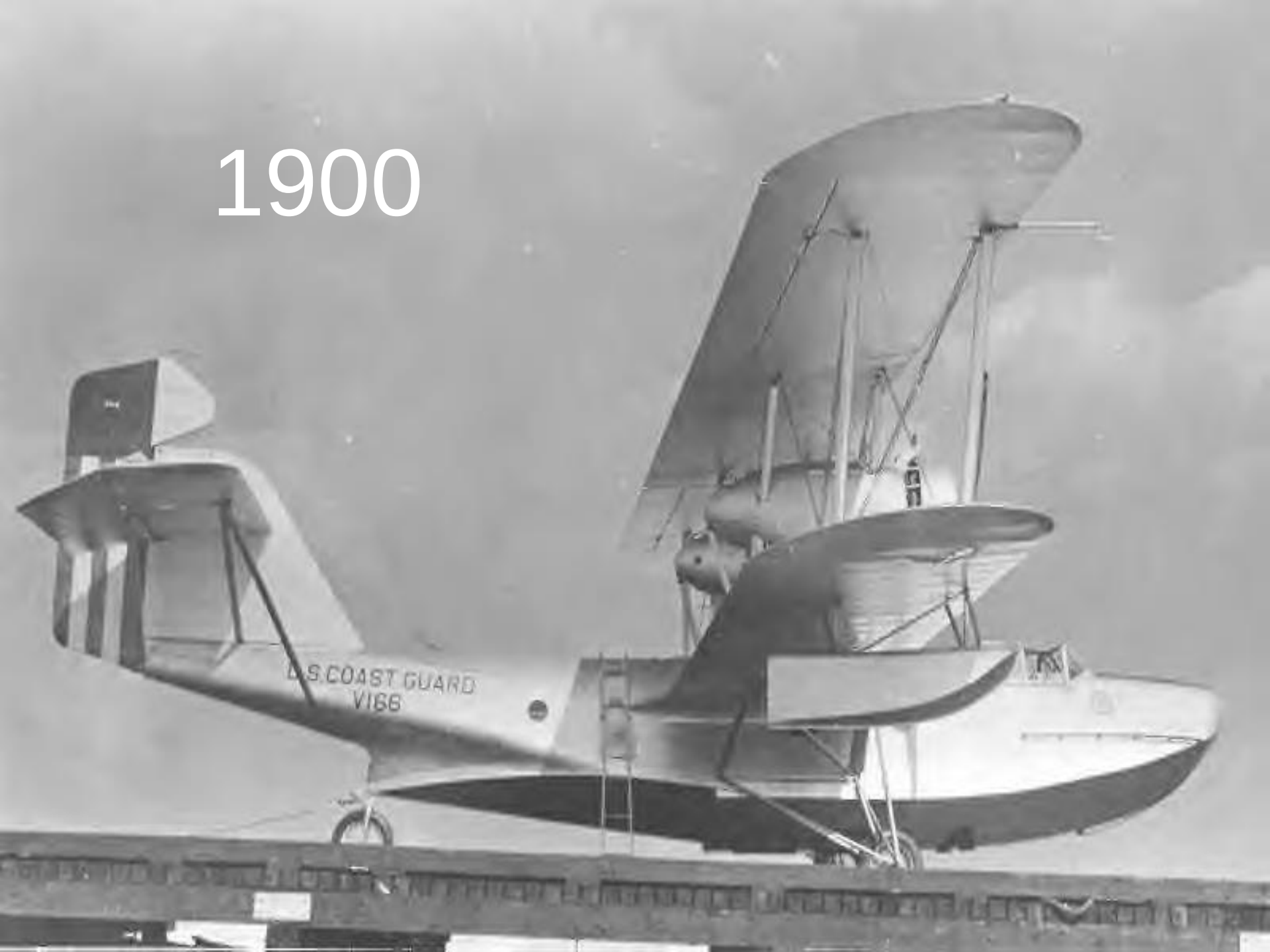
Molten iron is mixed with carbon & other elements.

