SOME INDUSTRIALLY IMPORTANT

INORGANIC MATERIALS

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OUTLINE

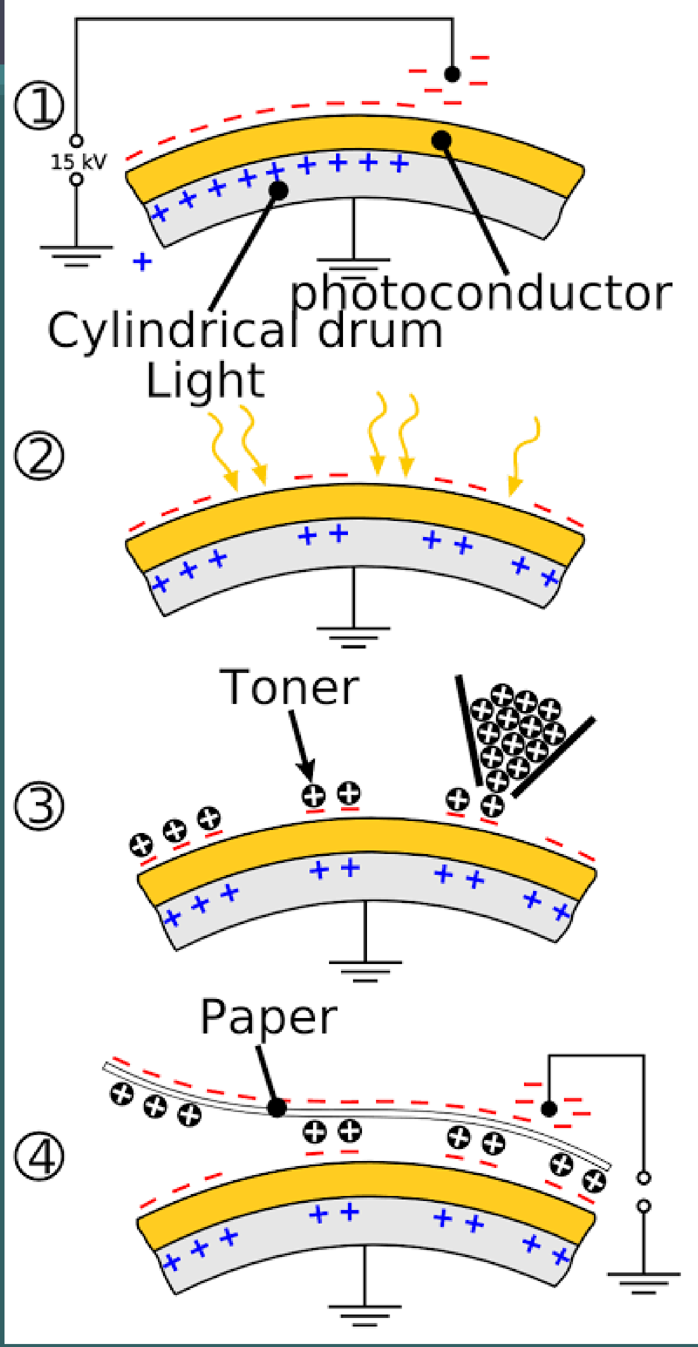
- **SELENIUM IN XEROGRAPHY**
- **REFRACTORY MATERIALS**
- **CERAMICS**

ROLE OF SELENIUM IN XEROGRAPHY

Application – Xerographic Copiers

- The process of xerography is used for making photocopies
- ‘Xerography’ in Greek means dry writing
- Uses photoconductive materials
  - A photoconductive material is a poor conductor of electricity in the dark but becomes a good electric conductor when exposed to light
  - Photoconducting nature of Selenium – Non conducting in dark and conducting in light.

The Xerographic Process



- **Fabrication of photoreceptor and its sensitization**
  - Prepared by vacuum depositing of a film of amorphous Selenium on aluminium sheet.
  - The selenium device is then sensitised in the dark by an electrostatic charge

- **Formation of latent image**
  - The image to be xeroxed, which consists of light and dark patterns, is then allowed to fall on the sensitised photoreceptor
  - A latent(hidden) image is obtained
    - Surface potential in the light region is reduced because electrostatic charge get reduced as Se conducts in light
    - Surface potential in the dark regions remain unaltered as Se is a non conductor in dark.

- **Development of latent image**
    - The toner particles mixed with spherical carrier beads are allowed to run over the photo receptor.
    - The toner particles become negatively charges due to friction and are attracted by the electrostatically charged patterns on the photo receptor
    - The toner particles are not attracted by the uncharged patterns on the receptor
    - The adherence of the toner particles on selective part of the photoreceptor thus leads to the formation of a visible image from the latent electrostatic image

- **Transfer of the image on print paper**

The print paper which is kept parallel to the photoreceptor is then electrostatically charged

This process transfers the toner particle from the photoreceptor to the print paper

- **Fixing**

  The toner particles are then fixed permanently on the print paper by melting them on the surface by electric heating

- **Cleaning**

  After the transfer of image from photoreceptor to the print paper, any toner particle left on the photoreceptor is removed by electrostatic and mechanical methods.

- **Erasing of the image- Exposed to light**

  The photoreceptor is then exposed to light so the whole of the Se layer become equally conducting

  Photoreceptor is now ready to use (The surface potential on the photoreceptor attains a uniformly low value.)

