Sputtering Process and its Types

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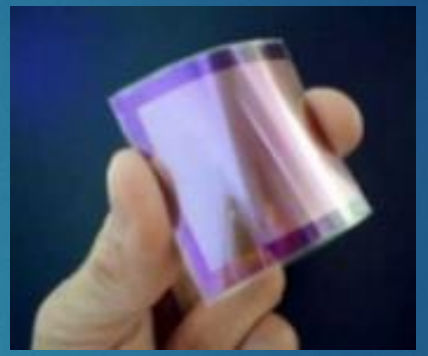
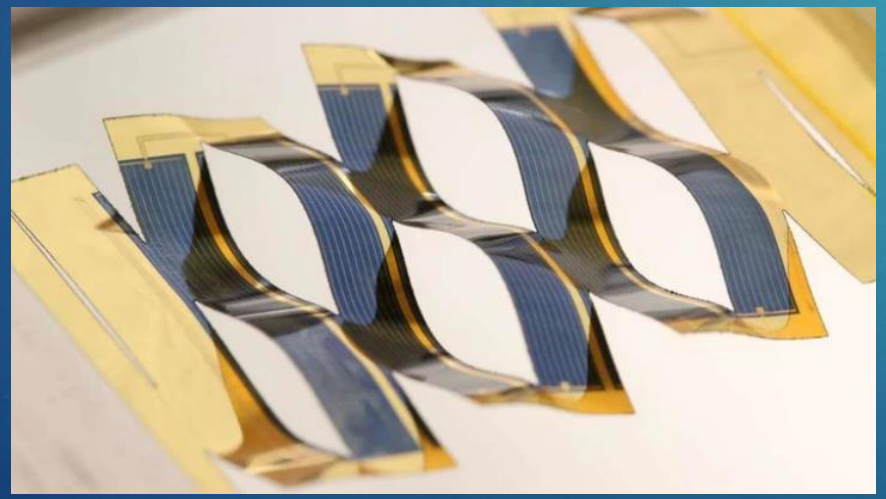
- 4th Level Biomedical Instrument

Thin films

- Thin films are thin material layer ranging from fractions of a nanometer (monolayer)To several micrometers in thickness





Applications of Thin Film Technology

Optics
- Antireflex coatings ("Multicoated Optics")
- Highly reflecting coatings (laser mirrors)
- Interference filters
- Beam splitter and thin film polarizers
- Integrated optics

Chemistry
- Catalysis, electrocatalysis, biocatalysis, photocatalysis
- Diffusion barriers
- Protection against corrosion/oxidation
- Sensors for liquid/gaseous chemical

(Alternative) Energies
- Solar collectors and solar cells
- Thermal management of architectural performance of ETFE foils (metal-coated foils)

Optoelectronics
- Photodetectors
- Image transmission
- Optical memories
- LCD/TFT

Magnetic Applications
- Audio, video and computer memories
- Magnetic read/write heads

Cryotechnics
- Superconducting thin films, switches, memories
- SQUIDS (Superconducting Quantum Interference Devices)

Biomedicine
- Biocompatible implant coatings
- Neurological sensors
- Claddings for depot pharmacy

Mechanics
- "Hard" layers (e.g. on drill bits)
- Adhesion providers
- Friction reduction

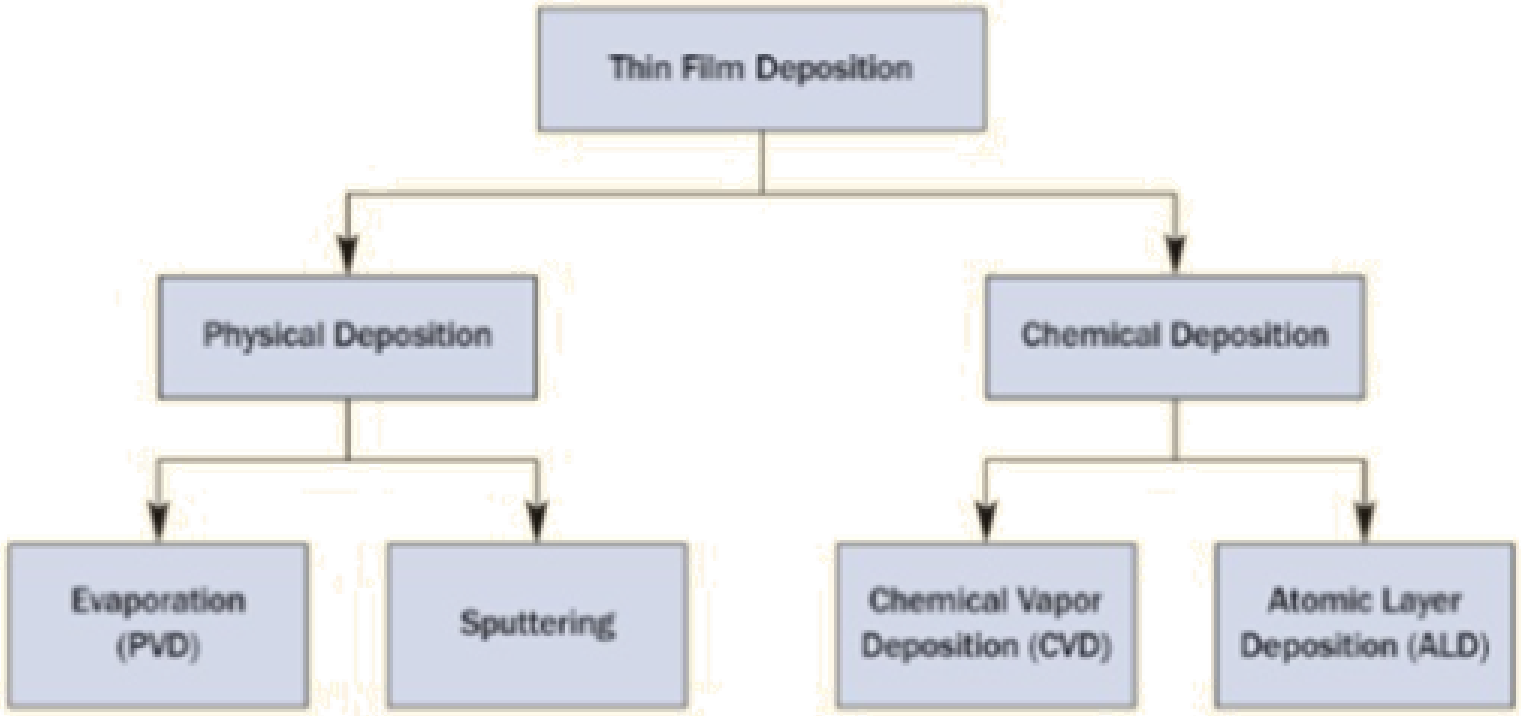
Sensorics
- Data acquisition in aggressive environments and media
- Telemetry
- Biological Sensorics