1850

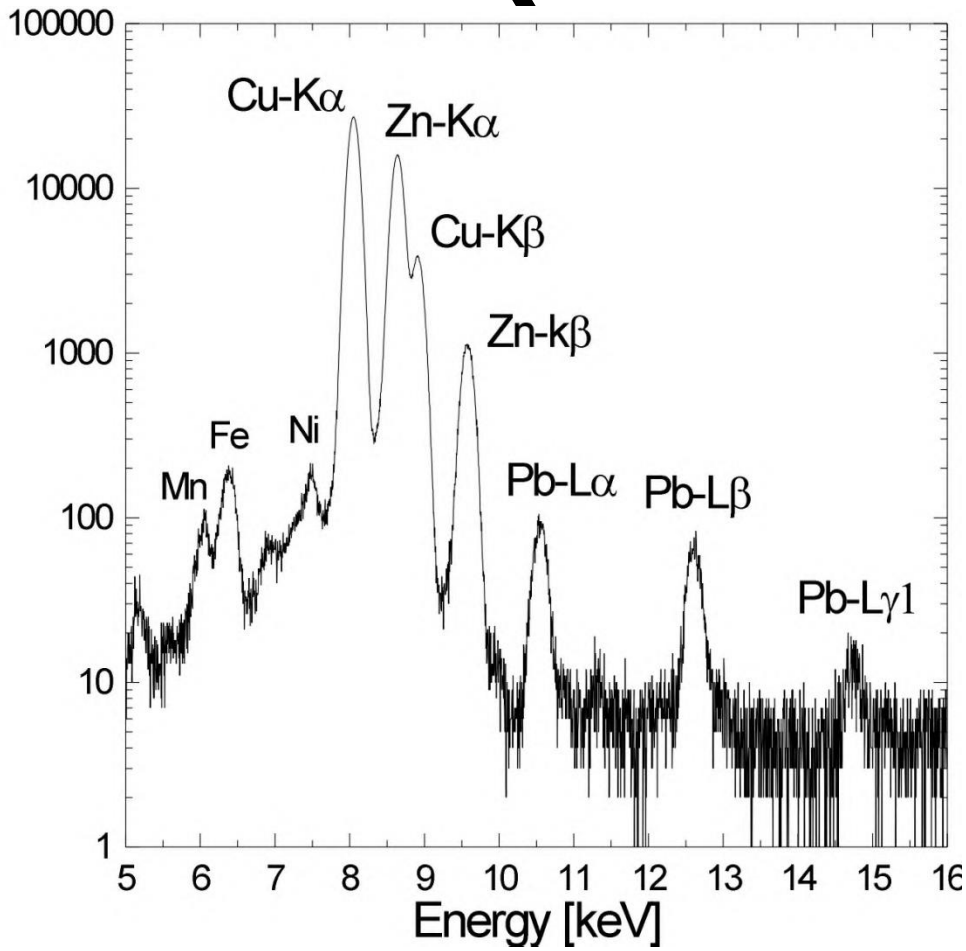


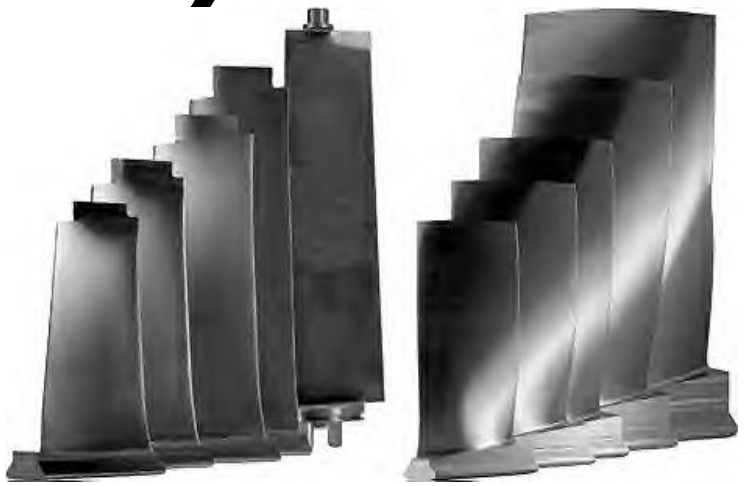
Charles Martin Hall

Isolated Pure Aluminum

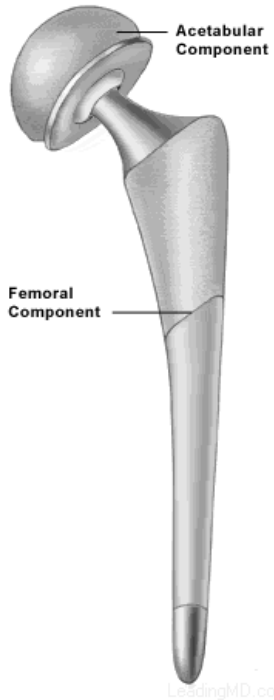

1900
U.S.COAST GUARD
V166

Specialty Alloys (1935-1955)



