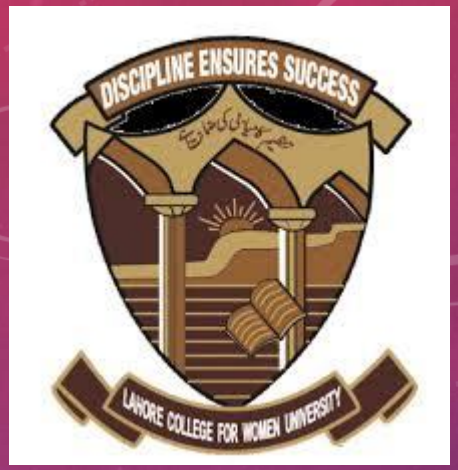

بسم الله الرحمن الرحيم



Lahore College for Women University Lahore

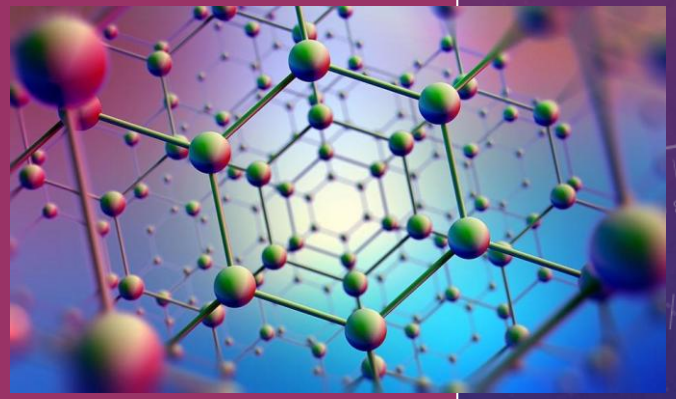
Nanotechnology & Nanostructures

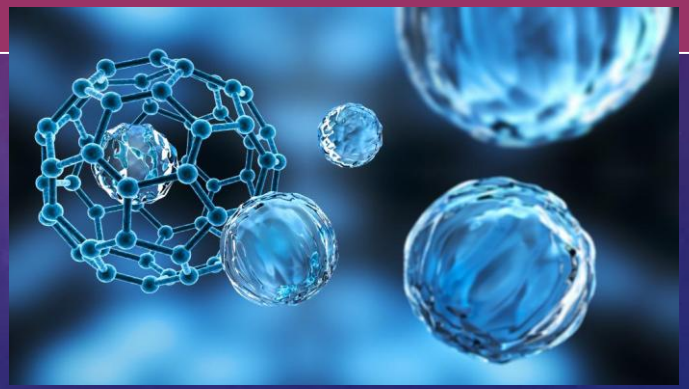
Prof .Dr. Zohra Nazir Kayani
Physics Department

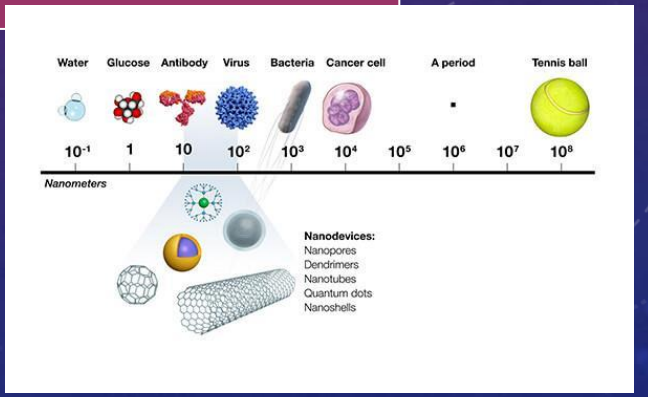
(Lecture # 6)

TOPIC NAME:

SYNTHESIS OF NANOMATERIALS:



