Practice quiz supercritical drying for realization of suspended structures; test microstructures for quantifying stress in thin layers

Questions:

0 points possible (ungraded)

1. Why is supercritical point drying used after HF etching of a SOI wafer?

- ○ To provide a smooth wafer surface for proceeding to next fabrication steps
- ○ To completely remove HF molecules on the surface in order to prevent any hazardous consequences during wafer handling
- ◉ To prevent collapse of free-standing Si structures on the wafer surface by capillary forces
- ○ To remove any organic residues remaining on the wafer surface after etching

✔

Explanation

After the wet etching of SiO_2, during the drying or the etching of the rinsing solution, the limited amount of liquid underneath the functional structure can pull down the latter to the substrate by capillary forces. Often, after such collapse, the functional structure cannot be released again and hence, cannot be used further in an application. The solution to avoid such a problem is to use supercritical point drying. See "Supercritical drying for realization of suspended structures; test microstructures for quantifying stress in thin layers" video from 2:30 to 3:10 for detailed explanations.

2. Which of the following steps is essential in a supercritical point drying cycle?

- ◉ CO_2 in the closed chamber is condensed into a liquid
- ○ HF is replaced by cold H_2SO_4
- ○ HF is filled back again in the chamber for one last removal
- ○ Water is replaced by high-pressure acetone

✔

Explanation

In supercritical point drying, after the etching of the sacrificial layer in HF bath, HF is replaced by deionized water. Later, water is replaced by ethyl alcohol which is a liquid with higher vapor pressure and lower surface tension. This is followed by the placement of the wafer in a closed chamber that can be filled with CO_2 gas to which one can apply high pressure so that the gas is condensed in liquid CO_2. This liquid will occupy also the space between the functional layer and the substrate. Hereafter, by increasing the temperature and pressure, a supercritical fluid is formed, in which there is no distinction between liquid and gas phase, hence no surface tension. Finally, the pressure is dropped, CO_2 is forced to evaporate and then room temperature is reached. See "Supercritical drying for realization of suspended structures; test microstructures for quantifying stress in thin layers" video from 3:05 to 6:30 for detailed explanations.

3. Which of the following is true for surface-machined microstructures?

- ◉ Stress may develop due to the different thermal dilation between the film and the substrate, while cooling down to room temperature after the release of the sacrificial layer
- ○ Stress can only be compressive
- ○ The compressive stress is less visible than tensile stress in simple beam test structures, as the test structures remain perfectly flat, until they eventually break
- ○ Ring-crossbar test structures can be fabricated to only investigate the tensile stress

Ring-crossbar test structures can be fabricated to only investigate the tensile stress

Explanation

An issue in surface micromachining is the presence of stress in the surface-micromachined microstructures. This results from the fact that the polySi layer is deposited at a high temperature and, when cooling down to room temperature, the thermal expansion coefficient of the thick substrate and the thin deposited layer is not the same. The stress becomes the most apparent after the removal of the sacrificial layer. The stress may be compressive or tensile. The tensile stress might not be visible because it will result in a straight beam or straight membrane just like a microstructure without stress. Ring-crossbar test structures are very useful for detecting and quantifying the stress in the thin film material. Both tensile and compressive stresses can be quantified with this test structures. See "Supercritical drying for realization of suspended structures; test microstructures for quantifying stress in thin layers" video from 6:30 to 11:50 for detailed explanations.

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