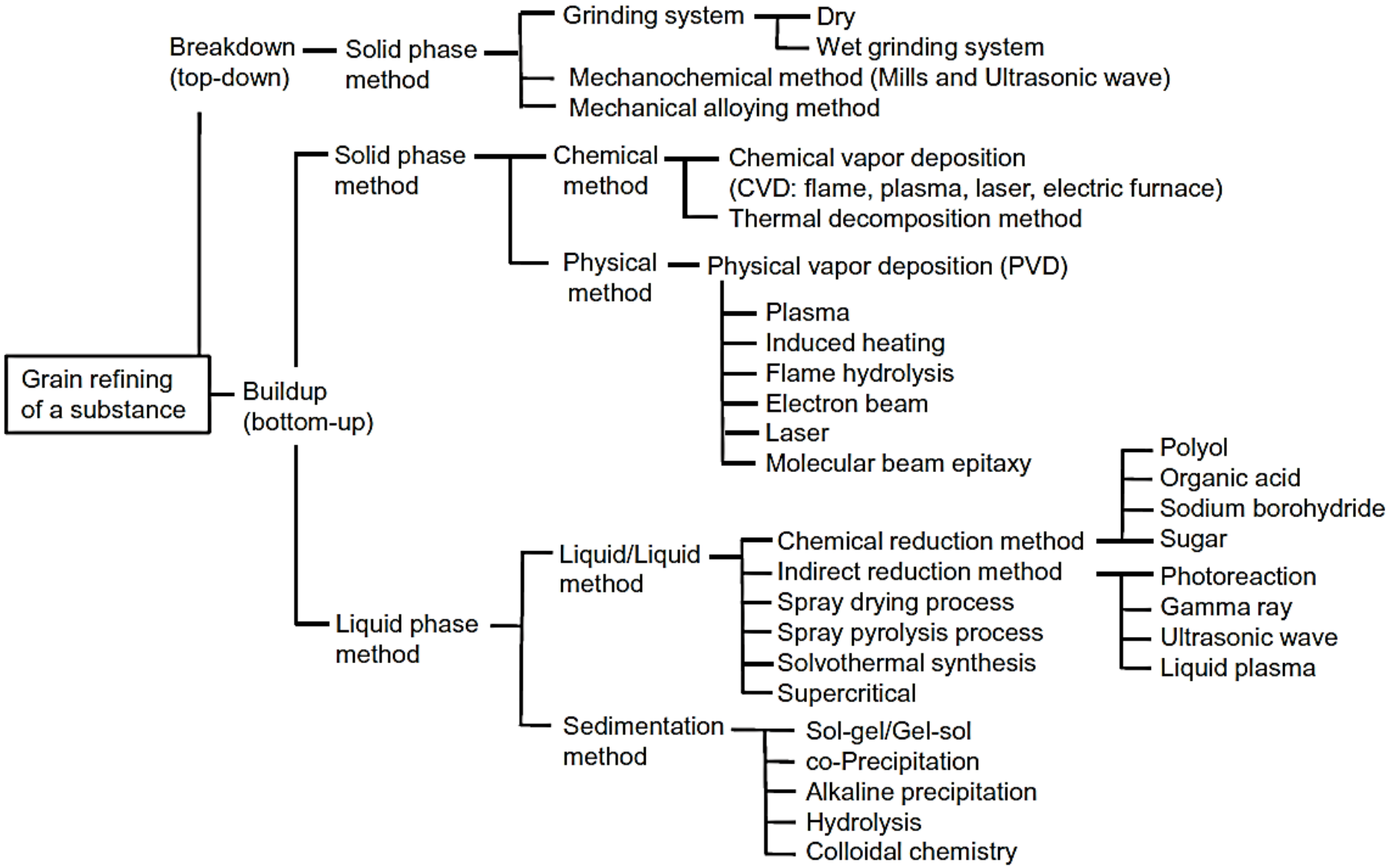
METHODS TO PREPARE NANOMATERIALS



Top-down – Ball Milling

- It is a Top-Down process.
- This process produces nanocrystalline nanoparticles and coarser particles that contain nanocrystals and used in fields, such as ,material classes, including metals, ceramics, and polymers. metallurgy industries for many years.
- The objectives of milling include : particle size reduction (comminution or grinding); shape changing (flaking); agglomeration; solid-state blending (incomplete alloying); modifying, changing, or altering properties of a material (density, flowability, or work hardening); and mixing or blending of two or more materials or mixed phases. However, the primary objective of milling is often purely particle size reduction.

