

# Introduction to Materials Science and Engineering



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# The objective of Materials Science Study

At some point of time or the other an engineering problem involves issues related to material selection. Understanding the behavior of materials, particularly structure-property correlation, will help selecting suitable materials for a particular application.

The objective of studying materials science is to develop this understanding .

# Objective and Scope of the present course

- ❑ Primary objective is to present the basic fundamentals of materials science and engineering.
- ❑ Expose the reader community to different classes of materials, their properties, structures and imperfections present in them.
- ❑ Help understand the subject with ease by presenting the content in a simplified and logical sequence at a level appropriate for students/teachers/researchers.
- ❑ Aid the teaching learning process through relevant illustrations, animations, web content and practical examples.
- ❑ Highlight important concepts for each topic covered in the subject
- ❑ Provide opportunity of self-evaluation on the understanding of the subject matter.

# Historical perspective

Materials Science  
and  
Human Civilization

# Materials in day to day life

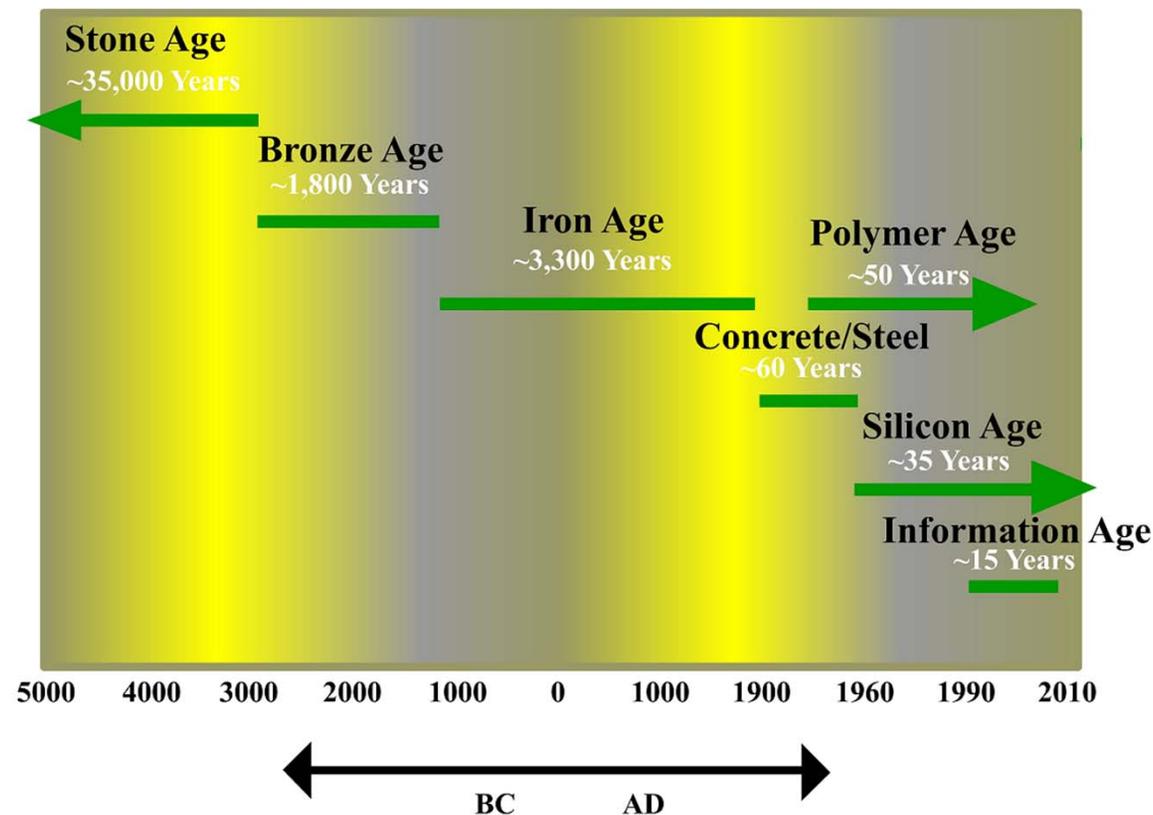


What would life be like without Materials??



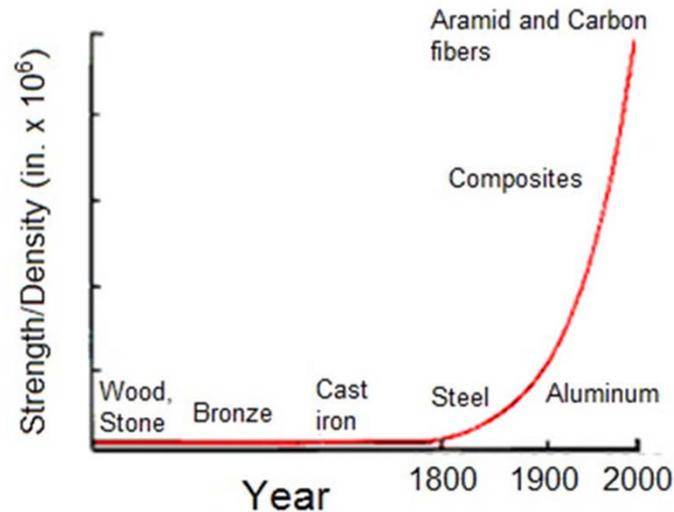
## Materials: The Milestones of Progress

- Development and advancement of Human societies- closely related with materials
- Civilizations have been named based on the level of their materials development – Stone age, Bronze age etc.



