

Chapter 4

The experiment

This experiment will be divided into three stages, those are (1) the first stage is the removal of photoresist after hard bake on the bare silicon wafer. (2) the second stage is the removal of photoresist after ion implantation process on the bare silicon wafer. (3) the third stage is the removal of photoresist and residue after silicon dioxide etched process. The three stages are described in detail as follows :

4.1 The procedure of this experiment

1. Put a sample into the cartridge, put the cartridge into the chamber, and sealed the chamber.
2. Set the process parameters that includes the chamber pressure, chamber temperature, and the proportion of co-solvent in the supercritical carbon dioxide solvent mixture.
3. The process steps are switched by manually. For example, the manual valves MV1 and MV2 will be opened by manually when the soak step is finished, and then the flush step is started.
4. The complete procedure and the status of manual valves for the removal of photoresist and residue are shown as Figure 13. Referring to the chapter 2.3 in detail.



- (1) $t_0 \sim t_1$, the chamber is pressurized to 1100 psi with the mixture of supercritical carbon dioxide and co-solvent.
- (2) $t_1 \sim t_2$, the mixture of supercritical carbon dioxide and co-solvent pass through the chamber to replace the air in chamber.
- (3) $t_2 \sim t_3$, the chamber is repressurized from 1100 psi to P_{soak} with mixture of supercritical carbon dioxide and co-solvent for the soak step.
- (4) $t_3 \sim t_4$, soak interval, the sample immersed in the mixture of supercritical carbon dioxide and co-solvent.
- (5) $t_4 \sim t_5$, To decompress the chamber pressure from P_{soak} to P_{flush} , and then result in the photoresist is swollen and broken.
- (6) $t_5 \sim t_6$, flush interval, to remove the loosened and loosening material during decompressive rendering.
- (7) To repeat the procedure 4, 5, 6 for user's requirement.
- (8) $t_{14} \sim t_{15}$, vent step, the vent valve of the chamber is opened automatically, and the chamber pressure decreased to the atmosphere.
- (9) $t_{15} \sim t_{16}$, the chamber is repressurized to P_{soak} with supercritical carbon dioxide only for the dry step.
- (10) $t_{16} \sim t_{17}$, soak interval for the dry step, the sample immersed in the supercritical carbon dioxide for the co-solvent is dissolved into the supercritical carbon dioxide.

- (11) $t_{17} \sim t_{18}$, flush interval for the dry step, the supercritical carbon dioxide pass through the chamber to carry the co-solvent and debries out of the chamber.
- (12) To repeat the procedure 10, 11 for user's requirement.
- (13) $t_{21} \sim t_{22}$, the vent valve of the chamber is opened automatically, and then the chamber pressure decreased to the atmosphere and the process is finished.



