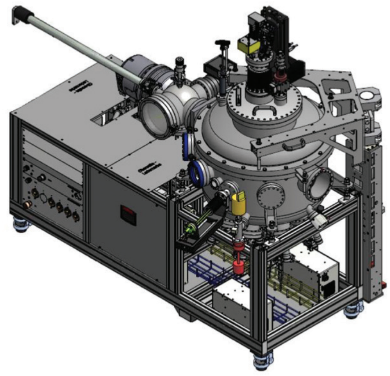
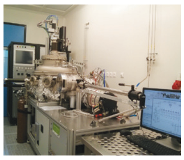
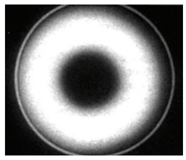
Magnetron sputtering system

PRINCIPLE

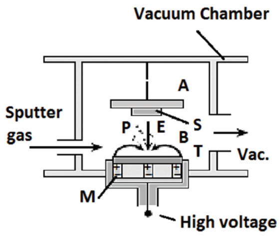
- sputter deposition of thin layers by an ion bombardment of a solid substrate (negativly charged target - cathode)
- using glow discharge of a process gas (Ar, O_2, N_2, etc.) in a magnetic field
- universal process - large range of applications
- standard (Ar) or reactive sputtering (O_2, N_2)
- good for layer by layer or alloy depositions
- relatively high deposition rates
- reduced substrate heating
- DC generators - used to sputter only conducting targets (charge accumulation on nonconducting targets)
- RF generators - conductors, semiconductors and insulator sputtering
- improved step coverage - higher impact energy and mobility of incident atoms compared to evaporation
- deposition conditions are generally determined empirically - i.e.: deposition rate, target voltage, working gas species and pressure, and the substrate temperature and plasma bombardment conditions
- targets can be formed by casting or by hot pressing powders. In addition, composite targets can be formed by placing wires, strips, or discs of one material over a target of another material.







Planar magnetron target using permanent magnets to supply the magnetic field (after Wasa and Hayakawa) [1].



Planar magnetron

Planar magnetron sputtering system using fixed bar magnets T: target, P: plasma, M: magnet, E: electric field, B: magnetic field (after Wasa and Hayakawa) [1].

- magnetron = sputtering source with magnetic plasma confinement
- magnetic field is induced on the cathode side to trap the electrone current
- electrons spiral around the magnetic fiel lines which increases their collision probability with neutral gas atoms and creation of ions
- higher ion density leads to higher io bombardment rate of the target
- allows plasma formation at lower pressur (10^{-5} to 10^{-3} torr)
- eliminates substrate heating by electro bombardment

Comparison of evaporation and sputtering

EVAPORATION	SPUTTERING
low energy atoms	higher energy atoms
high vacuum path • few collisions • line of sight deposition • little gas in film	low vacuum, plasma path • many collisions • less line of sight deposition • gas in film
large grain size	smaller grain size
fewer grain orientations	many grain orientations
poorer adhesion	better adhesion

SPECIFICATION

eight 2“ magnetron sputter sources (targets) in confocal sputter up configuration
3 DC source, power up to 500 W
1 RF source, power up to 500 W
substrate temperature RT – 900°C
rotation of substrate
sample size up to 4“
process pressure 2×10^{-4} to 7×10^{-2} mbar
gas line for reactive deposition O_2 or N_2
targets, e.g. Pt, Au, Ti, Ta, Gd, Ru, Si, Co, NiFe, FeRh, SiO2

PUBLICATIONS

[1] S.A. Campbell: Fabrication Engineering at the Micro- and Nanoscale, Oxford University Press, Oxford, 2008

[2] W. H. Class: Deposition and Characterization of Magnetron Sputtered Aluminum and Aluminum Alloy Films, Solid State Technol. 22: 61, 1979

Ceitec publications

Mozalev, A. et al. Formation and gas-sensing properties of a porous-alumina-assisted 3-D niobium-oxide nanofilm. *Sensors Actuators, B Chem.* **229**, 587–598 (2016).

P. Gallina, Fabrication of Graphene Mid-Infrared Biosensor, Brno University of Technology, 2016.

MORE INFO

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