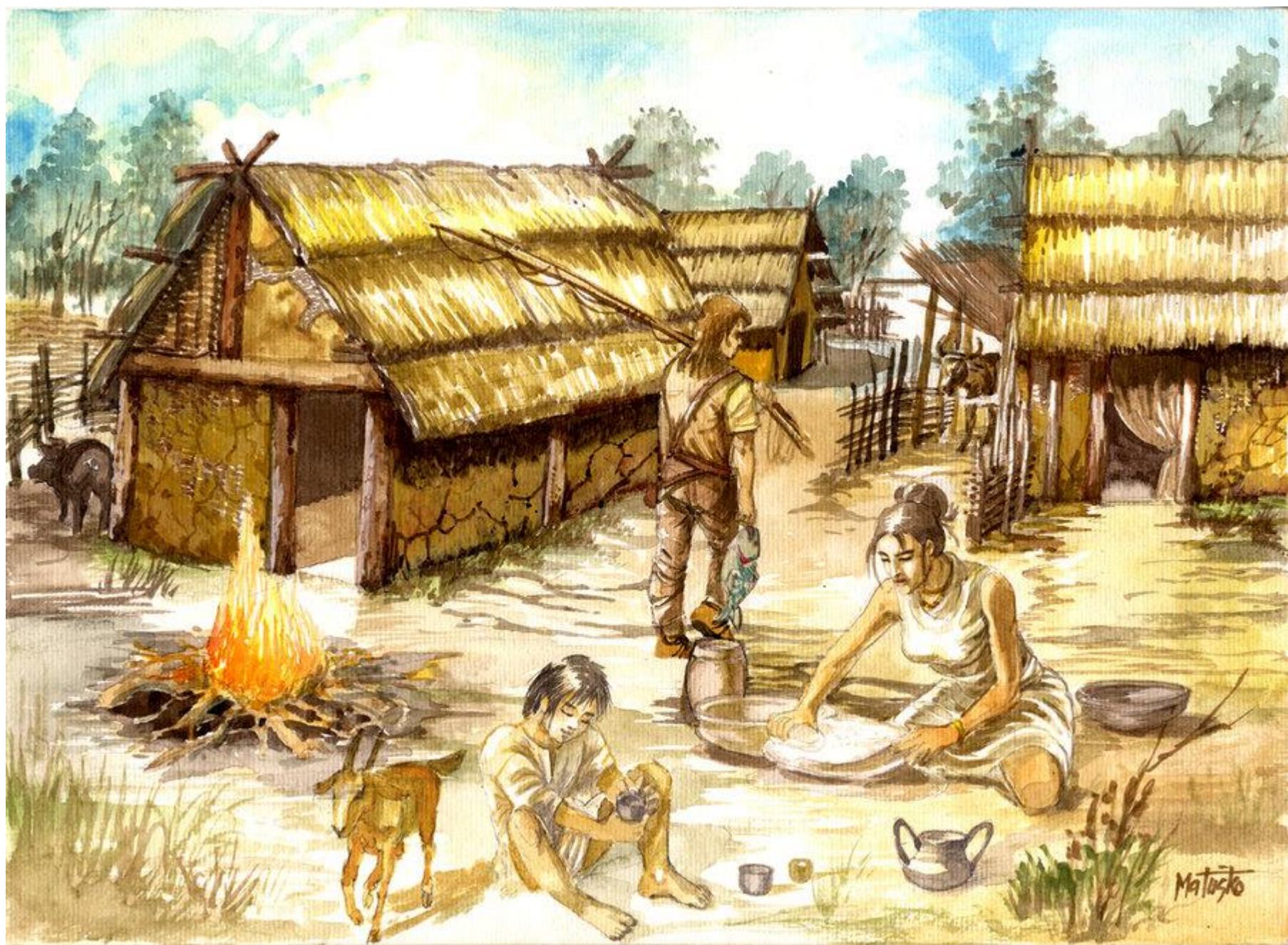


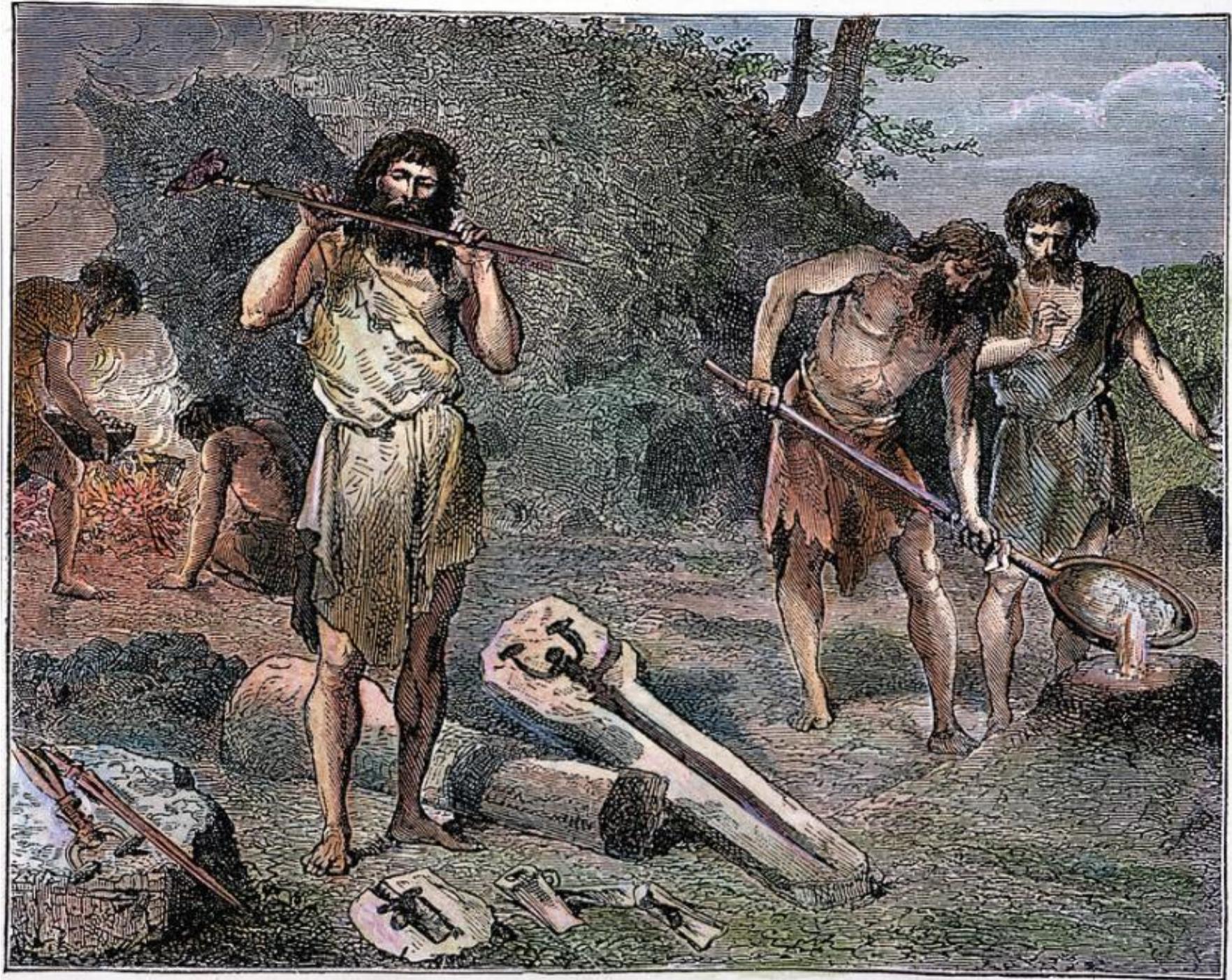
# Why materials science?