Top-down – Ball Milling

- Ball milling is a method of production of nano materials.
- This process is used in producing metallic and ceramic nano materials.
- These mills are equipped with grinding media composed of wolfram carbide or steel.
- Ball mills rotate around a horizontal axis, partially filled with the material to be ground plus the grinding medium.

Top-down – Ball Milling

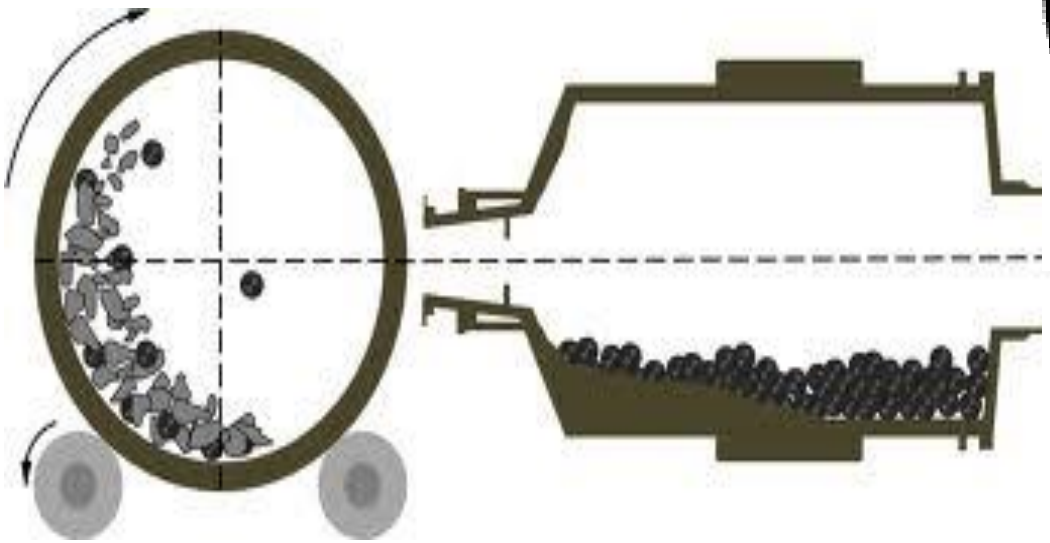
PRINCIPLE

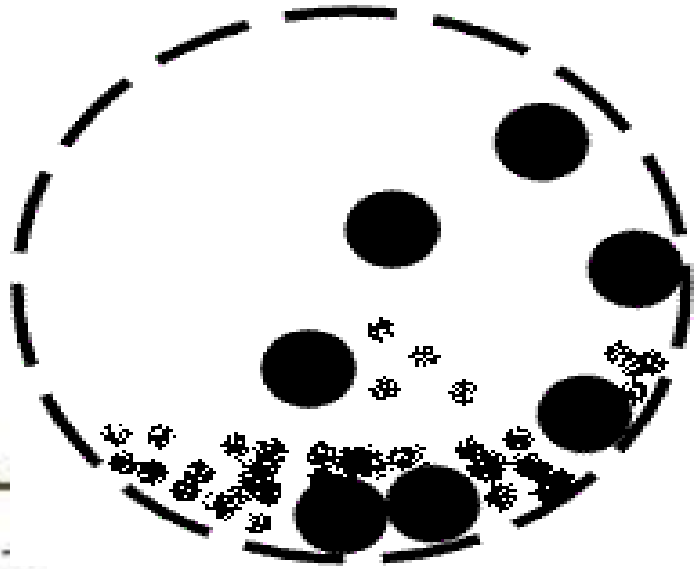
- It works on the principle of impact, i.e., size reduction is done by impact as the balls drop from near the top of the shell.