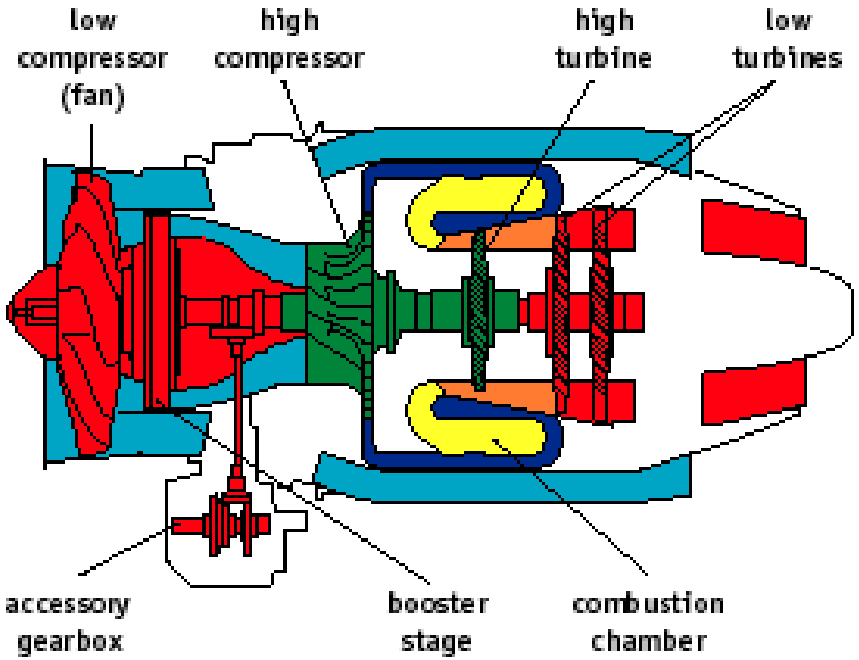


Human Body Parts (1955-present)



High quality alloys of titanium & cobalt.

Super Alloys (1970-Present)