Lecture – 1

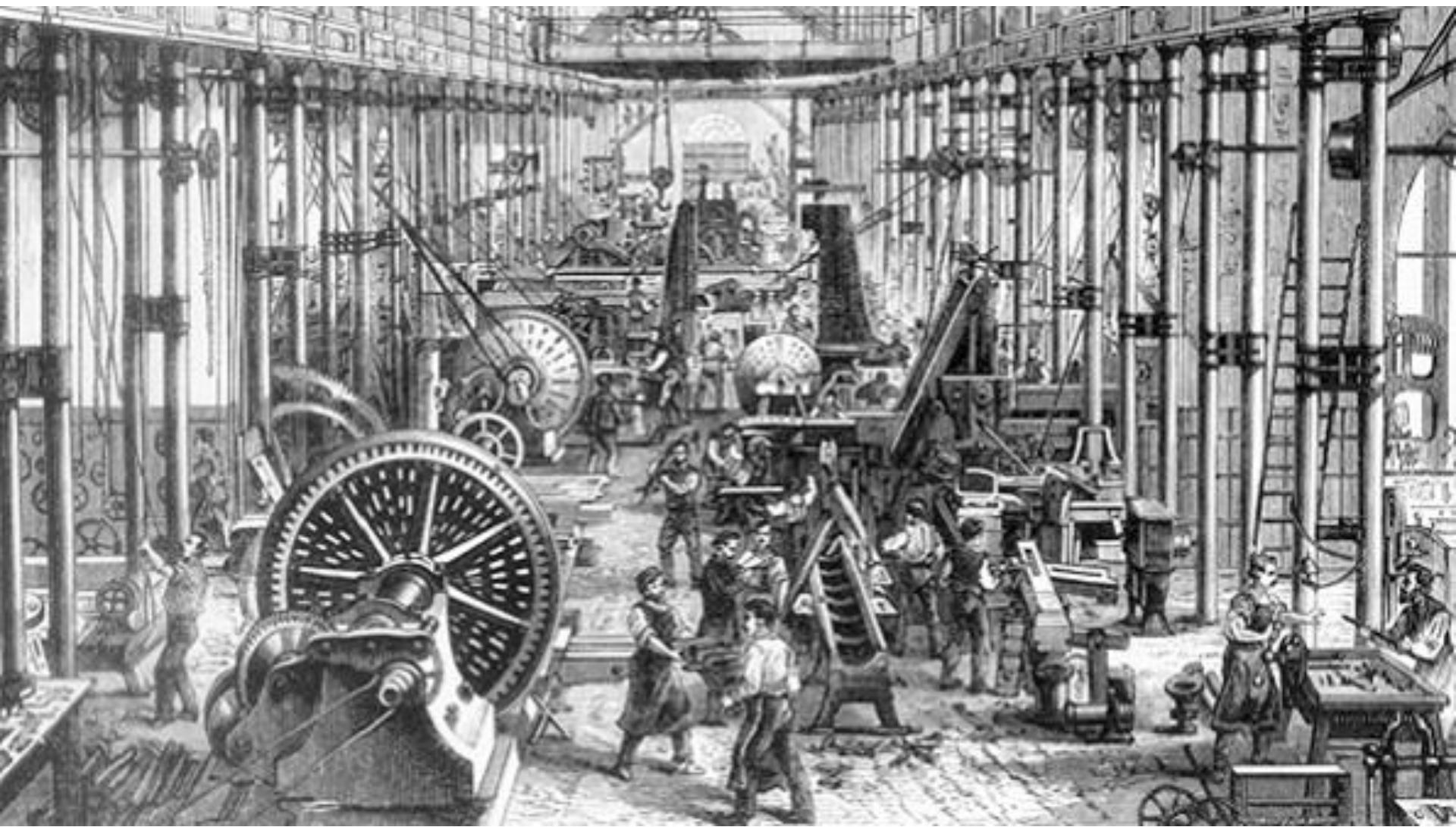


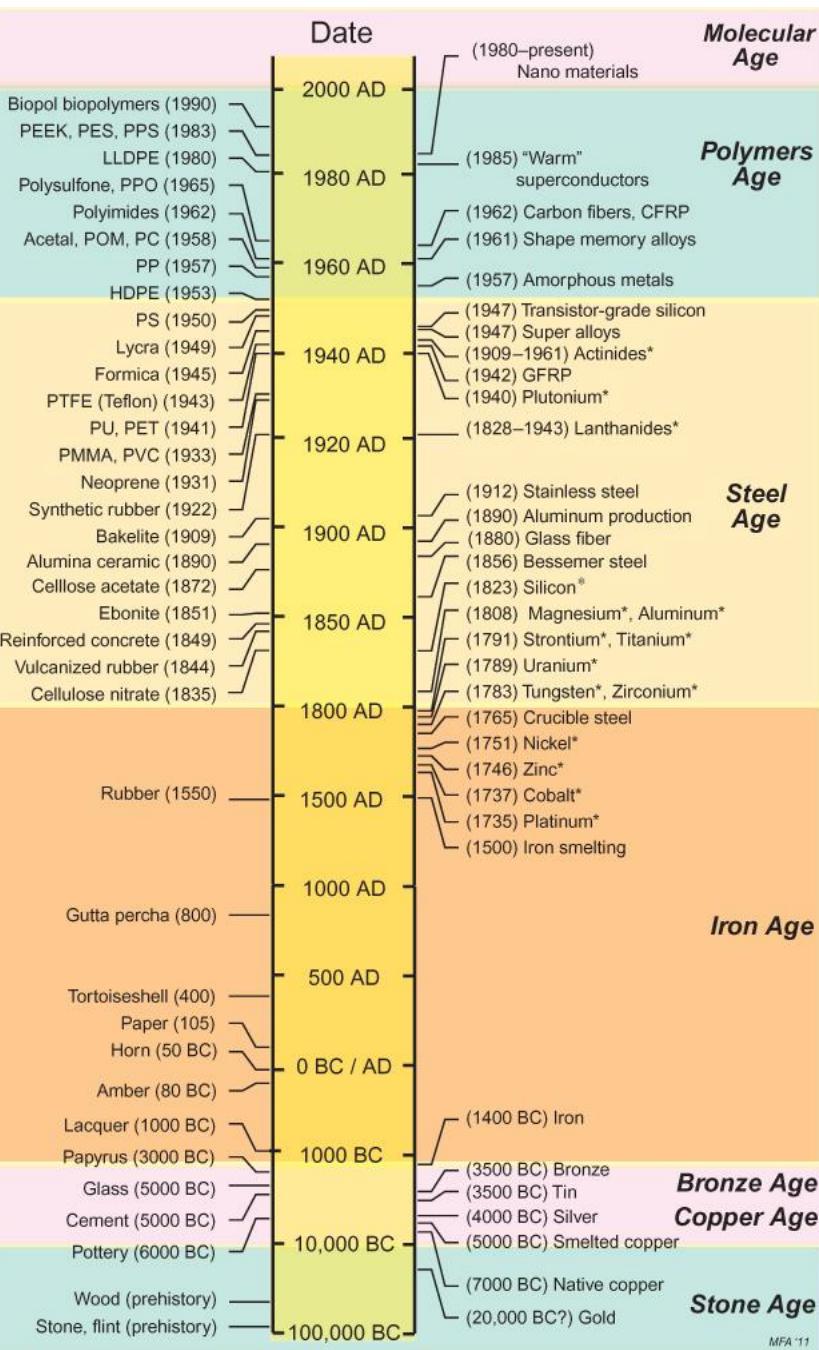




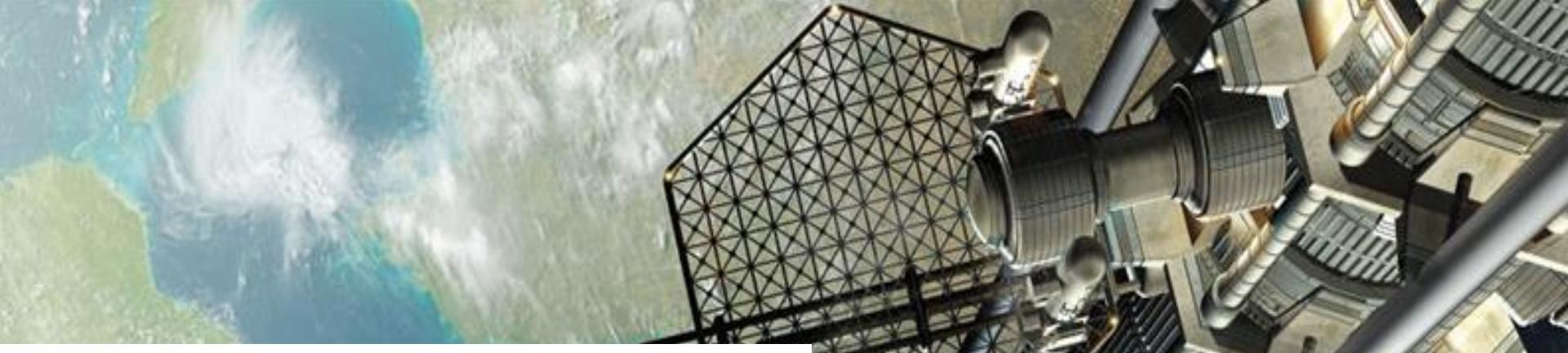








# Materials play a key role in advancing civilizations

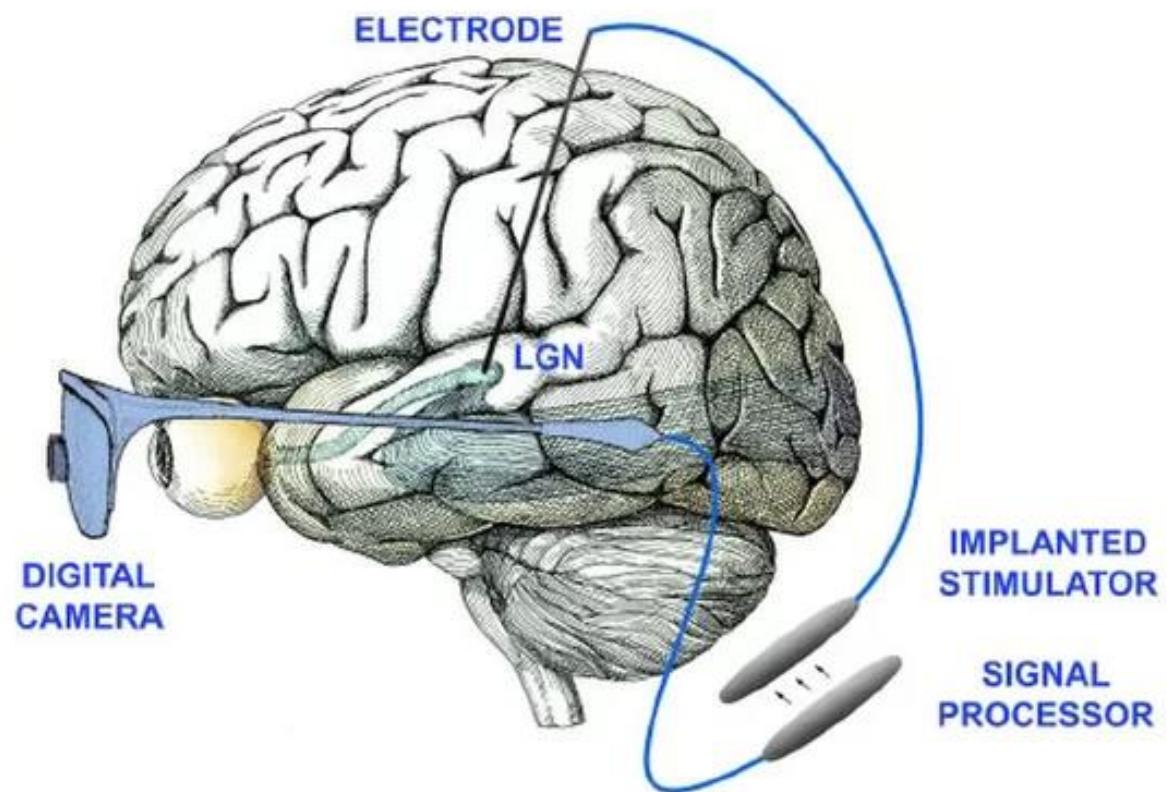






Ava K. & Jaden M.- Biomedical  
Research: Bionics