Electronics
- Passive thin film elements (Resistors, Condensers, Interconnects)
- Active thin film elements (Transistors, Diodes)
- Integrated Circuits (VLSI, Very Large Scale Integrated Circuit)
- CCD (Charge Coupled Device)

New Materials
- Superhard carbon ("Diamond")
- Amorphous silicon
- Metastable phases: Metallic glasses
- Ultrafine powders (diameter < 10nm)
- Spheroidization of high melting point materials (diameter 1-500µm)
- High purity semiconductors (GaAs)

Engineering/Processing
- Tribological Applications: Protective coatings to reduce wear, corrosion and erosion, low friction coatings
- Hard coatings for cutting tools
- Surface passivation
- Protection against high temperature corrosion
- Self-supporting coatings of refractory metals for rocket nozzles, crucibles, pipes
- Decorative coatings
- Catalyzing coatings

Synthesis of thin film



Sputtering process

Sputtering is a term used to describe the mechanism in which atom are ejected from the surface of the material when that surface is stuck by sufficient energetic particles

First discovered in 1852, and developed as thin film deposition technique by Langmuir in 1920.

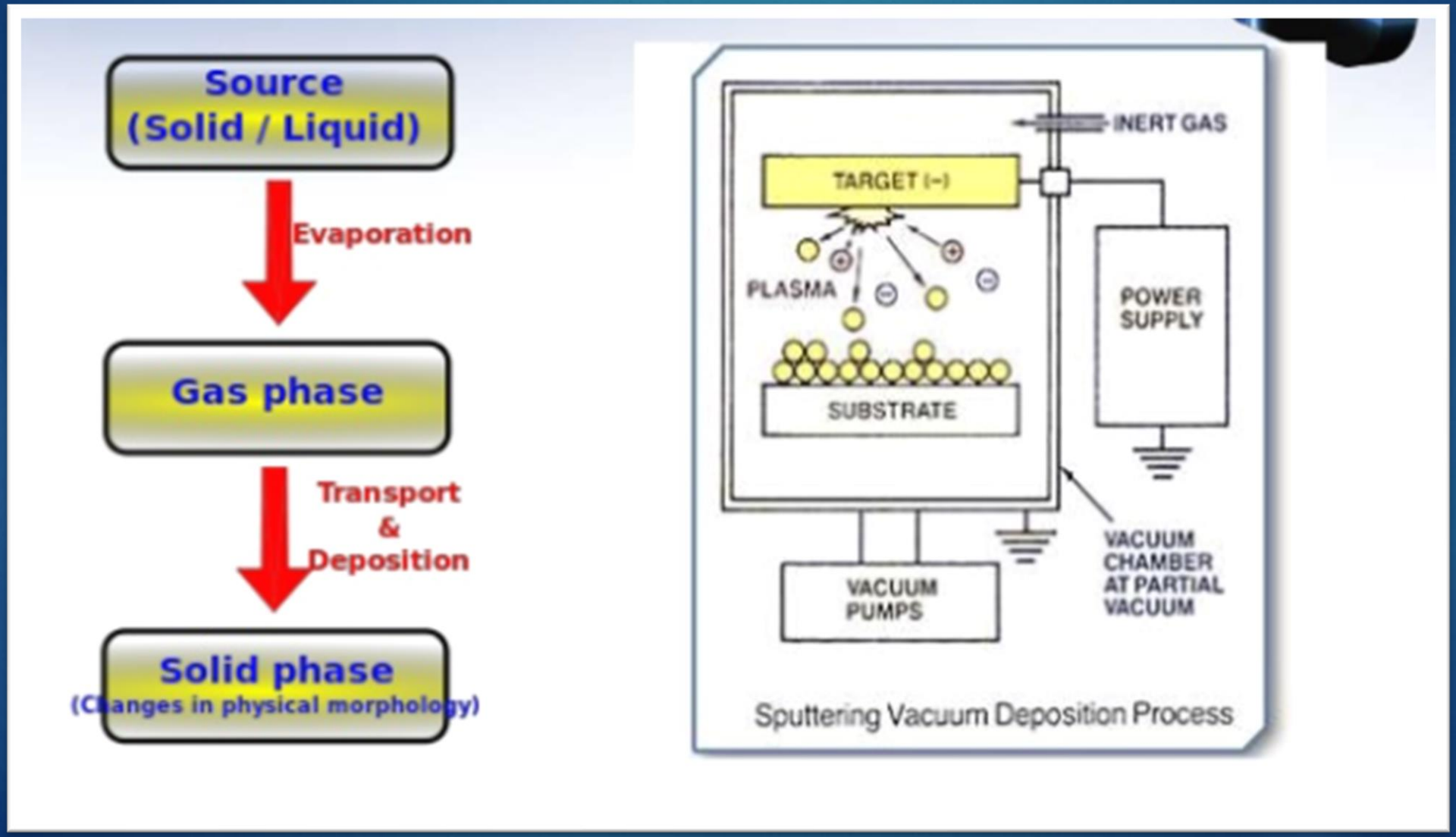
Metallic film: Al-alloys, Ti, Tantalum, Nickel ,Cobalt ,Gold etc.