REFRACTORY MATERIALS

Refractory materials

- Metal carbides
  - Salt like carbides
  - Covalent carbides
  - Interstitial carbides
- Borides
  - Borides having isolated B atoms
  - Borides having chains of B atoms
  - Borides having extensive 2/3-Dimensional network

CARBIDES

1. Salt like carbides

- Carbon + electropositive metals of Gr. 1,2 and 13
- Synthesis - The metal, its oxide or hydride is heated strongly in an electric arc with carbon to get the required carbide.
- Classification
  - Acetylide- Give acetylene on hydrolysis (BeC_2, MgC_2, CaC_2)- They contain C^{2-} ions, $(C{=}C)^{2-}$
  - Methanide- Give methane on hydrolysis (Al_4C_3, Be_2C)- They contain C^{4-} ions
  - Allylides- Mg_2C_3 is the only carbide which yield allylene on hydrolysis

2. Covalent carbides

- C + elements which have same electronegativity as C or a higher value.
- C forms carbides with hydrogen or elements of group 16 or 17.
- CH_4, CS_2, CCl_4
- They are either gases or volatile liquids, not thermally stable
- Other category consists of giant molecules formed by linking together a large number of small units
- Common examples are boron carbides, B_4C and silicon carbides, SiC

3. Interstitial carbides

- Metal + carbon or reduction of metal oxide with carbon at high temperature 2000˚C
- Transition metal carbides are interstitial carbides
- Metals retained their close packed structure and incorporated C atoms in their octahedral interstices to give MC and M_2C type carbides.
- They are extremely hard refractory materials, mp in the range 3000-4000˚C
- They are hard, brittle and good conductors of electricity and are chemically inert
- WC and TaC are used for the manufacture of high speed cutting tool.

Application of carbides in industry

- SiC is used as an abrasive under the name carborundum and also as a refractory material. Very resistant to corrosion, abrasion and also finds applications in nuclear reactors.
- Boron carbide harder than silicon carbide is now used as an abrasive and also used as a shield against radioactive radiations.
- Tungsten carbides is used in making tools and dies.

BORIDES

Borides

- Compounds of B with more electro positive elements
- Synthesis
  - Heating metal with B
  - Heating metal/metal oxide with boron carbide
  - Heating metal oxide with B_2O_3 and C
  - Heating the metal with B_2O_3 and B_4C

Structure of Borides

- Borides having isolated B atoms

  -metal rich borides-B occupy the interstitial space-Mn_4B, Co_3B, Pd_3B etc.

- Borides having chains of B atoms

  Proportion of B increases- M_3B_2 and MB types

- Borides having extensive 2/3-Dimensional network

  MB_2(2D),

  MB_4 , MB_6, MB_{12} (3D)

Properties and uses of borides

- Extremely hard, non-volatile refractory substances
- Chemically inert
- High MP, electrical and thermal conductivity
- Used for making turbine blades, combustion chambers and rocket nozzles.
- Metal borides are extensively used in nuclear reactors as neutron shield and as control rods.
- Used as electrodes in high temperature electrolysis

CERAMICS

Ceramics

- An inorganic compound consisting of a metal or semi metal and one or more non-metals
- A wide-ranging group of materials whose ingredients are clays, sand and felspar.
- Contain some of the following:
  - Silicon & Aluminium as silicates
  - Potassium compounds
  - Magnesium compounds
  - Calcium compounds

Metals	Ceramics
Crystal structure	Crystal structure
Large number of free electrons	Captive electrons
Metallic bond	Ionic/covalent bonds
Good electrical conductivity	Poor conductivity
Opaque	Transparent (in thin sections)
Uniform atoms	Different-size atoms
High tensile strength	Poor tensile strength[a]
Low shear strength	High shear strength
Good ductility	Poor ductility (brittle)
Plastic flow	None
Impact strength	Poor impact strength
Relatively high weight	Lower weight
Moderate hardness	Extreme hardness
Nonporous	Initial high porosity
High density	Initial low density

Classification

- Traditional ceramics
- New ceramics
- Glasses

Traditional ceramics

- Clay products such as pottery, bricks, cement, tile etc.
- Based on mineral silicates, silica and mineral oxides found in nature.
- Clay and alumina are the major raw materials

New ceramics

- Advanced ceramic materials have been developed over the past half century
- Applied as thermal barrier coatings to protect metal structures, wearing surfaces, or as integral components by themselves.
- Engine applications are very common for this class of material which includes silicon nitride (Si_3N_4), silicon carbide (SiC), Zirconia (ZrO_2) and Alumina (Al_2O_3)
- Heat resistance and other desirable properties have lead to the development of methods to toughen the material by reinforcement with fibers and whiskers opening up more applications for ceramics

Amorphous Ceramics (Glasses)

- Main ingredient is Silica (SiO_2)
- If cooled very slowly will form crystalline structure.
- If cooled more quickly will form amorphous structure consisting of disordered and linked chains of Silicon and Oxygen atoms.
- This accounts for its transparency as it is the crystal boundaries that scatter the light, causing reflection.
- Glass can be tempered to increase its toughness and resistance to cracking.


THANK
YOU