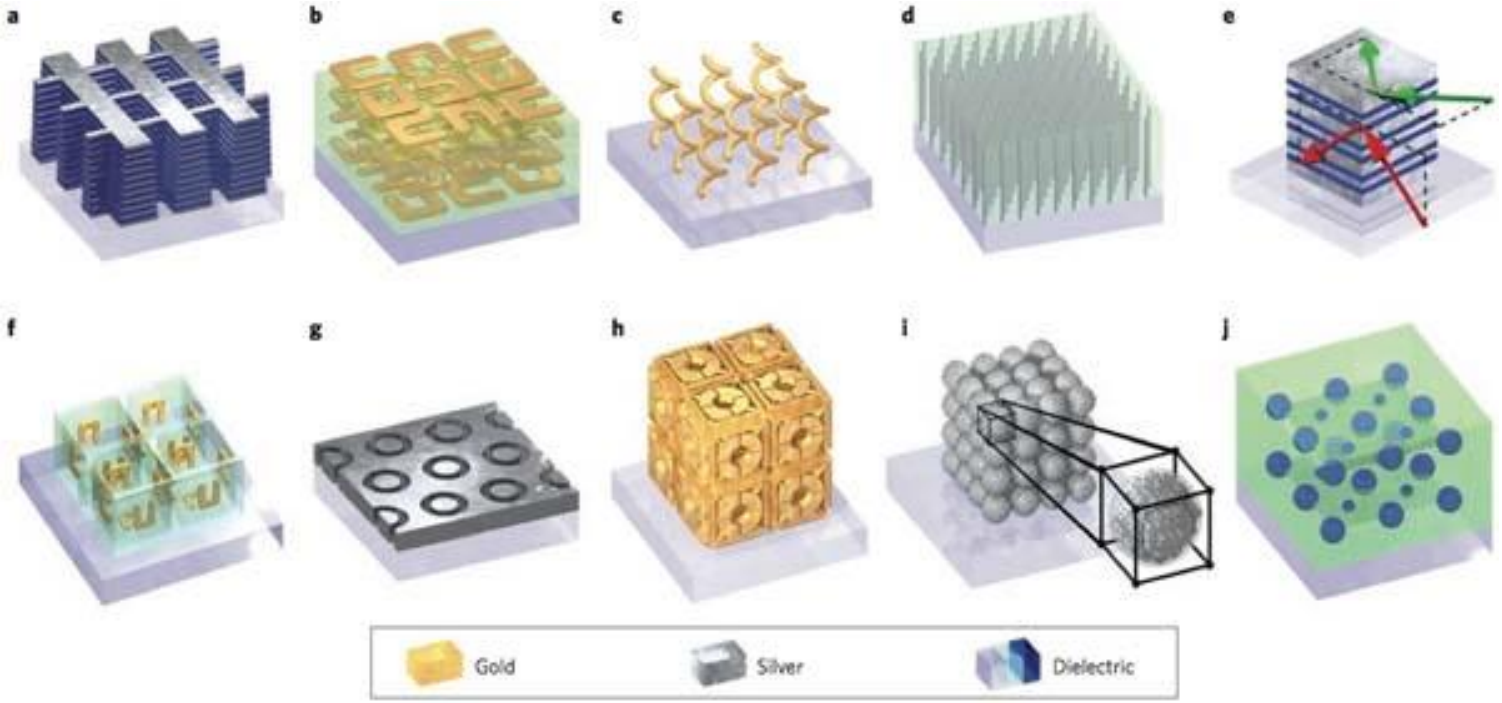
Since they can sustain high temperatures, super alloys were developed for jet engines.

Transparent Aluminum (2010)

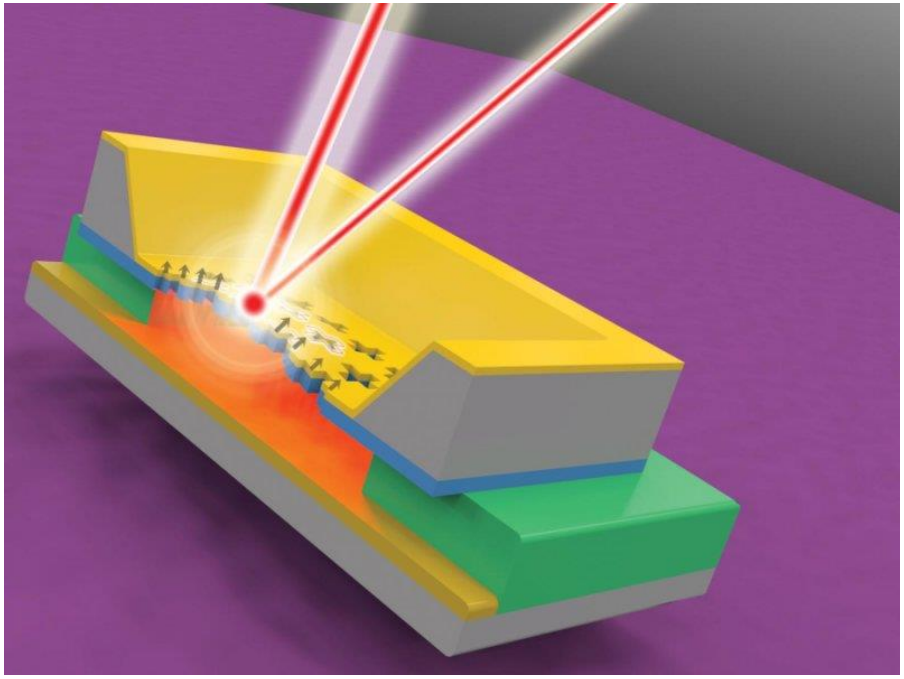
Fine grained aluminum is heated to 1200° C!

3X tougher than steel & it's see-through!