https://www.youtube.com/watch?v=-lm0Y3Hyw-Q

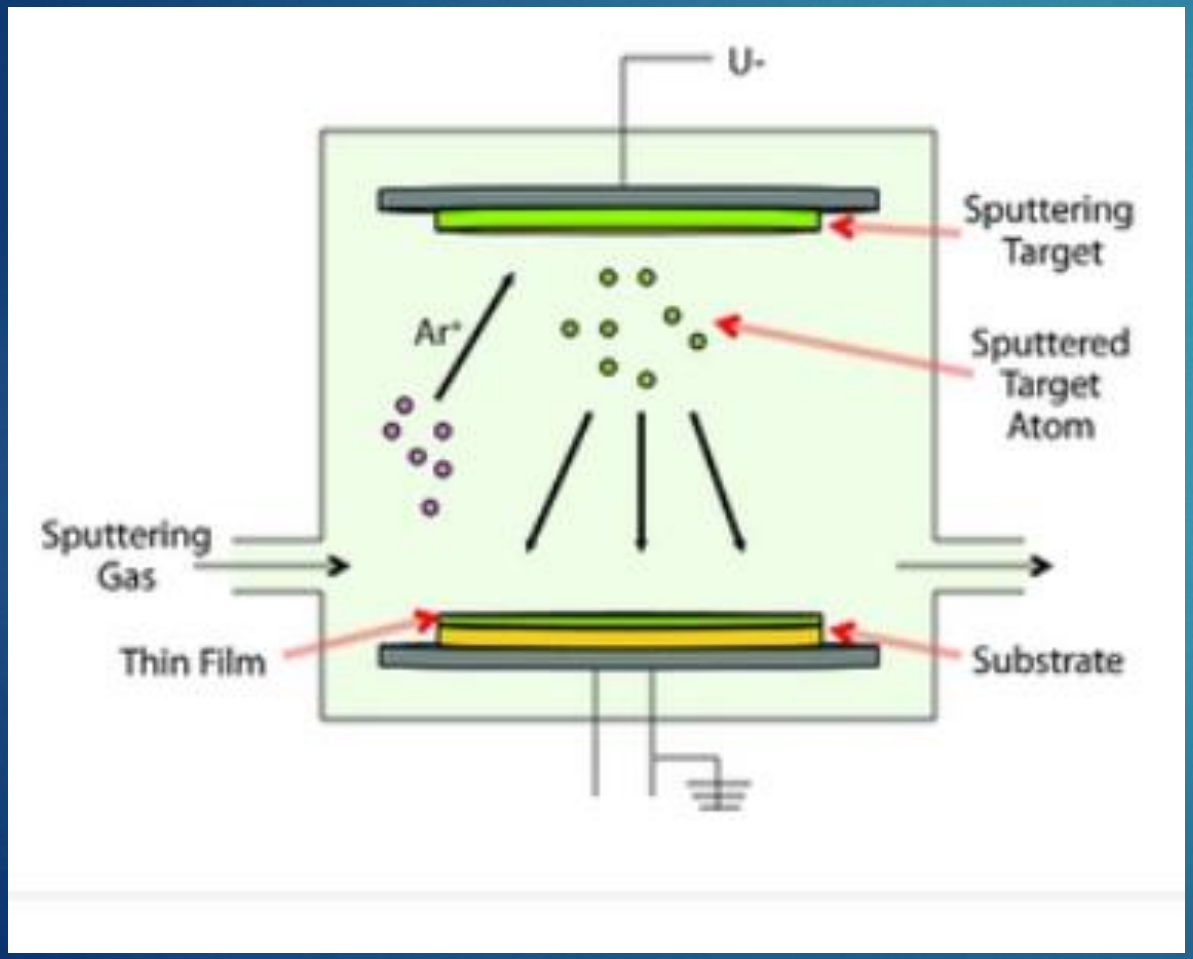
KORVUS TECHNOLOGY

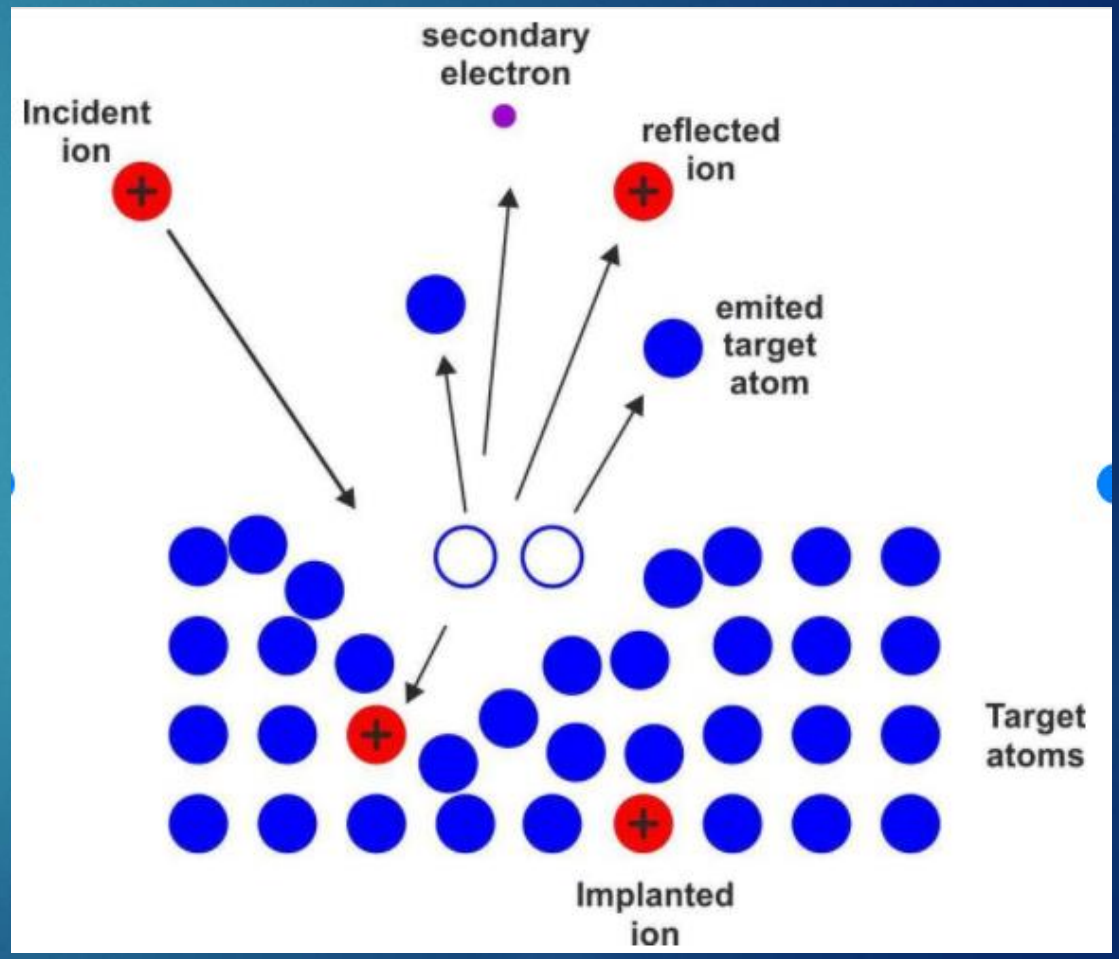
Sputtering Explained

Basic model


Source
(Solid / Liquid)
Evaporation
Gas phase
Transport
&
Deposition
Solid phase
(Changes in physical morphology)
INERT GAS
TARGET (−)
PLASMA
POWER
SUPPLY
SUBSTRATE
VACUUM
CHAMBER
AT PARTIAL
VACUUM
VACUUM
PUMPS
Sputtering Vacuum Deposition Process

