**Glass**

* An amorphous solid material – in between the crystalline and the liquid state
* Its molecules are arranged in irregular pattern
* Pros:
  + Visible transmittance
  + Optically transparent
  + Weather and rust resistant
  + Dustproof and waterproof
  + Safe packaging material
  + Insulator of electricity
  + Colour availability
  + Recyclable
  + UV stable
* Cons:
  + Brittleness
  + Heat transparency
  + Fragile
* Raw materials
  + Major
    - Quartz/silica sand
    - Soda ash
    - Limestone
  + Minor
    - Dolomite
    - Crushed/recycled glass (cullet)
    - Boric acid, lead oxide, sodium oxide (to get coloured glass)
* History of glass
  + The first manufactured glass material appeared 6000 years ago
  + 1st Century B.C. – glass blowing begins (blow pipe was developed)
  + By the 16th Century – glass was made all over Europe
* Glass processing
  + 3 steps
    - Fusion of raw materials
      * The raw materials are weighed and mixed together to form the BATCH. Later broken glass is added to lower the temperature. The batch is melted in a furnace.
      * The furnaces are usually electrical, gas-fired, or oil-fired. The temperature varies from 1500°C to 2800°C according to the type of product.
    - Working with molten glass
      * Blowing (automatic blowing – bottles, lamp bulbs, traditional hand blowing)
      * Casting (large pieces of glass – mirror)
      * Drawing (Windows – thin sheets of glass)
      * Pressing (glass bricks, lenses)
      * Rolling (wired and plate glass)
    - Annealing
      * Annealing of glass is a process of slowly cooling down hot glass objects after they have been formed (glass will break when cooled suddenly)
      * In glass manufacturing, a special type of furnace, a Lehr is used for this process
      * Glassware moves through the oven’s zones on a conveyor belt
      * After annealing the glass can be cut, drilled, sized and polished for use
    - Finishing
      * Cleaning
      * Griding
      * Polishing
      * Etching
      * Engraving
      * Sandblasting
      * Cutting
      * Painting
    - Coloured glass
      * Red coloured glass can be obtained by adding selenium sulfide
      * Blue glass can be obtained by adding copper oxide
      * Milky glass can be obtained by adding alumina or phosphate
    - Types of glass
      * According to the melting point
        + Soda glass – soft glass - melting temperature of batch is 1300°C, bottles, windows
        + Quartz glass – hard glass - melting temperature of batch is 1500°C, wine glasses, electrical bulbs
        + Pyrex glass - melting temperature of batch is 1700°C, baking Jena dish, laboratory glass ware
      * According to chemical composition
        + Silica glass
        + Soda-lime glass – bottles
        + Flint glass (lead glass) – optical lenses
        + Borosilicate glass – glassware in kitchens and laboratories
        + Alumo-silicate glass – screen of smartphones
      * Decorative and technical glass
        + Lead crystal glass – it sparkles, expensive glass ware
        + Technical

Chemical – glassware in laboratories

Optical – cameras, lenses, glasses

Building – windows

Safety – car glass, wired glass

Glass fibres – surfboards, helmets, canoe

* + - Future of glass
      * Functional integration of glass that can become an ideal substrate for OLED lighting, touch screens, etc.
      * Bioactive glass – include the original bioactive glass, bioglass, implant materials in the human body to repair and replace diseased or damaged bones
      * Smartphones – bendable glass, scratch resistance
      * Special coatings for buildings: Smart mirrors and highly insulating glass windows
    - Testing
      * Impact testing
      * Thermal shock resistance
      * Physical inspection
      * Stress testing