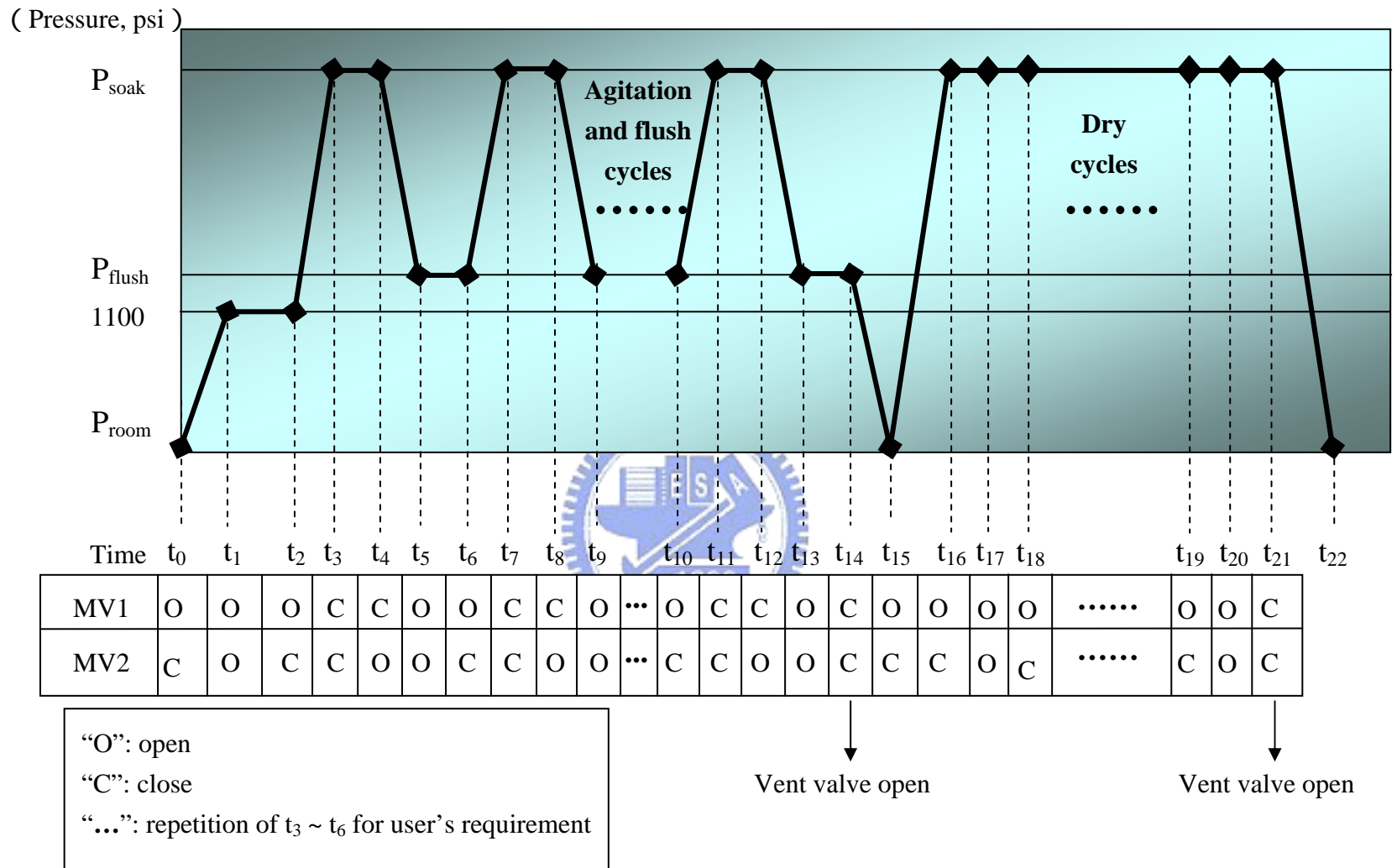


Figure 13 The time line chart of pressure in the chamber

4.2 The first stage, removal of photoresist after hard-bake on the bare silicon wafer

4.2.1 The preparation of samples

The sample preparation is according to the chapter 2.2.1, the photoresist with undergo soft-bake (90 °C , 90 second), post-exposure bake (110 °C , 120 second) and hard bake (120 °C , 90 second) .

4.2.2 The procedure of photoresist removal after hard-bake

Referring to the Figure 13, the procedure is described in detail as follows:

4.2.2.1 The chamber temperature is 50 °C ; A 5 vol.% co-solvent in supercritical carbon dioxide solvent mixture.

4.2.2.2 $P_{\text{soak}} = 1600 \text{ psi}$; $P_{\text{flush}} = 1100 \text{ psi}$.

4.2.2.3 The soak time ($t_3 \sim t_4, t_7 \sim t_8 \dots$) for agitation step is 60 seconds; The flush time ($t_5 \sim t_6, t_{13} \sim t_{14} \dots$) is 60 seconds. The agitation (depressurization/repressurization) and flush steps are repeated for 3 cycles.

4.2.2.4 The soak time ($t_{16} \sim t_{17}$) for dry step is 15 seconds; The flush time ($t_{17} \sim t_{18}$) for dry step is 20 seconds. The dry step is repeated for 5 cycles.

4.2.2.5 The chamber vent to the atmosphere when the dry step is finished.

4.3 The second stage, removal of photoresist after ion implantation process on the bare silicon wafer

4.3.1 The preparation of samples

In this process, the preparation of a sample is according to the chapter 2.2.2, and the diagram of the sample preparation is shown as Figure 14.