# Bionics

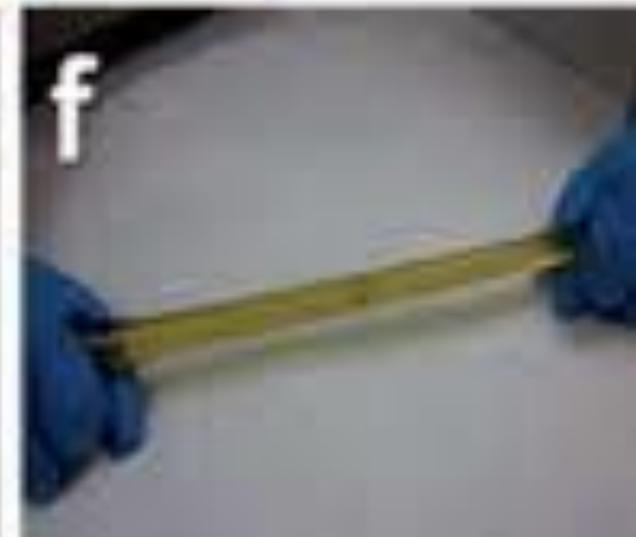


# Self-healing materials

a



d



# What is Materials Science and Engineering ?

- An interdisciplinary field concerned with inventing new materials and improving previously known materials by developing a deeper understanding of the microstructure-composition-synthesis-processing relationships.
- Materials Science: the emphasis is on understanding the underlying relationships between the synthesis and processing, structure, and properties of materials
- Materials Engineering: the focus is on how to translate or transform materials into a useful device or structure.