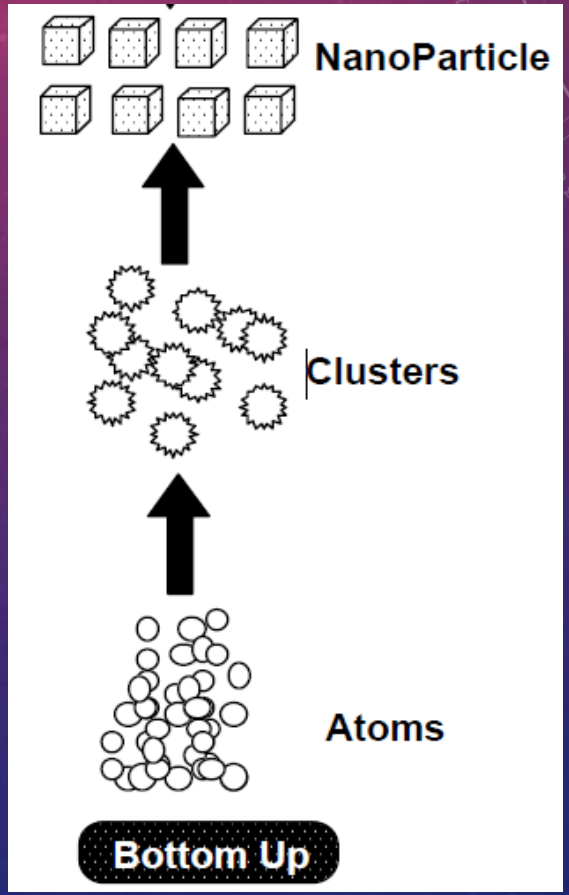




BOTTOM-UP APPROACHES:

❖These approaches include the miniaturization of materials components (up to atomic level) with further self-assembly process leading to the formation of nanoscales.

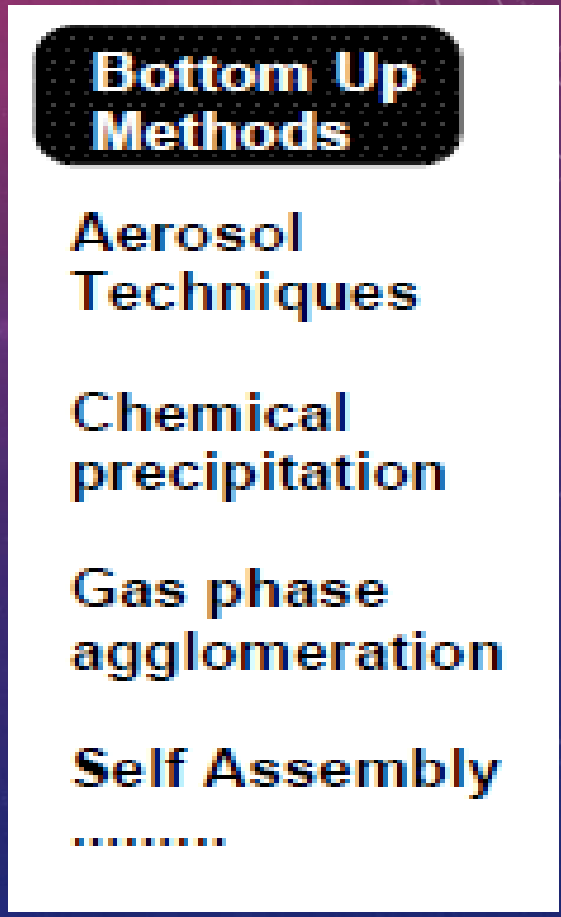
❖During self-assembly the physical forces operating at nanoscale are used to combine basic units into larger stable structures.



BOTTOM-UP APPROACHES:

❖Typical examples are quantum dot formation during epitaxial growth and formation of nanoparticles from colloidal dispersion. Bottom-up methods may make use of scanning probes or biotechnology for producing nanostructures.

❖Bottom-up methods start with atoms or molecules and build up to nanostructures.