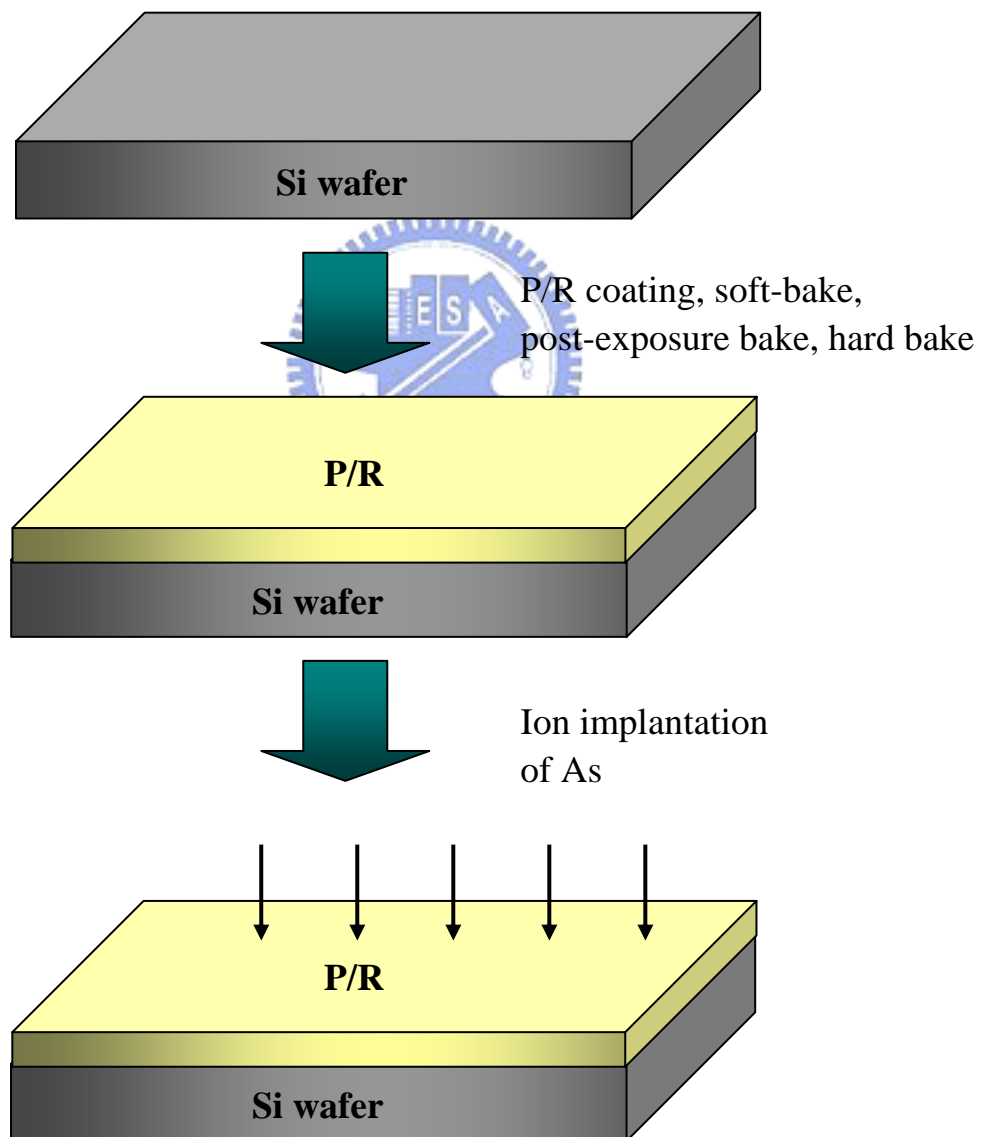


Figure 14 The sample preparation for the second stage

4.3.2 The procedure of photoresist removal after Arsenic ion implantation

Referring to the Figure 13, the procedure is described in detail as follows:

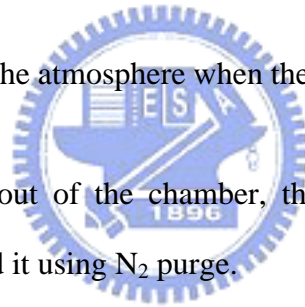
4.3.2.1 The chamber temperature is 70 °C ; A 7 vol.% co-solvent in supercritical carbon dioxide solvent mixture.

4.3.2.2 $P_{\text{soak}} = 5000 \text{ psi}$; $P_{\text{flush}} = 1500 \text{ psi}$.

4.3.2.3 The soak time ($t_3 \sim t_4, t_7 \sim t_8 \dots$) for agitation step is 120 seconds; The flush time ($t_5 \sim t_6, t_{13} \sim t_{14} \dots$) is 90 seconds. The agitation (depressurization/repressurization) and flush steps are repeated for 4 cycles.

4.3.2.4 The chamber vent to the atmosphere when the agitation and flush cycles is finished.

4.3.2.5 To take the sample out of the chamber, then rinsed the sample using DI water (shower) and dried it using N_2 purge.



4.4 The third stage, removal of photoresist and residue after silicon dioxide etched process

4.4.1 The preparation of samples

The preparation of a sample is according to the chapter 2.2.3, and the diagram of a sample preparation is shown as Figure 15. The range of line width is 50 ~ 0.5 in micrometer, and the range of pillar size is 5 ~ 0.5 in micrometer.