Sputtering process





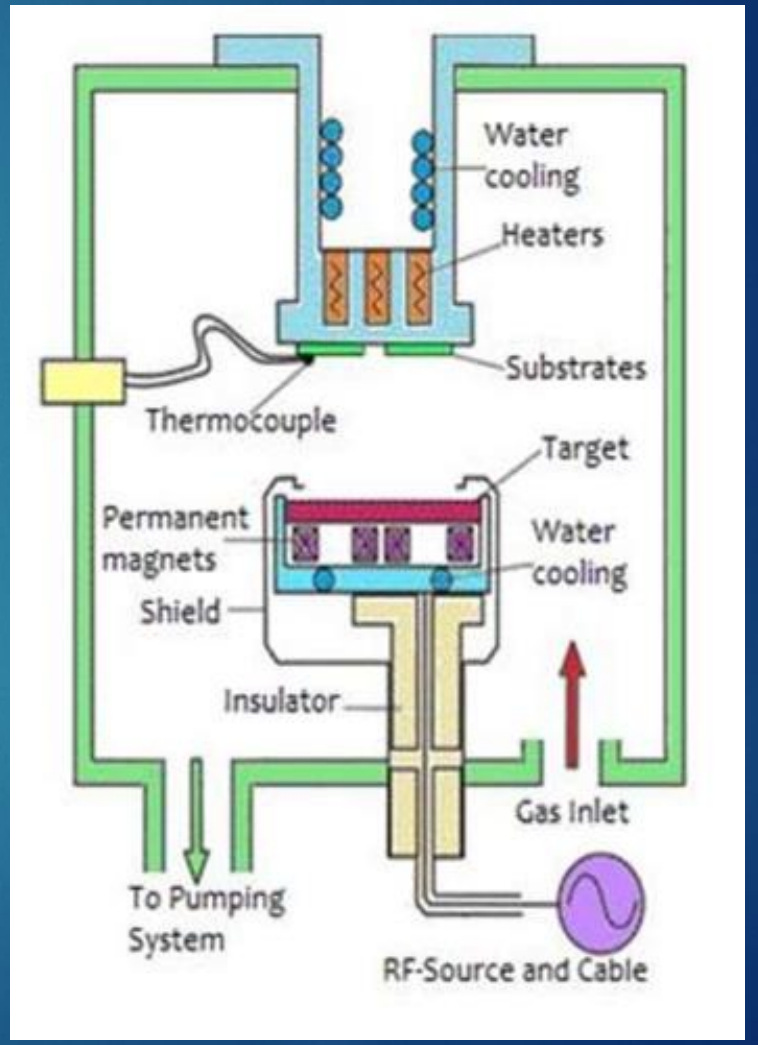
Types of sputtering deposition

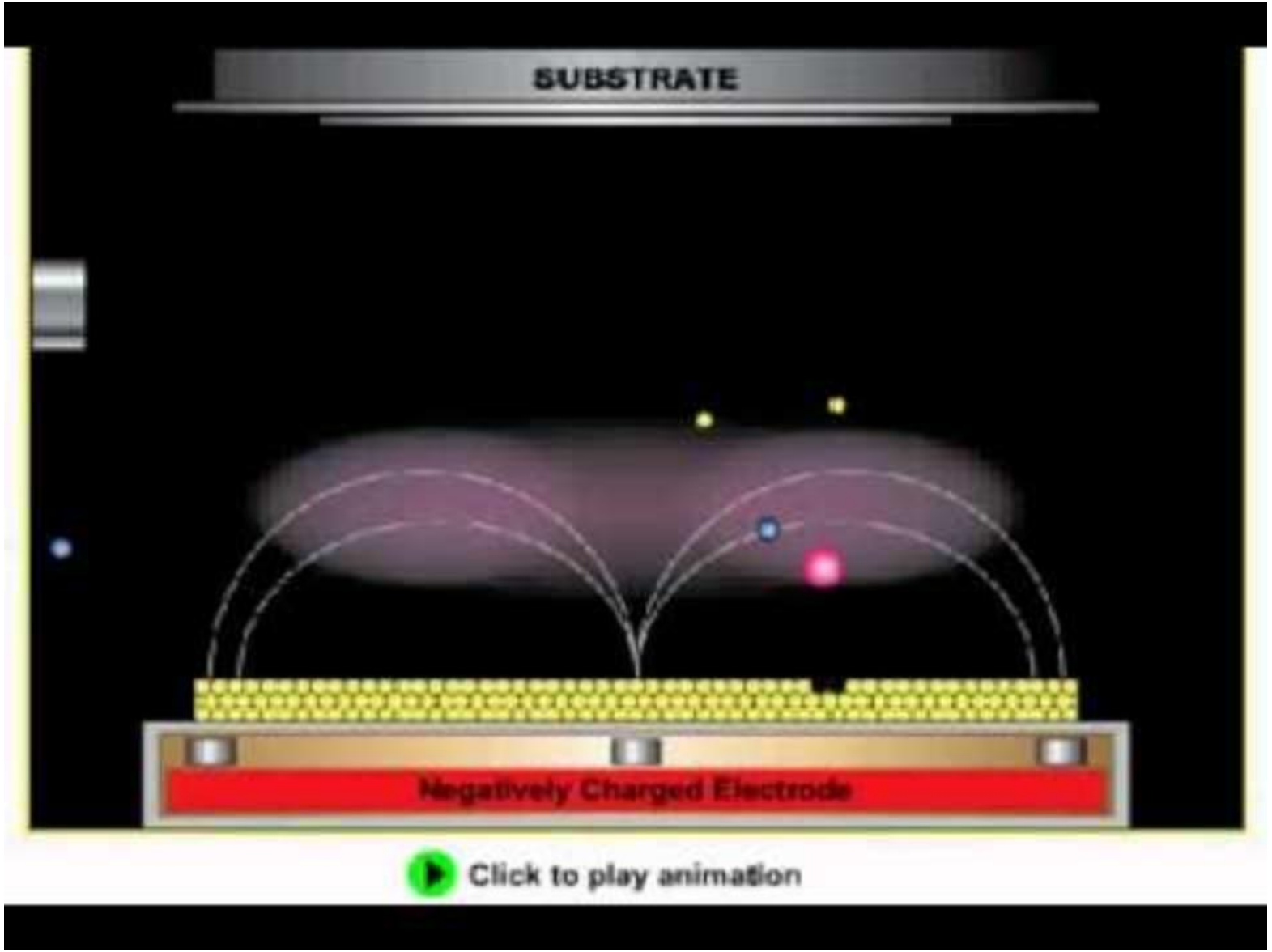
- Magnetron sputtering
- Ion-beam sputtering
- Reactive sputtering
- Ion-assisted deposition
- High target utilization sputtering (HiTUS)
- High- power impulse magnetron sputtering (HiPlMS)
- Gas flow sputtering

