

Actuation chip V4.0

2020-09

1 Masks

α : Identical masks between set 1 and 2

Design set 01 P38 + P42

1. α Platinum Align
2. Platinum MASK 01
3. ITO MASK 01
4. Parylene MASK 01
5. α Aperture
6. α Ordy1

Design set 02 P00 + P37

1. α Platinum Align
2. Platinum MASK 02
3. ITO MASK 02
4. Parylene MASK 02
5. α Aperture
6. α Ordy1

Design variants:

P00 62 Hexagonal electrodes (H63)

P37 55 Keystone electrodes (K55)

P38 61 Keystone electrodes (K61)

P42 49 Keystone electrodes (K49)

2 Short description of the fabrication process:

Substrate: 2x borosilicate wafers + 2x fused silica with etched fluidic channels

- Pt **alignment** layer (backside alignment with etched glass) -> sputtering + lift off
 - target: 100 nm Pt
- Pt layer flat alignment (or **alignment layer**) -> sputtering + lift off
 - target: 100 nm Pt
- Aperture layer alignment with Pt -> sputtering + lift off
 - backside deposition
 - target: 100 nm Pt, 100 nm Ir, 150 nm IrOx
- SiOx coating on IrOx -> PECVD
 - backside deposition
 - target: 400 nm
- ITO alignment with Pt -> sputtering + lift off
 - target: 90 nm ITO
- Parylene coating -> vapor deposition + RIE etch
 - target: 3.5+ μm Parylene
 - RIE etch to release contacts
- Ordyl SY355 -> lamination + photolithography
 - target: 1x sheets (55 μm)
 - hard bake

3 Process

1. On 2x fused silica wafer only
2. HMDS-priming oven. Std recipe
3. Spin coat: ma-N 1420 @ (3000 RPM recipe | 30 s | dispense 2.5 ml)

4. Softbake: 100 °C, 120 s
 5. Expose: **“Platinum Align”** brightfield mask, flat alignment @ (58 s | 9 mW) note: foil mask (> normal exp. dose)
 6. Develop in ma-D 533S @ (1:50)
 7. PVD: Leybold UNIVEX 500 Adhesion layer Wti: 20 nm | RF 100 W | 2:30 s Target Pt film thickness: 100 nm | RF 400 W | 2 x 50 s (wait interval: > 20 min)
 8. Lift-off: Pt (overnight): DMSO (course then fine), rinse, spin dry
 9. Optical inspection
 10. Measure film thickness with profilometer: t =
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10. All wafers
 11. HMDS-priming oven. Std recipe
 12. Spin coat: ma-N 1420 @ (3000 RPM recipe | 30 s | dispense 2.5 ml)
 13. Softbake: 100 °C, 120 s
 14. Expose: **“Platinum MASK 02”** brightfield mask, flat alignment @ (58 s | 9 mW) note: foil mask (> normal exp. dose)
 15. Develop in ma-D 533S @ (1:50)
 16. PVD: Leybold UNIVEX 500 Adhesion layer Wti: 20 nm | RF 100 W | 2:30 s Target Pt film thickness: 100 nm | RF 400 W | 2 x 50 s (wait interval: > 20 min)
 17. Lift-off: Pt (overnight): DMSO (course then fine), rinse, spin dry
 18. Optical inspection
 19. Measure film thickness with profilometer: t =
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20. Std cleaning