# Why should I have a course on Materials Science and Engineering ?

- All engineers, at one time or another will be exposed to a design problem involving materials.
- Transmission gear, the superstructure for a building, an oil refinery component, or an integrated circuit chip.
- Selecting the right material from the alternatives for in-service conditions
- Deterioration of materials properties (heat, moisture, wear and tear)
- Economics
- Judicious materials choices based on well-defined criteria and the knowledge of structure–property relationships

# Materials

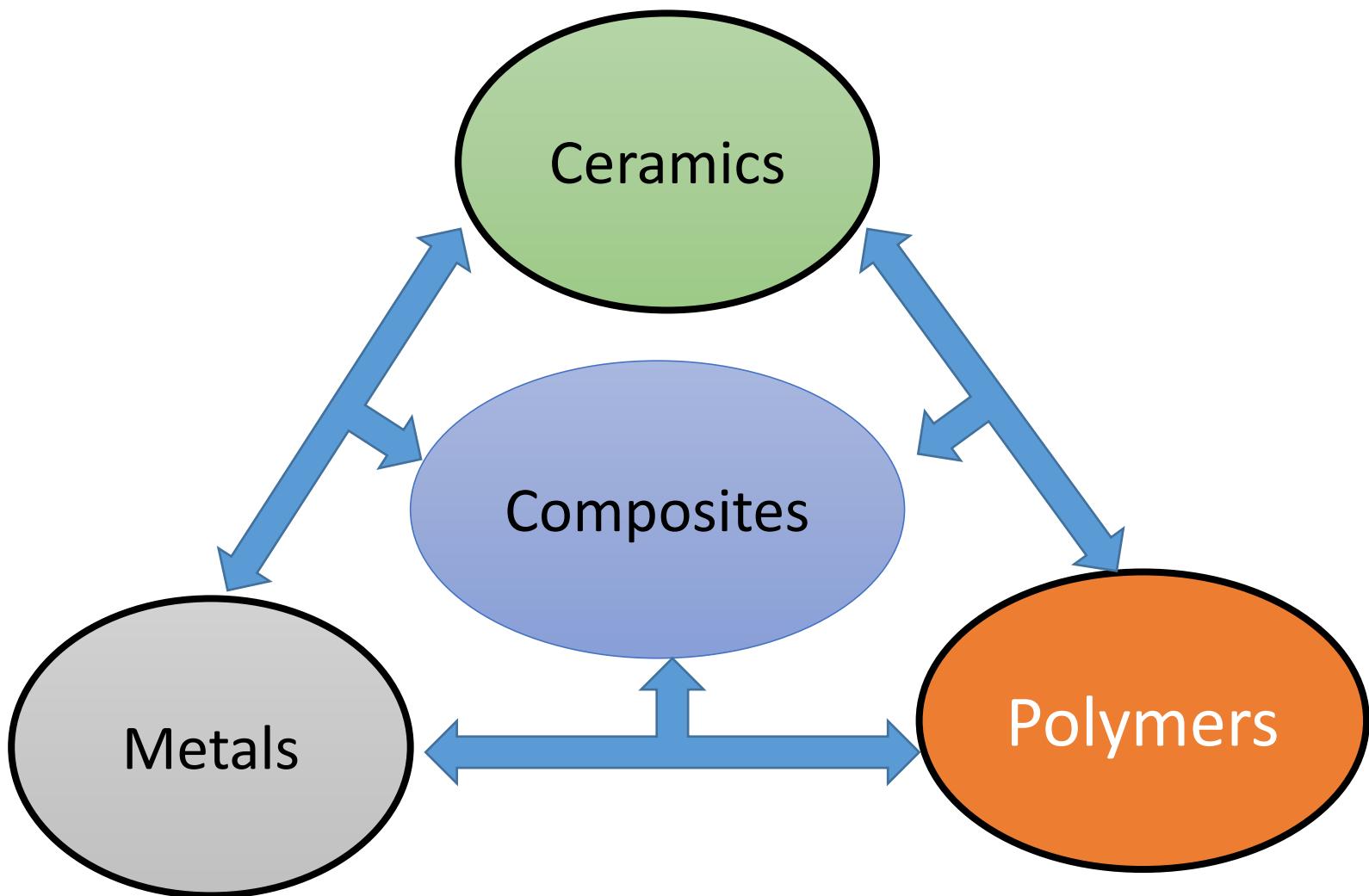
- Every segment of our everyday lives is influenced to one degree or another by materials.



# Materials

- Development of technologies is closely associated with the availability and accessibility of suitable materials.
- Advancement in the understanding of a material type is often the forerunner to the stepwise progression of a technology
  - Automobiles would not have been possible without the availability of inexpensive steel or some other comparable substitute.
  - Sophisticated electronic devices rely on components that are made from what are called semiconducting materials

# Types of Materials



# Types of Materials

- **Metals and alloys:**
  - Strong, ductile
  - High thermal & electrical conductivity
  - Opaque, reflective.
- **Polymers/plastics:**
  - Soft, ductile, low strength, low density
  - Thermal & electrical insulators
  - Optically translucent or transparent.
- **Ceramics:** ionic bonding (refractory) – compounds of metallic & non-metallic elements (oxides, carbides, nitrides, sulfides)
  - Brittle, glassy, elastic
  - Non-conducting (insulators)
- **Composites:**
  - Strong, ductile
  - High thermal & electrical conductivity
  - Opaque, reflective.

