Course material

Course:

Micro and Nanofabrication (MEMS)

Video:

3.3 Thermal evaporation in CMi

Concepts (extracted from automatically generated subtitles):

Different standard evaporants. Wafer surface. Specific case. Couple of silicon wafers. Vacuum chamber. Directional deposition. Desired film thickness. Additional material. Beam sweep. Required level of vacuum. Standard micro nano fabrication. Nice blue colour. Last example. Silicon nitride. Large source substrate distance.

to video sequence search
(within Micro and Nanofabrication (MEMS).)

to video

Evaporation is performed in the vacuum chamber. The evaporant is heated in a crucible at the bottom of the chamber and the vapour flux condensates on the wafer surface placed in the upper part of the chamber. A large source substrate distance, here roughly 1 meter, enables directional deposition that is important for lift-off processes. Different standard evaporants are permanently loaded in various crucibles inside the evaporation chamber. The material to evaporate is selected by rotating the crucibles at the bottom of the chamber. If an additional material is required, a crucible filled with the material to be evaporated can be placed in an empty pocket. In this specific case we used chromium. A shutter is used to control the deposition. When the shutter is covering the evaporation source no vapour flux can reach the substrate. To start the deposition the shutter is moved on the side and the flux can reach the substrate. Such a mechanical shutter is much better to control the on off state of deposition, compared to switching on or off the evaporation itself. This sequence shows some typical substrate before evaporation. For standard micro nano fabrication, we typically use silicon or glass substrates. Here are shown a couple of silicon wafers that are either bare silicon in grey, or silicon with dielectric coating, silicon nitride in this specific case, which gives the nice blue colour. The wafers are first loaded upside down into the sample holder which has an opening at the bottom which itself is then loaded into the evaporator chamber. The chamber is closed and pumped down to reach a vacuum of about 10 to the minus 7 torr. The pumping is the longest step in the evaporation process. It takes a few minutes to several tens of minutes depending on the required level of vacuum. This leaves some time for the scientists to discuss with students and technicians. The evaporant is then

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heated in this case with an electron beam. Depending on the material the electron beam movement varies. For chromium for example which is not a very good thermal conductor the beam sweep is rather large. Here the sweep speed is reduced compared to the one used in a real process for the purpose of this video. When using gold on the other hand the sweep area is smaller as it is an excellent thermal conductor. Finally this last example shows titanium in the crucible under the bombardment of the electron beam. The deposition time depends on the rate and required thickness Typical times for 30 nanometer gold are in the order of 1 to 1.5 minutes. Once the desired film thickness is reached, the shutter is closed and the e-beam power is ramped down. After a cooling period of about 20 minutes, the chamber is vented opened and the wafers are unloaded. Note that here we see the back side of the wafers and not the coated sides. After removing the wafers from the holder and turning them around we can see here the wafers after deposition. Gold in yellow and chromium in grey. The blue ring of the underlying silicon nitride layer at the wafer edge stems from the shadow of the wafer holder.

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