21. Metalization on backside
 22. HMDS-priming oven. Std recipe
 23. Spin coat: ma-N 1420 @ (3000 RPM recipe | 30 s | dispense 2.5 ml)
 24. Softbake: 100 °C, 120 s
 25. Expose: **“Aperture”** brightfield mask, flat alignment @ (58 s | 9 mW) note: foil mask (> normal exp. dose)
 26. Develop in ma-D 533S @ (1:50)
 27. PVD: Leybold UNIVEX 500 Adhesion layer Wti: 20 nm | RF 100 W | 2:30 s Target Pt film thickness: 100 nm | RF 400 W | 2 x 50 s (wait interval: > 20 min) Target Ir film thickness: 100 nm | DC 100 W | 2 x 60 s (50 nm/min @ 26 sccm Ar + 0 sccm O2) Target IrOx film thickness: 150 nm | DC 100 W | 2 x 45 s (100 nm/min @ 26 sccm Ar + 15 sccm O2)
 28. Lift-off: IrOx (overnight): DMSO (course then fine), rinse, spin dry
 29. Optical inspection
 30. Measure film thickness with profilometer: t =
 31. PECVD: STS 310PC Target SiOx Film thickness: 400 nm
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32. Std cleaning
33. Metalization on frontside
34. HMDS-priming oven. Std recipe
35. Spin coat: ma-N 1420 @ (3000 RPM recipe | 30 s | dispense 2.5 ml)
36. Softbake: 100 °C, 120 s
37. Expose: **“ITO MASK 02”** brightfield mask @ (58 s | 9 mW) note: foil mask (> normal exp. dose)
38. Develop in ma-D 533S @ (1:50)
39. PVD: Leybold UNIVEX 500 Target ITO film thickness: 90+ nm | DC 250 W | 100 s (~60 nm/min @ 26 sccm Ar + 0.4 sccm O2)

- 40. Lift-off: ITO (overnight): DMSO (course then fine), rinse, spin dry
 - 41. Optical inspection + check resistance with multimeter
 - 42. Measure film thickness with profilometer: $t =$
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- 43. Std clean
 - 44. Dry bake: 120 °C, 15 min -> Take wafers out of clean room
 - 45. Parylene deposition: 2.5 g of dimer should result in $\sim 3.5 \mu\text{m}$ film thickness Dielectric strength $\sim 276 \text{ V}/\mu\text{m}$. (rate $0.7 \text{ g}/\mu\text{m}$)
 - 46. Take wafer in clean room + clean in DI water + dry bake (do std HMDS priming. Also assists with PR adhesion)
 - 47. Spin coat: AZ9260 @ (4000 RPM | 30 s | dispense 2.5 ml) Target resist thickness: $7 \mu\text{m}$
 - 48. Let the resist level out - keep the wafer on the pins of the hotplate for 3 min
 - 49. Softbake: 100 °C, 8 min
 - 50. Rehydration: >30 min @ 60% humidity at wet chemistry room
 - 51. Multi-Exposure: **“Parylene MARK 02”** brightfield mask @ (9 x 5 s | 9 mW | 30 s wait intervals)
 - 52. Spray develop: 1x recipe L (Alternate: immersion development -> AZ400K:H2O = 1:3, 180 s)
 - 53. RIE: 85 mTorr, 50 sccm O2 | Etch rate $\sim 400 \text{ nm}/\text{min}$ Recipe 12411_p: 8:00 min @ 150(300) Watt - 2 min wait - 4:30 min 75(150) Watt
 - 54. Check if Parylene is etched (scratch test with scalpel) or check with water droplet (should not be hydrophobic) If not etched. Etch for 2 min more with cytop recipe (to clean residue)
 - 55. Resist strip: std clean (max 20% ultrasound power)
 - 56. Measure film thickness with profilometer (different point): $t =$
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- 57. Std clean
 - 58. HMDS-priming oven. Std recipe
 - 59. Laminate 1x55 μm sheet of Ordyl SY355
 - 60. Expose: "Ordyl" darkfield mask @ (27 s | 9 mW)
 - 61. Post Exposure Bake: 85 $^{\circ}\text{C}$, 3 min
 - 62. Ordyl development in BMR developer Develop until structures are well defined, iso to remove developer, rinse. Use 10% US power about 10 mins
 - 63. Hardbake: 110 $^{\circ}\text{C}$, 60 - 120 mins
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- 63. Dicing. Fragile, use blue tape by hand and no vacuum.
 - 64. Substrate thickness 2x500 μm (borosilicate), 2x675 μm (fused silica)
Feed speed: 3 mm/s
 - 65. Cut distance: 33.2 mm x 33.2 mm (chip size: 33 mm x 33 mm)
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4 Notes