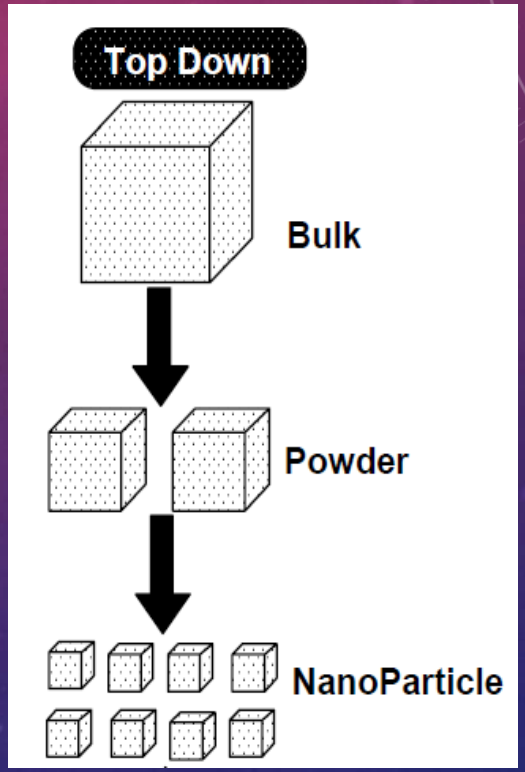


TOP-DOWN APPROACH:

❖In Top-down approach, an operator first designs and controls a macro-scale machine shop to produce an exact copy of itself, but smaller in size.

❖Subsequently, this down scaled machine shop will make a replica of itself, but also a few times smaller in size.

❖This process of reducing the scale of the machine shop continues until a nanosize machine shop is produced and is capable of manipulating nanostructures.



TOP-DOWN APPROACH:

❖Top-down methods begin with a pattern generated on a larger scale that reduced to nanoscale. So these approaches have larger (macro-scale) initial structures which can be extremely controlled and reduced to nanostructures.

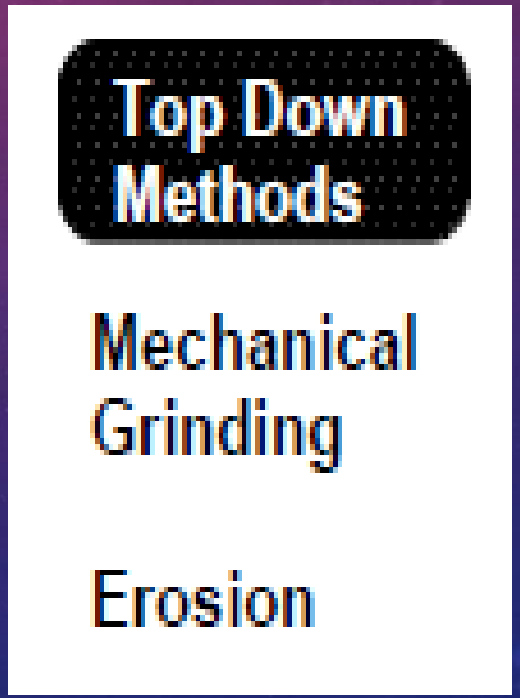
❖They are slow and are not suitable for large scale production.

Typical Examples are:

➢Etching through the mask

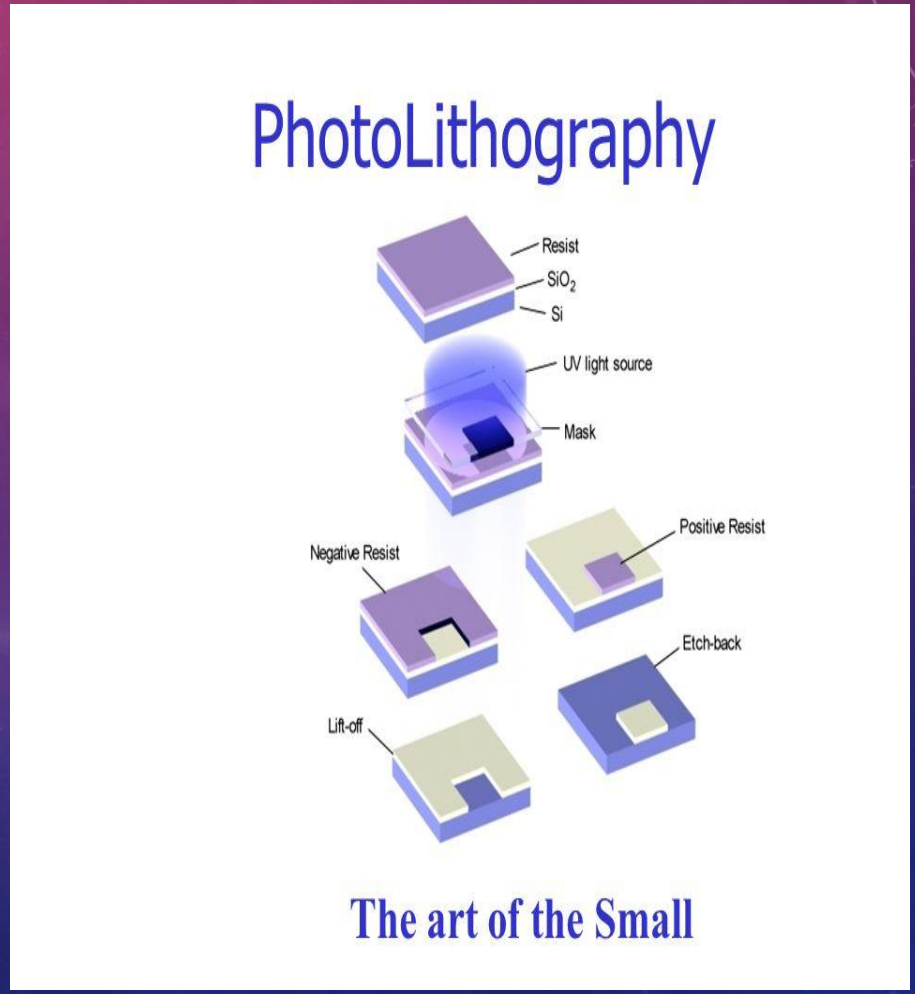
➢Ball milling

➢Application of sever plastic deformation



PHOTOLITHOGRAPHY:

The most used technology to produce nanostructures using a top-down approach is photolithography. It has been used to manufacture computer chips and produce structures smaller than 100 nm.



PROCEDURE:

•Typically, an oxidized silicon (Si)wafer is coated with a 1μm thick photoresist layer. After exposure toultraviolet (UV) light, the photoresist undergoes a photochemical reaction.

•Ultraviolet (UV) light breaks down the polymer by rupturing the polymer chains. When the wafer is rinsed in a developing solution, the exposed areas are removed. In this fashion, a pattern is produced on the wafer surface.

•The system is then placed in an acidic solution, which attacks the silica but not the photoresist and the silicon.

•The remaining photoresist reproduce the pattern. Once the silica has been removed, the remaining photoresist can be etched away in a different acidic solution.
•Pattern is transferred to the substrate material.