# Metals



Courtesy of Dr. A. Mandal

# Advanced Metals and Alloys



Rafale Fighter Jet



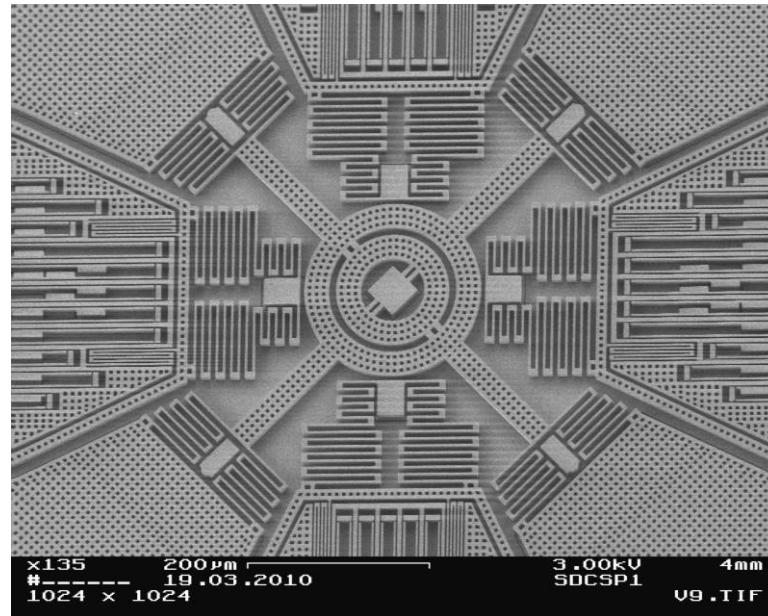
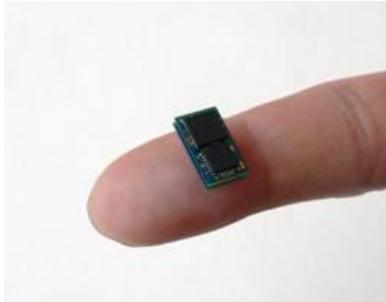
Sneecma M88 engine  
Nickel-based superalloys

# Ceramics



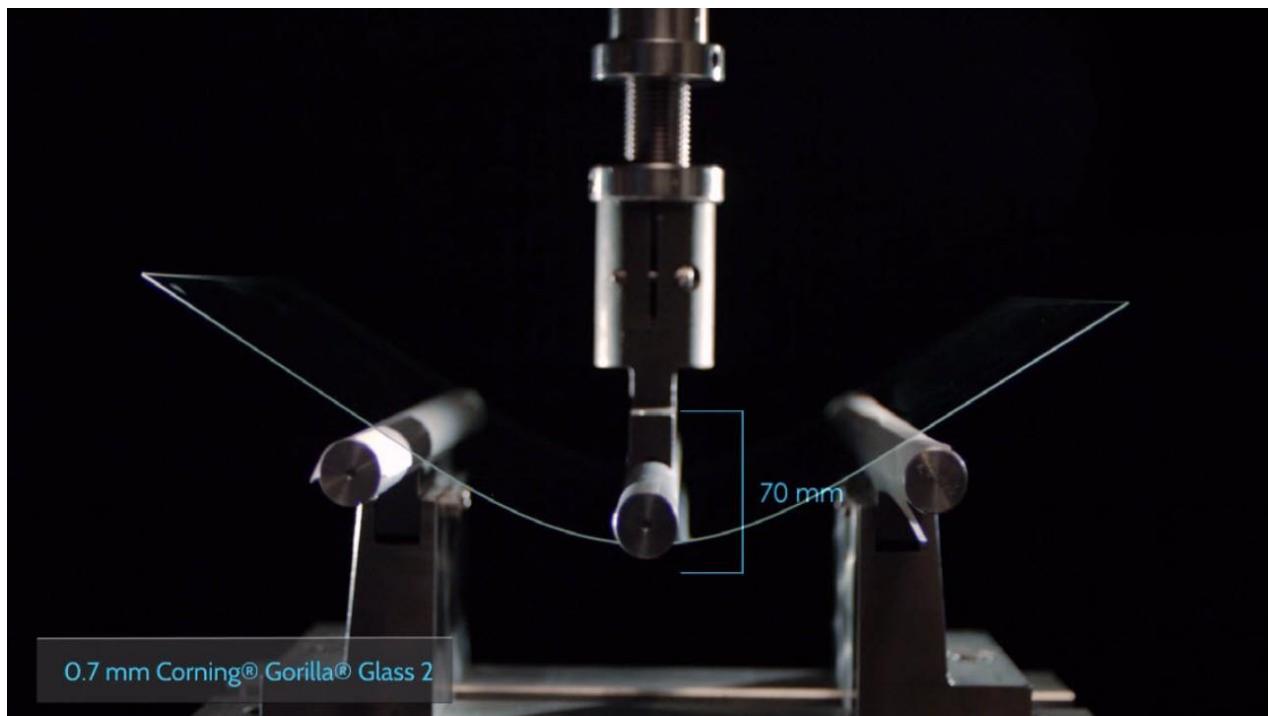
Courtesy of  
Dr. A. Mandal

# Advanced Ceramics



Bulk micromachined Silicon  
MEMS gyroscope

# Advanced Glass: Not so brittle!



<http://www.corninggorillaglass.com/>

# Polymers



Courtesy of  
Dr. A. Mandal

# Advanced Polymers



Flexible Electronics: Polyimide

Recent Developments in Polymer MEMS, Chang Liu  
[Advanced Materials Volume 19, Issue 22](#), page 3783–3790



