Texture in Thin films
Where does texture come from in thin films and coating?

- It is rather difficult to produce the films and coatings without texture.
- Thin films exhibit texture in such a way that every crystallite has tendency to possess a definite crystallographic axis along their growth.
- Volmer reported preferred orientation in Zinc crystals grown from vapour with respect to the vapour beam direction in 1921.

Why is texture so important for thin films??

- Elastic properties

Texture Influences

- thermal expansion

- These properties are essential for mechanical stability of films.
Electrical and Magnetic films

**Electronic interconnects:**

- Longer time to failure – failure occurs by voiding due to electromigration
- Lifetime varies by a factor of 10 compared to \(<110>\) oriented films

**High Tc superconductors:**

- Oriented high Tc superconductors
Texture of thin films

Two types of film textures

Films on polycrystalline or amorphous substrate
- Substrate’s influence is minor
- Texture formed by anisotropic growth

Epitaxial Films on single crystalline substrate
- Extremely strong, approaching a single crystal
- Controlled by match between two crystal structure
Vapour deposition texture

- Strong fibre textures develops

- Effect of the forming process and geometry of the sample must be considered when selecting planes to measure textures on vapour deposited materials

- Aluminium produces a strong \(<111>\) fibre on evaporation

- Sputtering produces stronger texture than evaporation
Electrodeposition texture

A wide variety of fibre textures are produced after electrodeposition. It depends on

- Crystal structure of the substrate and the deposit
- Bath conditions

The theoretical explanation to account for texture in electrodeposits:

1. Competitive nucleation
2. Growth Competition
   - Free mode of growth
3. Inhibited deposition
   - Hindered growth
When lattice parameter difference of the substrate and the deposit exceed by 15% - texture depends only on the bath conditions

- When lattice parameter difference of the substrate and the deposit is very less initial layer of the deposited metal grow epitaxially texture is independent of the bath conditions

- Epitaxial influence gradually diminishes and texture of the deposit becomes dependent on the bath conditions

Continue…
Low current density and high temperature

- Crystallites are oriented such that most densely populated atom planes lie parallel to the substrate.
  - for F.C.C. $<111>$
  - for B.C.C. $<110>$
  - for H.C.P. $<0001>$
For high current density and low temperature crystallites are oriented such that most densely populated atom rows in the most densely populated atom planes lie perpendicular to the substrate

- for F.C.C. <110>
- for B.C.C. <111>
- for H.C.P. <11 20>

Exceptions do exist, when some other strong textures are found

for example

- for F.C.C. <100>, <112>, <113> and <210>
- for B.C.C. <112>, <310>
- for H.C.P. <10 10>, <10 11>, <11 22>

if such substances are present which can be adsorbed on the electrode, texture may change
Questions

1. Texture of thin films depends on substrate texture
   (a) if there is little difference between the lattice parameters of the substrate and deposited materials
   (b) if there is substantial difference between the lattice parameters of the substrate and deposited materials
   (c) if the film is thin
   (d) if the film is thick

2. Why do thin films possess texture?

3. What are the parameters that affect the texture of thin films?

4. What kind of texture in general formed in thin films?

5. How texture in thin films helps to improve the properties?