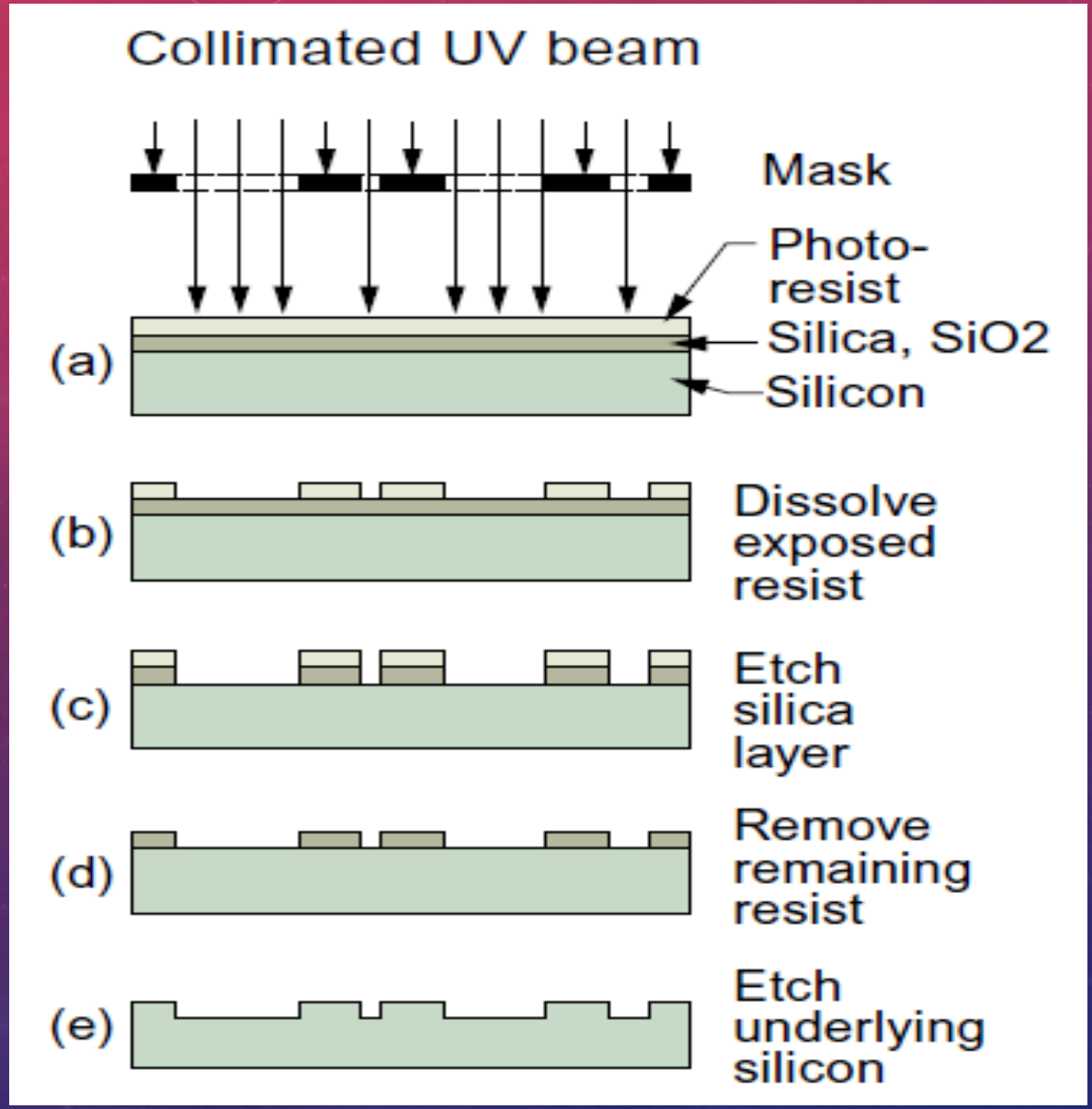


Figure: Schematic diagram of Photolithography

COMPLICATIONS:

Though the concept of photolithography is simple, the actual implementation is very complex and expensive. This is because :

•Nanostructures significantly smaller than 100 nm are difficult to produce due to diffraction effects.

•Masks need to be perfectly aligned with the pattern on the wafer.

•The density of defects needs to be carefully controlled.

•Photolithographic tools are very costly, ranging in price from tens to hundreds of millions of dollars.

•As a response to these difficulties, electron-beam lithography, X-ray lithography and soft lithography techniques have been developed as alternatives to photolithography.

THANK YOU