TI xLift
image reversal resist

Technical Data Sheet
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MicroChemicals

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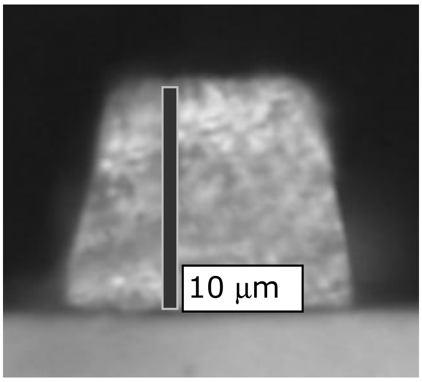
General Information

The **TI xLift** image reversal resist is optimized for **lift-off** of thick to very thick (5 .. 20 µm) films.

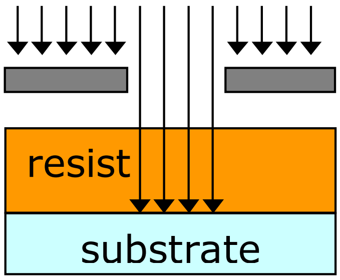
This technical data sheet intends to give you a guide-line for process parameters for various applications. However, the optimum values for e.g. spin profile, exposure dose, or development depend on the individual equipment and need to be adjusted on each individual demand.



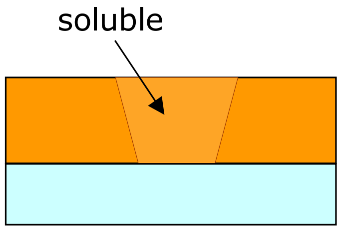
← *10.5 mm thick metal via lift-off with TI xLift*

'Image Reversal' – A Short Introduction

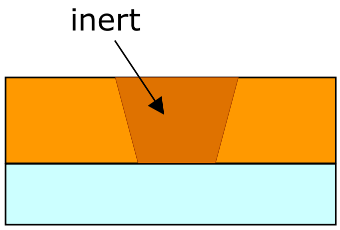
What 'image reversal' generally means



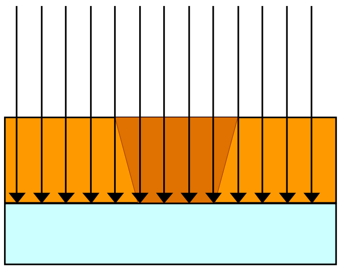
(1) Exposure using an inverted mask (the exposed areas finally remain)



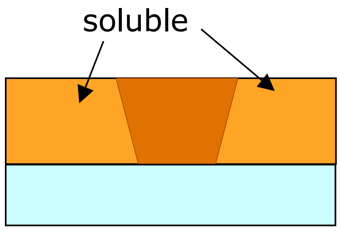
(2) The resist now would behaves like an exposed positive resist.



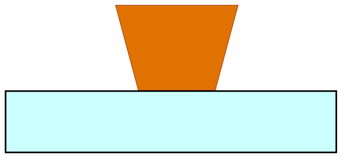
(3) The **reversal bake** cross-links the exposed area, while the unexposed area remains photo-active



(4) The **flood exposure** (without mask) ...



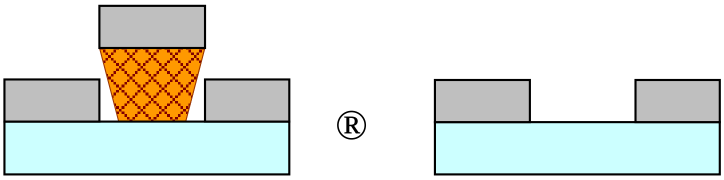
... **(5)** makes the resists, which was not exposed in the first step, soluble in developer



(6) After developing, the areas exposed in the first step now remain

... and for what image reversal is good for:

Adjustable undercut for lift-off of thin and thick sputtered, CVD, and evaporated films like metals, a-Si:H, a-SiN:H etc.



Processing the TI xlift

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In chronological order:

- After **cleaning** the **substrate**, put the substrate on the hotplate at minimum 120 °C for 10 minutes to remove adsorbed water from the substrate surface. Alternatively, you can use a furnace at same temperature for 30 min. Standard HMDS procedure (only from vapor phase with an optimum substrate temperature of 125°C !) is also an adequate preparation.