Bullet-proof vest: Kevlar

<http://armorcorr.com/bullet-proof-vests-c-1/>

## Composites



Courtesy of  
Dr. A. Mandal

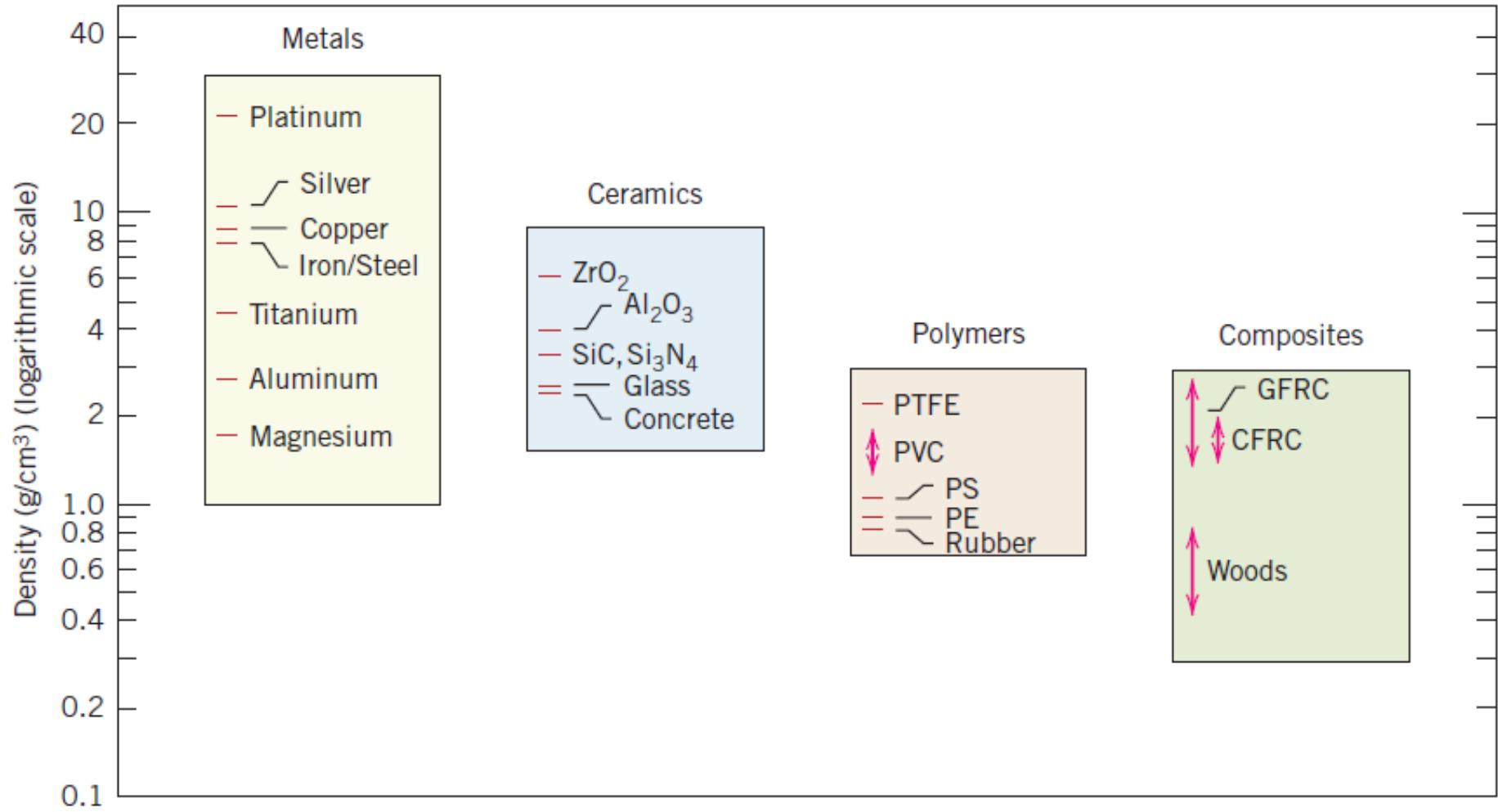
# Advanced Composites



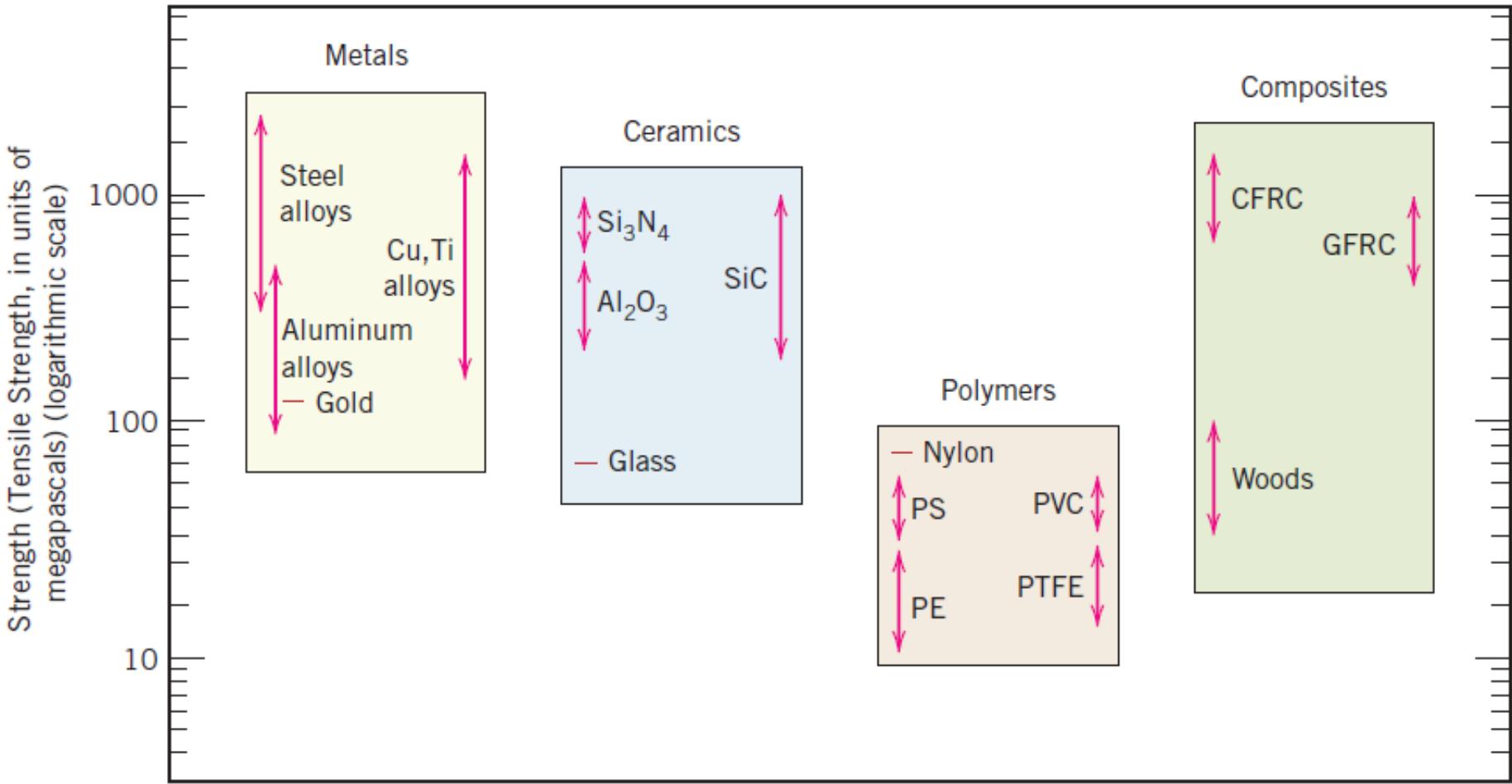
Woven carbon fibre composites



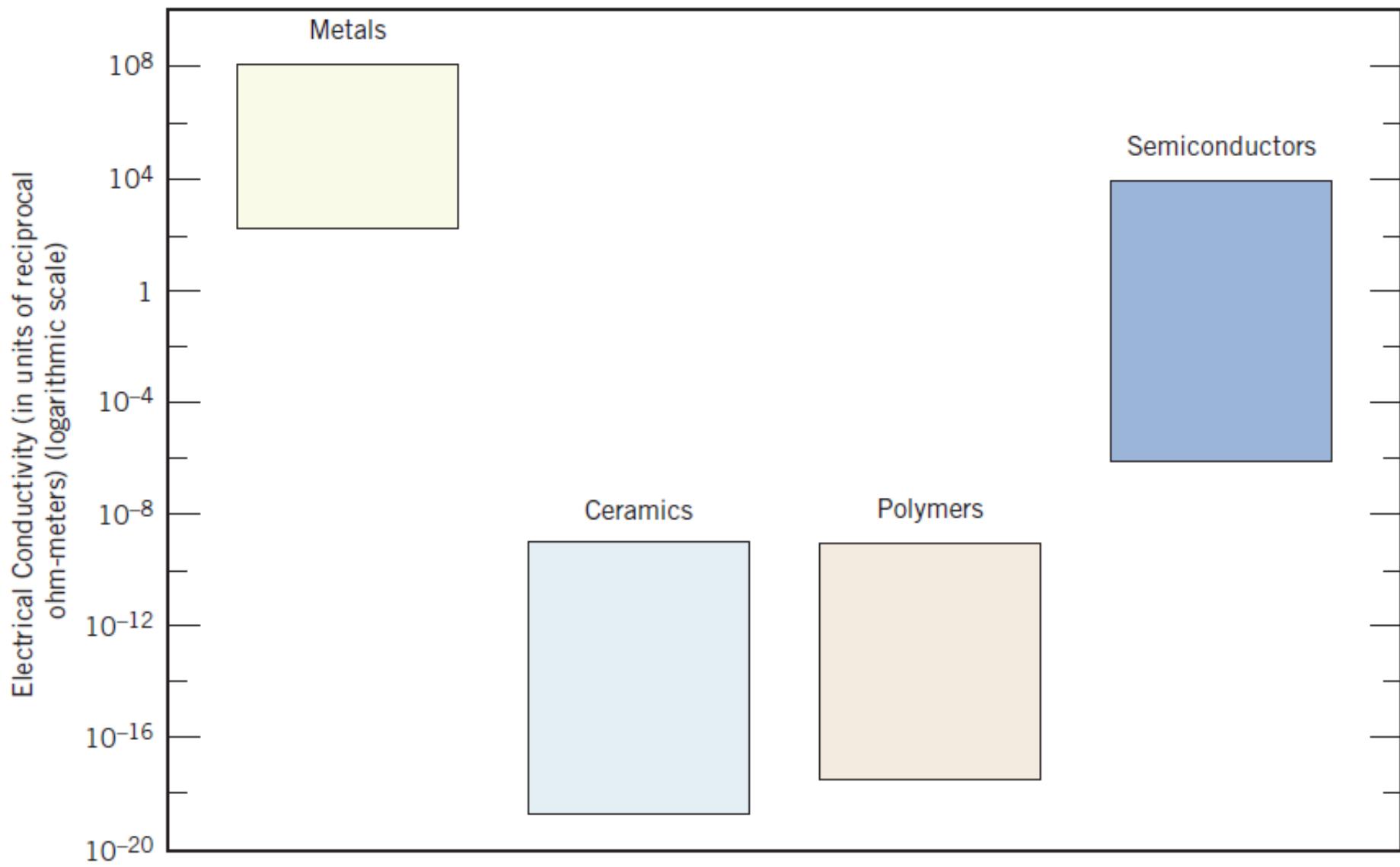
# Materials Properties: Density



# Materials Properties: Strength



# Electrical Conductivity



Completely new materials → New Elements,  
but these are unstable

The image shows a periodic table of elements with a fun, educational twist. Each element's box is filled with a hand-drawn style illustration that relates to the element's name or properties. For example, Hydrogen has a rocket, Helium has a hot air balloon, and Oxygen has a bomb. The illustrations are varied and often whimsical, making the table more engaging for children.

# Designing hybrid materials

Find new materials to fill the empty space