Magnetron sputtering

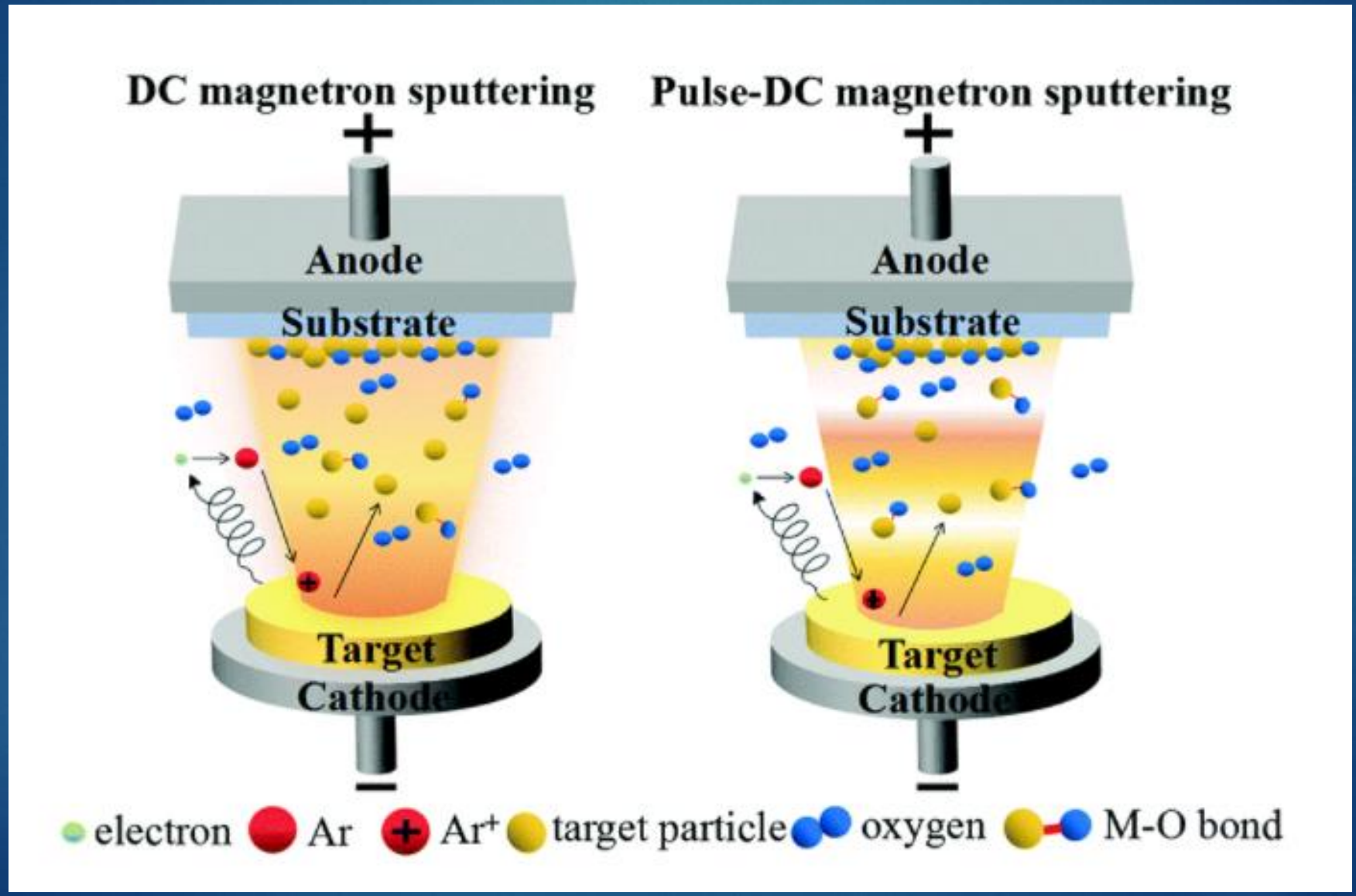
https://www.youtube.com/watch?v=Hf2kkqZhL7U

- Magnetron sputtering is the most commonly used method for a sputter deposition
- It usually utilizes a strong electric and magnetic fields to trap electrons close to the surface of the magnetron, which is known as the target.
- The electrons follow helical paths around the magnetic field lines undergoing more ionizing collisions with gaseous neutrals near the target surface than would otherwise occur
- The extra argon ions created as a result of these collisions leads to a higher deposition rate. It also means that the plasma can be sustained at a lower pressure.
- The sputtered atoms are neutrally charged and so are unaffected by the magnetic trap.