Metamaterials (2015)



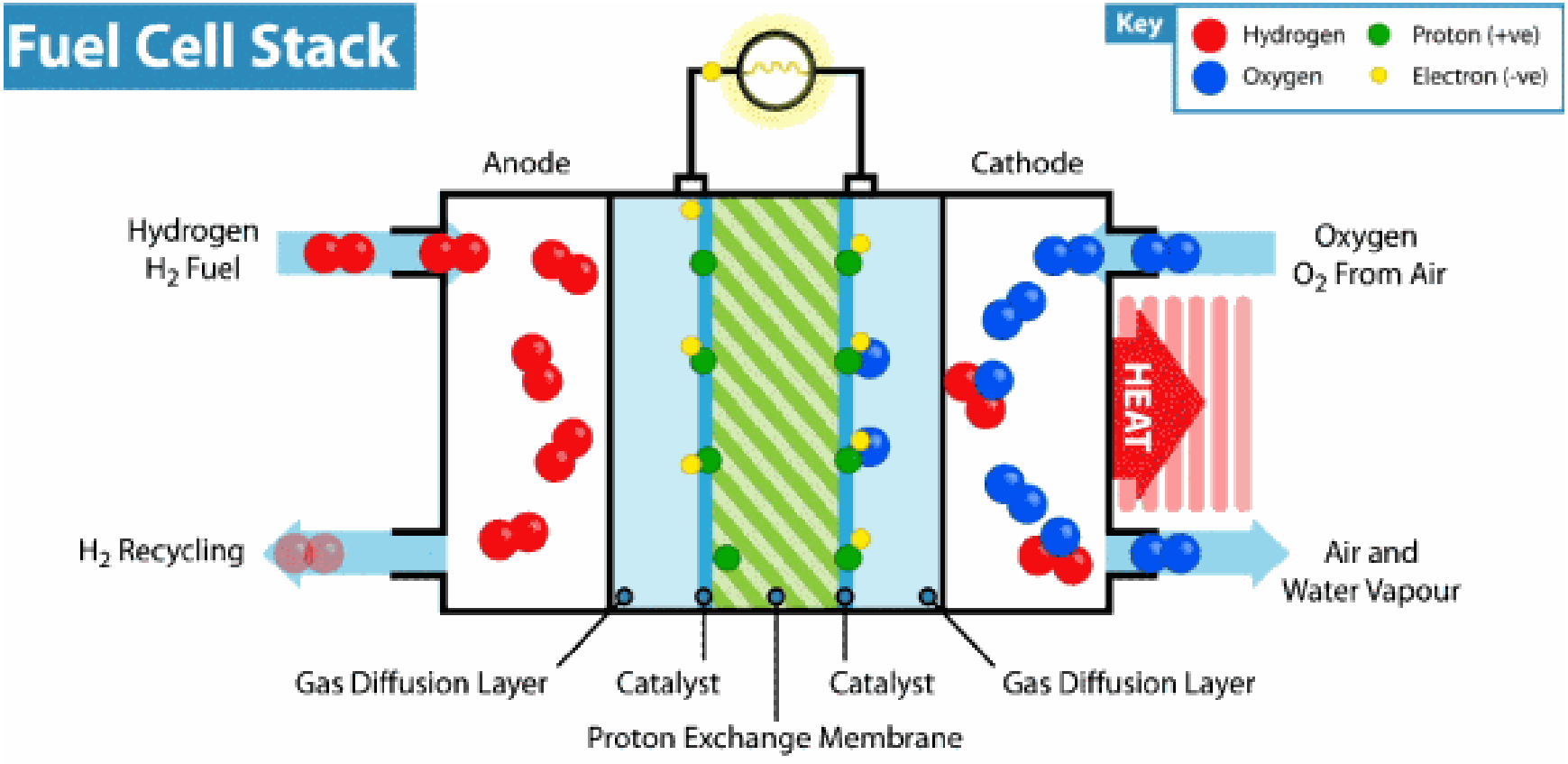
Materials designed that use light to manipulate its mechanical properties.



The top is a bilayer gold/silicon nitride membrane containing an array of cross-shaped nanoantennas etched into the gold layer. The bottom is a metal reflector that is separated from the gold/silicon nitride bilayer by a three-micron-wide air gap.

The device can potentially be used as a new frequency reference to accurately keep time in GPS, computers, wristwatches and other devices.

New Fuel Cell Catalyst (2016)



A nanosize squeeze can significantly boost the performance of platinum catalysts that help generate energy in fuel cell.