- **Spin-coat** the resist immediately after cooling down the substrate at:

resist thickness	5.9 µm	7.0 µm	8.2 µm	10.5 µm	14.4 µm	20.0 µm
final rpm	2.200	1.600	1.400	1.200	900	600

with an acceleration of approx. 900 rpm/s and keep at **final spin speed for 5 seconds**. Then decelerate down to 0 rpm at approx. –900 rpm/sec. For 4 inch wafer, a minimum of 3.0 ml of resist is recommended.

- **Leave** the substrate on the spin-coater (or on any horizontal surface at room temperature) for at least 5 min (≈ 5 µm resist thickness) to 30 min (≈ 20 µm resist thickness). This will smooth the surface, reduce striations, and allow the edge bead near the substrate edge i) to flatten and ii) to contract to the outermost few mm of the wafer. If subsequent soft-bake causes foaming or patterning of the resist, increase the **delay**.

- **Soft-bake** at 95°C on a hot-plate or in an fufor:

total resist thickness	5 .. 9 µm	10 .. 16 µm	17 .. 24 µm
time (min)	20	40	60

- **Remove** the **edge bead** on the edge of the substrate. We recommend giving a sharp stream of AZ EBR solvent (PGMEA) focused on the outer few mm of the substrate spinning at 1.000 rpm. Avoid spattering drops of EBR on the inner side of the substrate, this will cause spots with reduced resist thickness.

- **Exposure** broadband or i-line (with the mask) at a (as calibrated on **i-line**, 365 nm) dose of approximately:

total resist thickness	5.9 µm	7.0 µm	8.2 µm	10.5 µm	14.4 µm	20.0 µm
first exposure dose (mJ/cm^2)	40 .. 100	50 .. 140	80 .. 200	110 .. 280	150 .. 400	180 .. 500
= exposure time (sec.) (holds for all standard mask aligners with a 350W Hg-lamp)	4 .. 10	5 .. 14	8 .. 20	11 .. 28	15 .. 40	18 .. 50

This first exposure dose adjusts the final wall profile and can be increased/decreased by up to 50% for optimum results (see Appendix).

- **Post-exposure delay time:**

total resist thickness	5 .. 9 µm	10 .. 16 µm	17 .. 24 µm
Room temperature 20° (min) ...	5	5	10
... subsequent hot-plate 50°C (min)	0	15	30

In this delay time, N_2, generated during exposure, will diffuse out the resist. If the resist foams on the hot-plate, next time increase the delay time at room temperature.

- **Reversal Bake:** After the delay bake the substrate at a temperature of 130°C on the hotplate for 2 minutes (when using furnace try 20 minutes at 120°C-130°C. Because this step is very temperature critical furnace baking is not recommended). This step is the reversal bake where the image is reversed due to cross link the exposed areas making them insoluble in the developer. If the resist foams, next time increase the delay time at 50°C (see previous point)

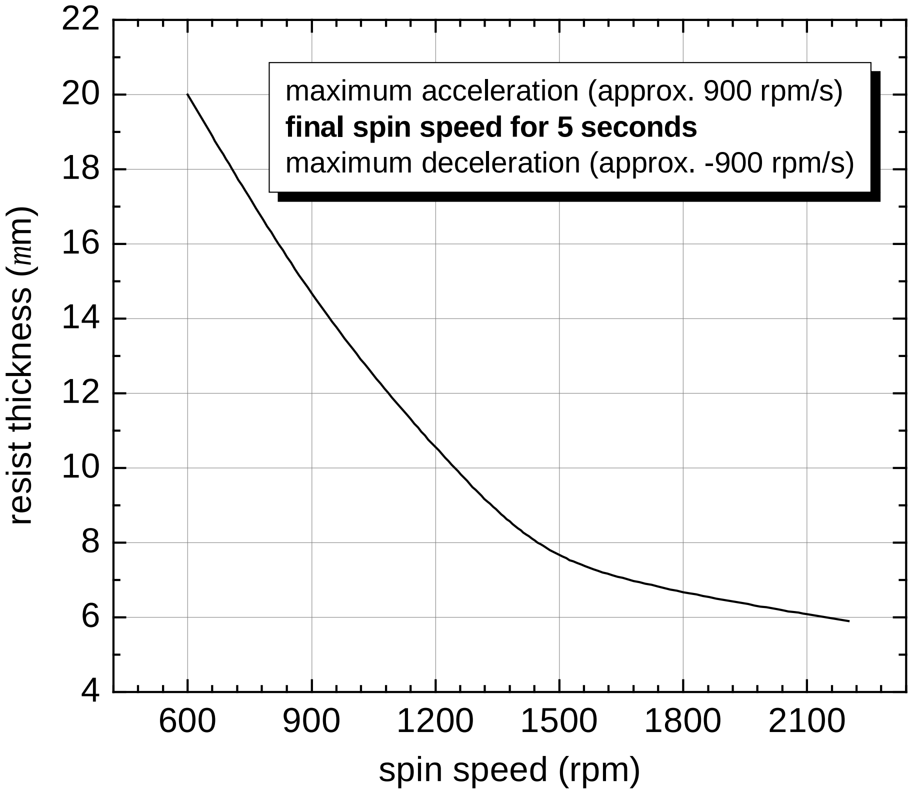
- **Flood Exposure:** Exposure the substrate for the second time **without a mask** (flood exposure).