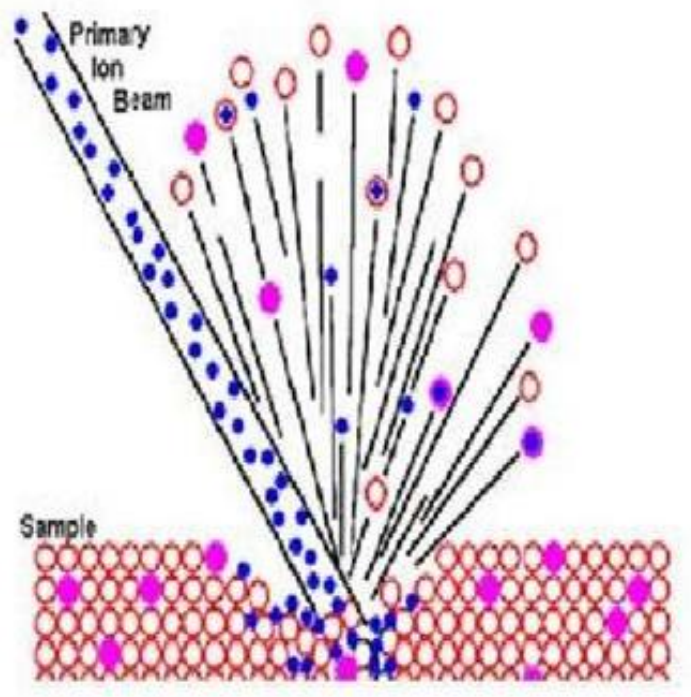

SUBSTRATE
Negatively Charged Electrode
Click to play animation

Magnetron sputtering



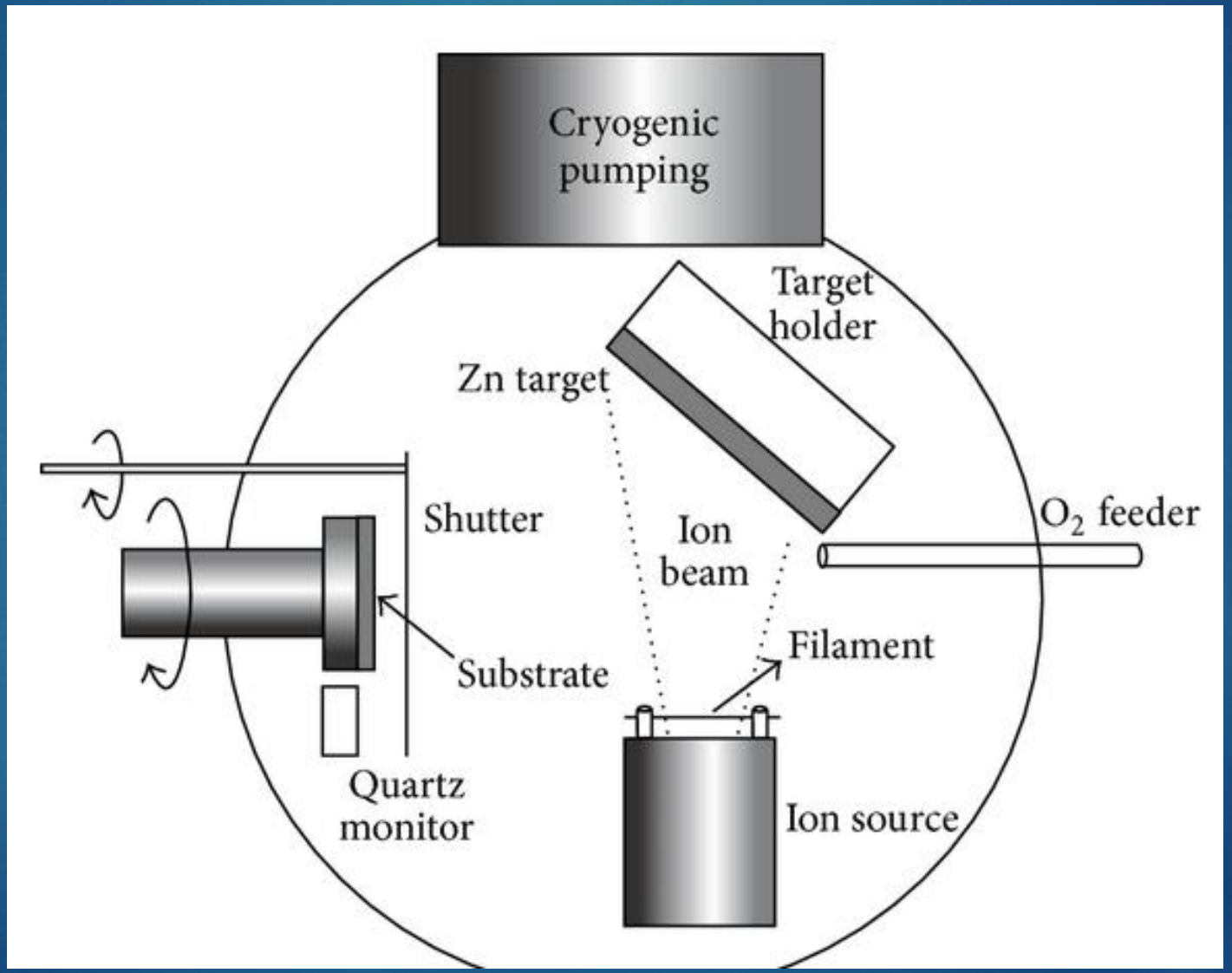
Ion-beam sputtering

- Ion beam sputtering utilizes an ion source to generate a relatively focused ion beam directed at the target to be sputtered.
- The ion source consists of a cathode and anode with a common central axis.
- Applying a high voltage field of 2-10 kV to the anode creates an electrostatic field inside the ion source, confining electrons around a saddle point in the center of the source.
- When argon gas is injected into the ion source, the high electric field causes the gas to ionize, creating a plasma inside the source region.
- The ions are then accelerated from the anode region to the exit aperture (cathode) creating a "collimated" ion beam.
- The resulting ion beam impinges upon a target material and, via momentum transfer between the ion and the target, sputters this material onto the sample