# Quest for newer materials:

The driving force for the progress- stone age to IT age



Quest for more advanced materials to meet the growing needs as the civilization progressed.

A look at the history of materials chronologically clearly reveals this

# Stone age

300,000 BC

Stone age – People living in caves and hunting with stone-made weapons

200,000 BC

**Discovery of fire** – Said to be the most significant discovery in human civilization. However, till the time the fire was controlled to contain and utilize the heat, it was not significant.

**Containing the fire** – Was not possible without materials. Started with **clay** (a ceramic material) pots and now we have all kinds of means to control and contain fire.

# Introduction of metals

5500 BC

First metals to be discovered – Copper and Gold

5000 BC

Material processing - Annealing and Shaping.  
Throwing copper into camp fire and hammering  
in early days

4000 BC

Melting and casting of metals. Melting of Gold  
to give it different shapes

3500 BC

Reduction of copper from its ore – Nile Valley  
The dawn of metallurgy.  
Perhaps discovered by chance much before by  
early potters

# Discovery of Alloy - Metal Combinations

**3000 BC**

The discovery of alloy – combination of metals

Mixing of Tin with Copper – Bronze

Copper ore invariably contains some Tin – Mixing of different ores having different Tin content produced the first Bronzes.

# Iron and Steel – Building blocks of human civilization

**1450 BC**

Iron wheels – discovery of iron making.  
Revolution in warfare and cultivation

**1500 AD**

Invention of Blast furnace – Production of pig iron from ores

**1855 AD**

Sir Henry Bessemer (1813-1898)  
Bessemer steel making patent

**20<sup>th</sup> Century**

Many other steel making processes – LD, Electric Arc, VAR for making high quality steels

## Early 20<sup>th</sup> Century – The golden era

1886 AD

**Hall process-** Electrochemical process for extraction of Aluminium from Alumina ( $\text{Al}_2\text{O}_3$ )

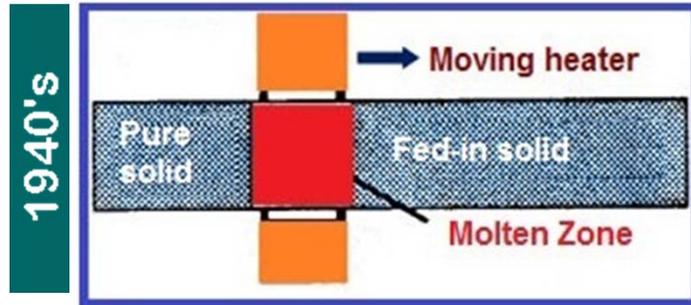
1890 - 1910 AD

**Revolution in Transportation – Discovery** of automobiles and Aero plane

1939

**Process for making Nylon** – Introduction of plastics

# The Electronic revolution



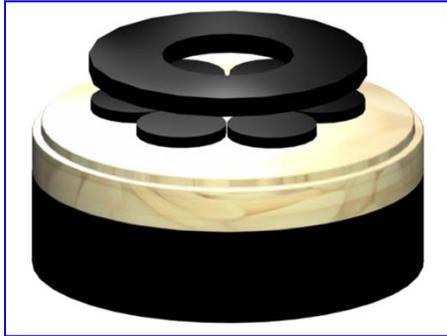
Zone refining – A metallurgical process to produce ultra pure Si

1960's

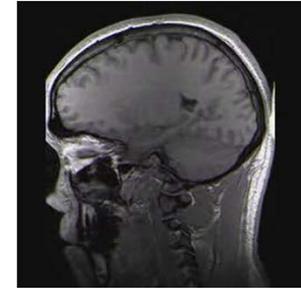
Ultra pure Si through zone refining – Si chip, the heart of electronics. Smaller and smaller Si wafers - Miniaturization

# Superconductors

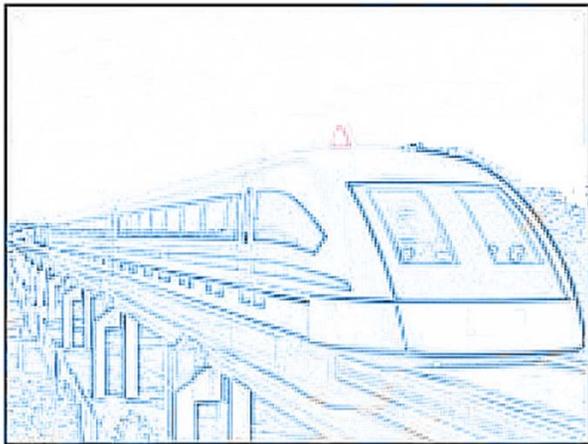
1980's



High temperature ceramic superconductors



MRI Machine, Brain Scan –  
Advancement in Medical science



Magnetic Levitation: Maglev train :–  
300 – 500 kmph

(See Lecture # 15)

## Further reading

<http://neon.mems.cmu.edu/cramb/Processing/history.html>

<http://materialiaindica.wordpress.com/2009/02/16/a-brief-history-of-materials1metallurgical-heritage-of-india/>

**Key words:** History of materials science; Material development; Progress of human civilization