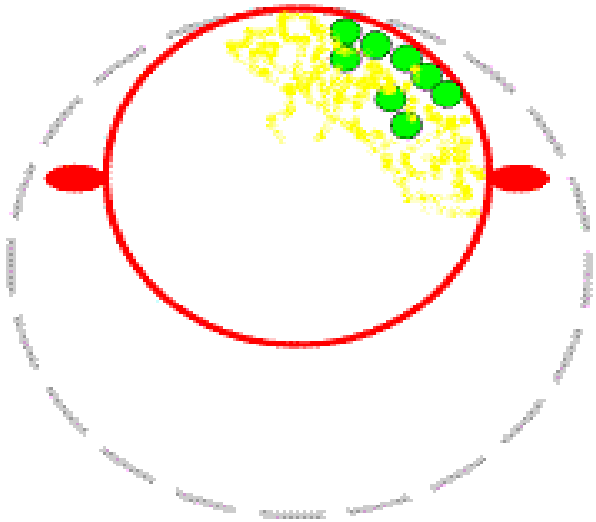
Construction

- A ball mill consists of a hollow cylindrical shell rotating about its axis. The axis of the shell may be either horizontal or at a small angle to the horizontal. it is partially filled with balls. The grinding media is the balls which may be made of steel (chrome steel), stainless steel or rubber. The inner surface of the cylindrical shell is usually lined with an abrasion-resistant material such as manganese steel or rubber. less wear takes place in the rubber lined mills. The length of the mill is approximately equal to its diameter.

Top-down – Ball Milling







Top-down – Ball Milling - Applications

- The ball mill is used for grinding materials such as coal, pigments, and felspar for pottery.
- Widely used in production lines for powders such as cement, silicates, refractory material, fertilizer, glass ceramics, etc. as well as for ore dressing of both ferrous non-ferrous metals.

Bottom-up - CVD

Chemical Vapour Deposition

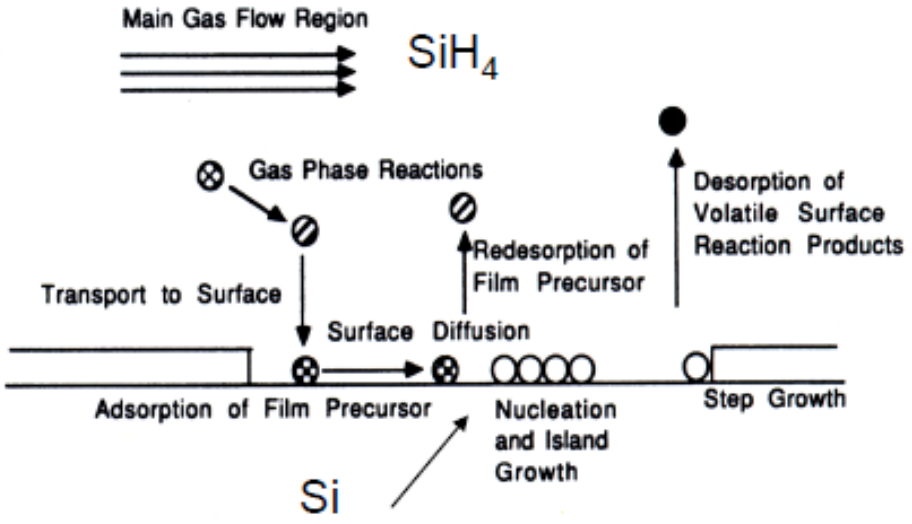
Introduction

- Chemical vapour deposition or CVD is a generic name for a group of processes that involve depositing a solid material from a gaseous phase.
- Microfabrication processes widely use CVD to deposit materials in various forms, including: monocrystalline, polycrystalline, amorphous, and epitaxial.
- These materials include: silicon, carbon fiber, carbon nanofibers, filaments, carbon nanotubes, SiO2, silicon-germanium, tungsten, silicon carbide, silicon nitride, silicon oxynitride and titanium nitride.
- CVD process is also used to produce synthetic diamonds.

Chemical vapor deposition: reaction mechanisms

- Mass transport of the reactant in the bulk
- Gas-phase reactions (homogeneous)
- Mass transport to the surface
- Adsorption on the surface
- Surface reactions (heterogeneous)
- Surface migration
- Incorporation of film constituents, island formation
- Desorption of by-products
- Mass transport of by-producets in bulk

CVD: Diffusive-convective transport of depositing species to a substrate with many intermolecular collisions-driven by a concentration gradient



Bottom-up - CVD

Applications

- CVD processes are used on a surprisingly wide range of industrial components, from aircraft and land gas turbine blades, timing chain pins for the automotive industry, radiant grills for gas cookers and items of chemical plant, to resist various attacks by carbon, oxygen and sulphur.
- Some important applications are listed below.
- Surface modification to prevent or promote adhesion
- Photoresist adhesion for semiconductor wafers Silane/substrate adhesion for microarrays (DNA, gene, protein, antibody, tissue)
- MEMS coating to reduce stiction
- BioMEMS and biosensor coating to reduce "drift" in device performance
- Promote biocompatibility between natural and synthetic materials Copper capping Anti-corrosive coating