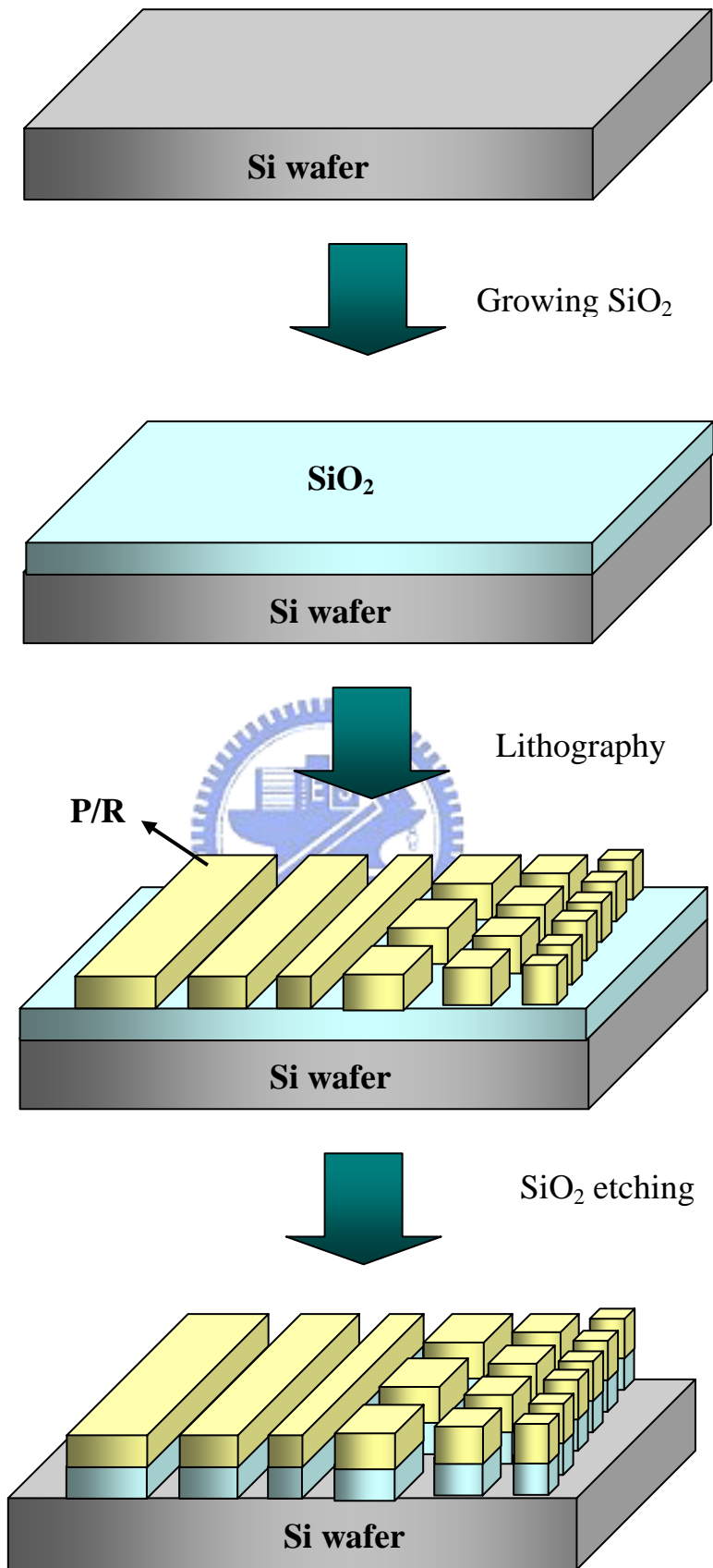


Figure 15 The sample preparation of the third stage

4.4.2 The procedure for the removal of photoresist and residue after silicon dioxide etched process

Referring to the Figure 13, the procedure is described in detail as below:

4.4.2.1 The chamber temperature is 70 °C ; A 7 vol.% co-solvent in supercritical carbon dioxide solvent mixture.

4.4.2.2 $P_{\text{soak}} = 5000 \text{ psi}$; $P_{\text{flush}} = 1500 \text{ psi}$.

4.4.2.3 The soak time ($t_3 \sim t_4, t_7 \sim t_8 \dots$) for agitation step is 120 seconds; The flush time ($t_5 \sim t_6, t_{13} \sim t_{14} \dots$) is 90 seconds. The agitation (depressurization/repressurization) and flush steps are repeated for 4 cycles.

4.4.2.4 The chamber vent to the atmosphere when the agitation and flush cycles is finished.

4.4.2.5 To take the sample out of the chamber, then rinsed the sample using DI water (shower) and dried it using N_2 purge.

