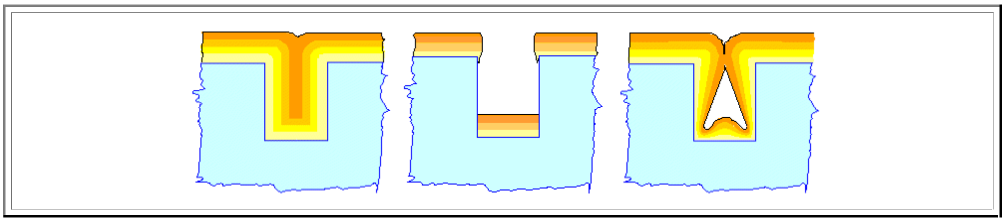
3.4.2 Thin Film Structure

- This will be short, because we will discuss this topic mostly when we come to deposition methods.
- Let's distinguish to separate points

  1. Geometry and morphology.
  2. Internal structure.

- The first topic has been mentioned before, but now we go beyond the points made there.
  - Let's consider to grow a thin film on a substrate that has a small hole in it - say half a **µm** in lateral size and **1 µm** deep. We deposit a thin film (atomic) layer by layer (symbolized by various shade of yellow). What we might get could have one of the topologies shown below or anything in between



  - The only difference between these quite different topologies is the deposition method; we will cover that in more detail in chapter 6.
- There is much more along this line, but we cover it when we get to it.
- As far as the internal structure goes, the situation is similar. Everything known from bulk materials goes:
  - *Poly-crystalline* thin films with grain sizes ranging from a few nanometers to **cm** (Are the **Zn**-covered steel lamp posts, letter boxes, etc. with huge grains products of the thin film industry?)
  - *Single crystalline* thin films, but full of defects like dislocations, precipitates, point defects.
  - *Nearly perfect* single crystalline thin films **-** what we often would like to have, but not always get.
- If we just look at polycrystalline thin films, we may have just regular grains, or all kinds of textures. Again, we deal with it when we run across it.
- Then we have some **thin film specialities**:
  - **Amorphous thin films**, like amorphous **Si** (***a-Si***) or many other materials. You just can't have amorphous *bulk* **Si** or most everything else that usually likes to form a crystal.
  - Mixtures of amorphous and crystalline phases; truly nanocrystalline structures (i.e. grain size around **10 nm**) **-** practically never found in bulk.
- A case in point is *Silicon* (what else?). We have:
  - **Amorphous Silicon**, used, e.g., in microelectronics. If it is heavily mixed (= "doped" with Hydrogen (**> 15 %**), we have the crucial thin film for **a-Si:H solar cells** or for the transistor matrix of **liquid crystal displays** (***LCD***). Another example is amorphous **SiO_2**, the work-horse of microelectronics.
  - *Amorphous-crystalline* mixes, like **a-Si:H** containing nanometer-sized embedded islands of crystalline silicon (***c-Si*** and then called **µc-Si:H**. This is the base of the so-called "microcrystalline **Si** thin-film solar cell", one of the hottest contender for the solar cell market of the future.