Cap-On Bi-Resist-Layer Photolithography (For Lift-Off Process)

1) Using AZ5214 (thickness≅1.6 μm, Image Reversal Process: Negative Ridge Mask was used) as the top imaging resist

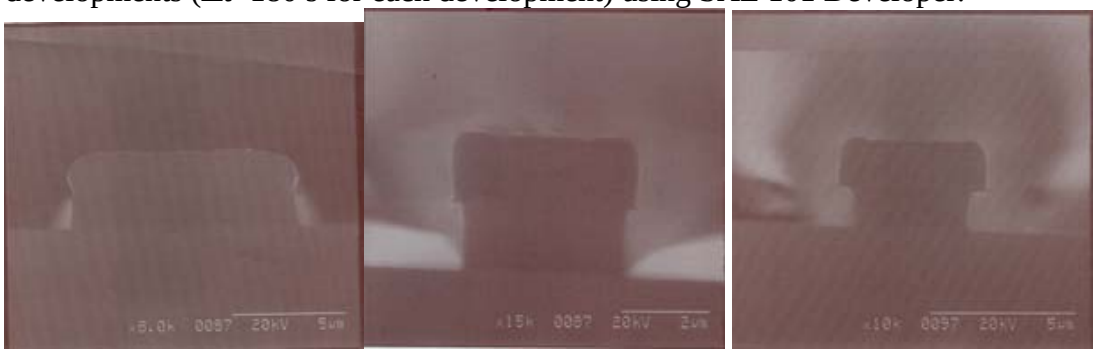
a) PMGI: SF-11 (thickness≅1.5 μm)

Process Steps:

- Sample Solvent Clean: acetone (2 minutes), methanol (1 minute) in ultrasonic machine.
- Sample Dehydration Bake: @200 C for 1 minute.
- Coat SF-11 Resist: spinning speed of 4000 rpm (rotation per minute) for 30 seconds.
- Pre-Exposure-Bake: @200 C for 2 minutes.
- Coat AZ5214 Resist: spinning speed of 4000 rpm for 30 seconds.
- Pre-Exposure-Bake: @95 C for 2 minutes.
- Resist-Edge-Bead Removal.
- Expose Top AZ5214 Resist: exposure time=7 seconds.
- Post-Exposure-Bake: @110 C for 1 minute.
- Flood Expose the Resist: exposure time=1 minute.
- Develop the Resist: using diluted AZ-400K developer (dilution ratio of 1:4), development time=40 seconds.
- Post-Development Bake: @110 C for 1 minute.
- 1^{st} DUV (Deep-Ultra-Violet) Expose SF-11 Resist: exposure time=300 seconds (power=1000 W).
- Develop SF-11 Resist: using SAL101 developer, development time=70 seconds.
- 2^{nd} DUV Expose SF-11 Resist [Double DUV exposures and developments increase the undercut, see the following resist profiles of Figures 1 (b) and (c)]: exposure time=300 seconds (power=1000 W).
- Develop SF-11 Resist: using SAL101 developer, development time=60 seconds [see Figure 1 (b)].
- O2 plasma Resist Residue Des-cum: pressure=300 mT, plasma power=100 W for 1 minute (ready for metal or dielectric layer deposition).

Results:

Figure 1 (a) Only one DUV exposure (Δt=300 s) and development (Δt=70 s) using SAL 101 Developer; **(b)** Double DUV exposures (Δt=300 for each exposure) and developments (Δt=70 s for 1st development and Δt=60 s for 2nd development) using SAL 101 Developer; **(c)** Double DUV exposures (Δt=300 for each exposure) and developments (Δt=180 s for each development) using SAL 101 Developer.



(a) **(b)** **(c)**

Note: There is almost no undercut (only a cusp) at the boundary between AZ5214 and SF-11 resists with only one DUV exposure and development, which is shown in Figure 1 (a). With double DUV exposures and developments, there appears a clear undercut at the boundary between these two resists and the undercut increases with the increase of development time, which is show in Figures 1 (b) and (c).

b) PMGI: SF-15 (thickness≅3.3 μm)

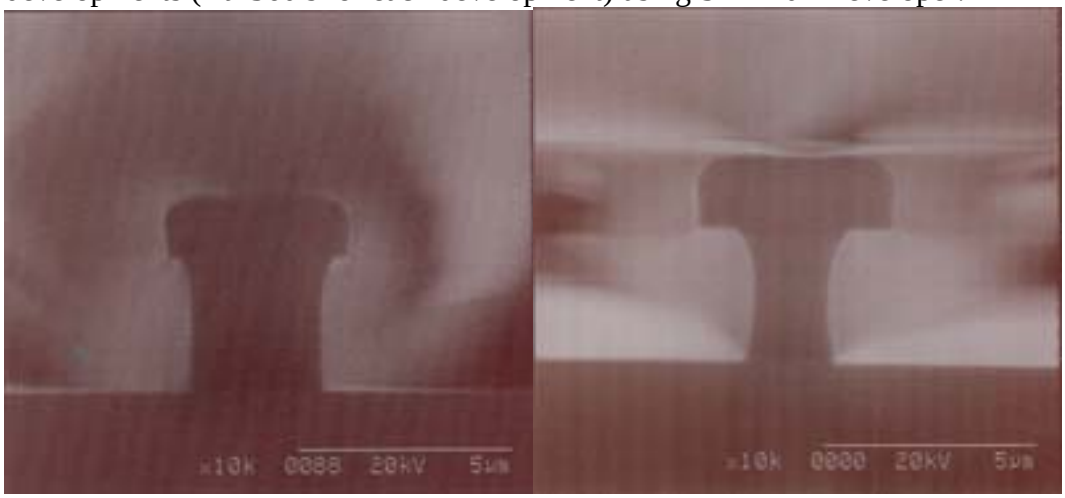
Process Steps:

- Sample Solvent Clean: acetone (2 minutes), methanol (1 minute) in ultrasonic machine.
- Sample Dehydration Bake: @200 C for 1 minute.
- Coat SF-15 Resist: spinning speed of 4000 rpm (rotation per minute) for 30 seconds.
- Pre-Exposure-Bake: @200 C for 2 minutes.
- Coat AZ5214 Resist: spinning speed of 4000 rpm for 30 seconds.
- Pre-Exposure-Bake: @95 C for 2 minutes.
- Resist-Edge-Bead Removal.
- Expose Top AZ5214 Resist: exposure time=7 seconds.
- Post-Exposure-Bake: @110 C for 1 minute.
- Flood Expose the Resist: exposure time=1 minute.
- Develop the Resist: using diluted AZ-400K developer (dilution ratio of 1:4), development time=40 seconds.
- Post-Development Bake: @110 C for 1 minute.
- 1st DUV Expose SF-11 Resist: exposure time=300 seconds (power=1000 W).

- Develop SF-11 Resist: using SAL101 developer, development time=200 seconds.
- 2nd DUV Expose SF-11 Resist: exposure time=300 seconds (power=1000 W).
- Develop SF-11 Resist: using SAL101 developer, development time=180 seconds [see Figure 2 (a)].
- O2 plasma Resist Residue Des-cum: pressure=300 mT, plasma power=100 W for 1 minute (ready for metal or dielectric layer deposition).

Results:

Figure 2 (a) Double DUV exposures (Δt=300 for each exposure) and developments (Δt=200 s for 1st development and Δt=180 s for 2nd development) using SAL 101 Developer; **(b)** Double DUV exposures (Δt=300 for each exposure) and developments (Δt=360 s for each development) using SAL 101 Developer.



(a) **(b)**

Note: The undercut at the boundary between AZ5214 and SF-15 resists increases with the increase of development time, which is show in Figures 2 (a) and (b).

2) Using AZ4110 (thickness≅1.3 μm, Positive Ridge Mask was used) as the top imaging resist

a) PMGI: SF-11 (thickness≅1.5 μm)

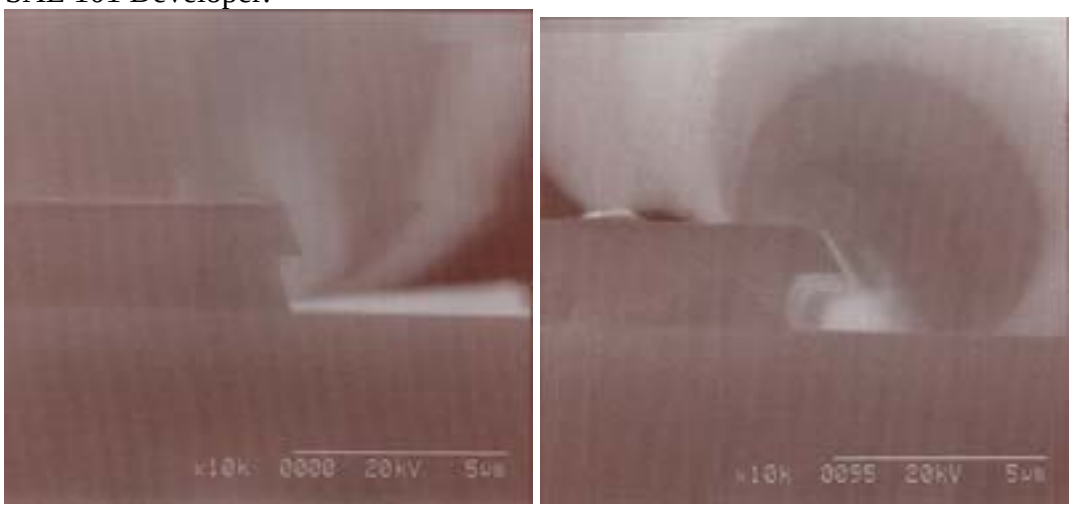
Process Steps:

- Sample Solvent Clean: acetone (2 minutes), methanol (1 minute) in ultrasonic machine.
- Sample Dehydration Bake: @200 C for 1 minute.
- Coat SF-11 Resist: spinning speed of 4000 rpm (rotation per minute) for 30 seconds.
- Pre-Exposure-Bake: @200 C for 2 minutes.
- Coat AZ4110 Resist: spinning speed of 4000 rpm for 30 seconds.
- Pre-Exposure-Bake: @95 C for 2 minutes.