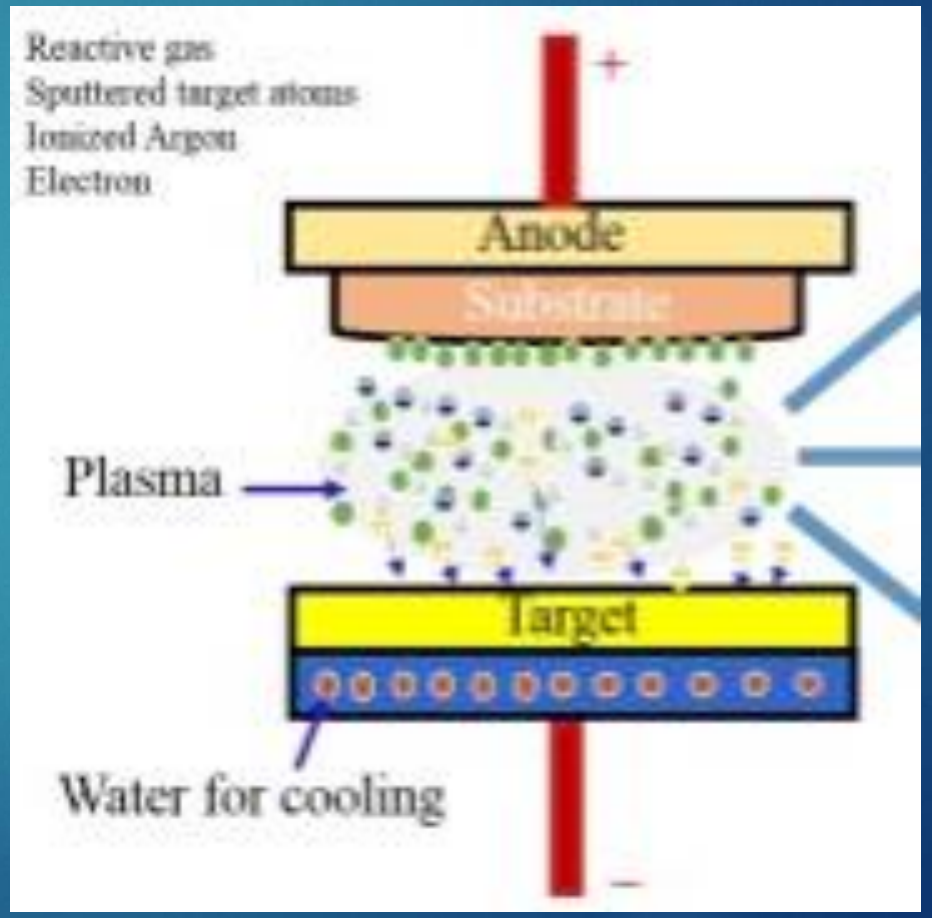
Ion-beam sputtering

https://www.youtube.com/watch?v=Hf2kkqZhL7U



Reactive sputtering

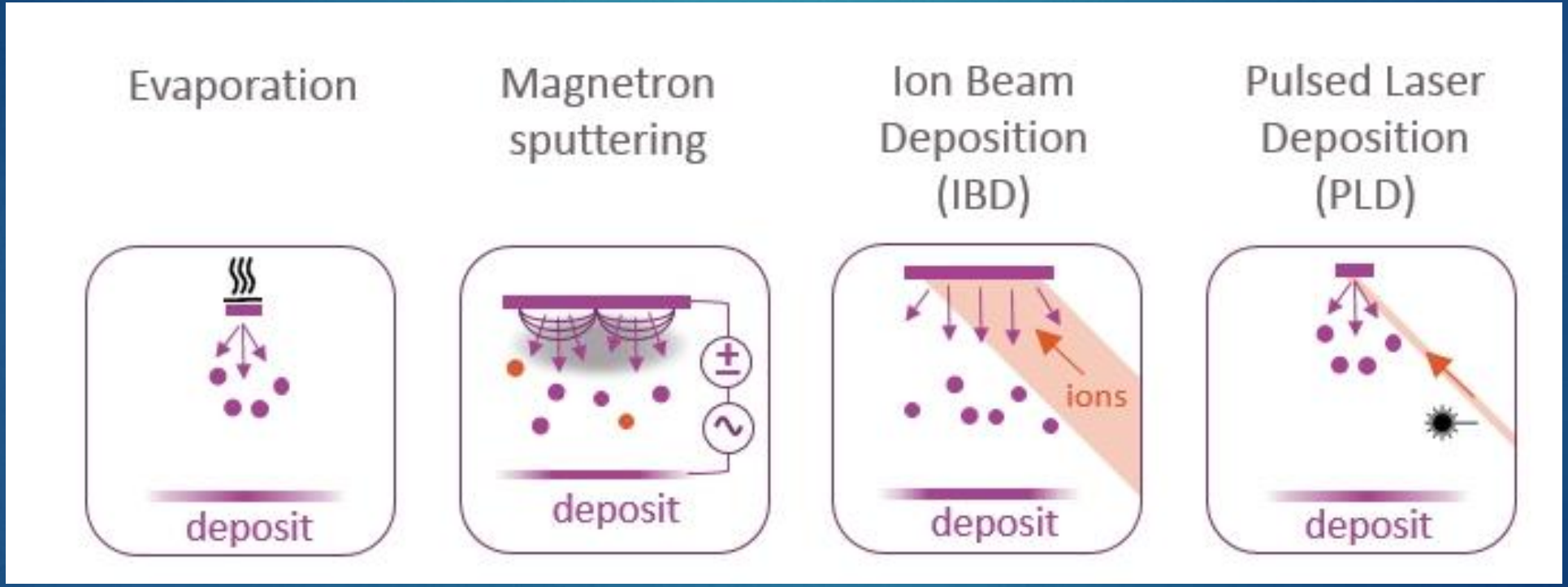
- In reactive sputtering, the sputtered particles from a target material undergo a chemical reaction aiming to deposit a film with different composition on a certain substrate.
- The chemical reaction that the particles undergo is with a reactive gas introduced into the sputtering chamber such as oxygen or nitrogen, enabling the production of oxide and nitride films, respectively



Application of sputtering

- Heads-up cockpit displays
- Jet turbine engines
- Mirrors for optical and x-ray telescopes
- Night vision equipment.
- Anti-corrosion coatings
- Anti-seize coatings
- Dies and molds
- Sewing needles
- Tool and drill bit hardening.

conclusion


Evaporation
Magnetron sputtering
Ion Beam Deposition (IBD)
Pulsed Laser Deposition (PLD)
deposit
deposit
ions
deposit
deposit