- Resist-Edge-Bead Removal.
- Expose Top AZ4110 Resist: exposure time=10 seconds.
- Post-Exposure-Bake: @110 C for 1 minute.
- Develop the Resist: using diluted AZ-400K developer (dilution ratio of 1:4), development time=60 seconds.
- Post-Development Bake: @110 C for 1 minute.
- 1st DUV (Deep-Ultra-Violet) Expose SF-11 Resist: exposure time=300 seconds (power=1000 W).
- Develop SF-11 Resist: using SAL101 developer, development time=70 seconds.
- 2nd DUV Expose SF-11 Resist: exposure time=300 seconds (power=1000 W).
- Develop SF-11 Resist: using SAL101 developer, development time=60 seconds [see Figure 3 (a)].
- O2 plasma Resist Residue Des-cum: pressure=300 mT, plasma power=100 W for 1 minute (ready for metal or dielectric layer deposition).

Results:

Figure 3 (a) Double DUV exposures (Δt=300 for each exposure) and developments (Δt=70 s for 1st development and Δt=60 s for 2nd development) using SAL 101 Developer; **(b)** Double DUV exposures (Δt=300 for each exposure) and developments (Δt=200 s for 1st development and Δt=180 s for 2nd development) using SAL 101 Developer.



(a) **(b)**

Note: The undercut at the boundary between AZ4110 and SF-11 resists increases with the increase of development time, which is show in Figures 3 (a) and (b).

b) PMGI: SF-15 (thickness≅3.3 μm)

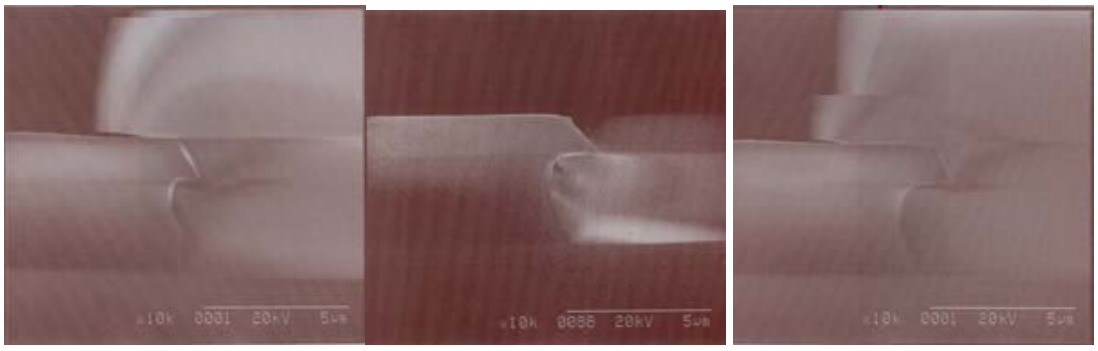
Process Steps:

- Sample Solvent Clean: acetone (2 minutes), methanol (1 minute) in ultrasonic machine.

- Sample Dehydration Bake: @200 C for 1 minute.
- Coat SF-15 Resist: spinning speed of 4000 rpm (rotation per minute) for 30 seconds.
- Pre-Exposure-Bake: @200 C for 2 minutes.
- Coat AZ4110 Resist: spinning speed of 4000 rpm for 30 seconds.
- Pre-Exposure-Bake: @95 C for 2 minutes.
- Resist-Edge-Bead Removal.
- Expose Top AZ4110 Resist: exposure time=10 seconds.
- Post-Exposure-Bake: @110 C for 1 minute.
- Develop the Resist: using diluted AZ-400K developer (dilution ratio of 1:4), development time=60 seconds.
- Post-Development Bake: @110 C for 1 minute.
- 1^{st} DUV (Deep-Ultra-Violet) Expose SF-11 Resist: exposure time=300 seconds (power=1000 W).
- Develop SF-11 Resist: using SAL101 developer, development time=200 seconds.
- 2^{nd} DUV Expose SF-11 Resist: exposure time=300 seconds (power=1000 W).
- Develop SF-11 Resist: using SAL101 developer, development time=180 seconds [see Figure 4 (b)].
- O2 plasma Resist Residue Des-cum: pressure=300 mT, plasma power=100 W for 1 minute (ready for metal or dielectric layer deposition).

Results:

Figure 4 (a) Double DUV exposures (Δt=300 for each exposure) and developments (Δt=200 s for 1^{st} development and Δt=90 s for 2^{nd} development) using SAL 101 Developer; **(b)** Double DUV exposures (Δt=300 for each exposure) and developments (Δt=200 s for 1^{st} development and Δt=180 s for 2^{nd} development) using SAL 101 Developer; **(c)** Double DUV exposures (Δt=300 for each exposure) and developments (Δt=360 s for each development) using SAL 101 Developer.



(a) **(b)** **(c)**

Note: The undercut at the boundary between AZ4110 and SF-15 resists increases with the increase of the 2^{nd} development time, which is show in Figures 4 (a) and (b). With the further increase of the development time, the undercut remains almost the same, which is shown in Figures 4 (b) and (c).