total resist thickness	5 .. 9 μm	10 .. 16 μm	17 .. 24 μm
dose (mJ/cm²)	≈ 800	≈ 1.000	≈ 1.200

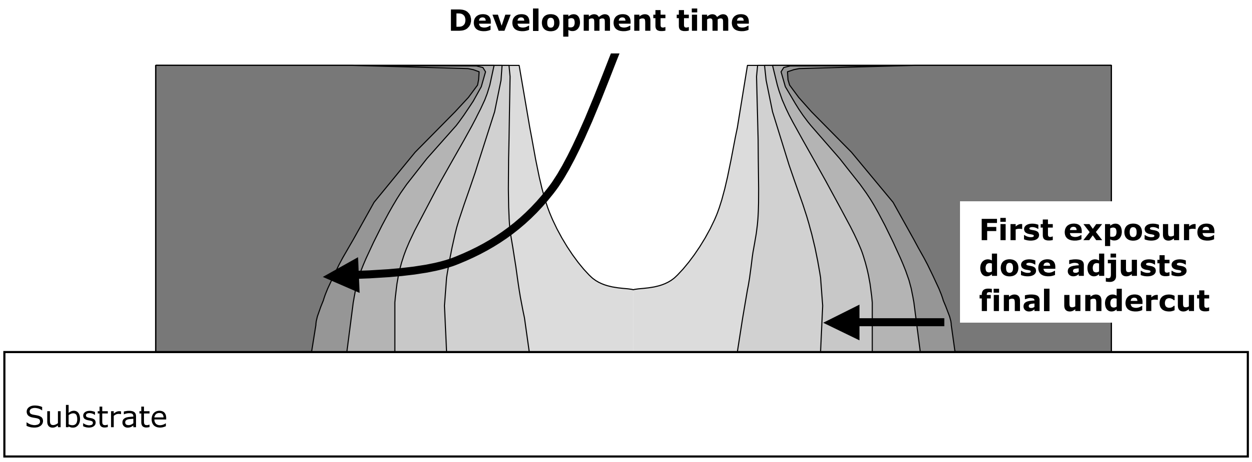
When, during a subsequent deposition, the temperature will raise over 80°C, use a high exposure dose to avoid nitrogen bubbles in the resist during the deposition.

- **Develop** e.g. in AZ 826MIF. When the structures are through-developed, add another approx. 10-30% of the time in the bath of development time to finalize the side wall profile (see appendix). Beside the used developer, development time depends on resist thickness and strongly on reversal bake temperature.

  If shorter development times are important, use AZ 400K 1:3.5 (e.g. 100 ml AZ 400K and 350 ml DI-water). Resist dark erosion might slightly increase.



Appendix A: Adjusting the undercut



Undercut depends on:

1. First exposure dose

At low 1st exposure doses, only the upper part of the resist is exposed. Only this region will subsequently be 'reversed' during image reversal bake. The substrate-near resist now is still unchanged and will be exposed (and made soluble) in the subsequent flood exposure. If the first exposure dose is too low, development will lift the upper resist layer, or/and the dark erosion is too high.
® **High 1st exposure dose: Reduced undercut**

2. Reversal bake temperature and reversal bake time

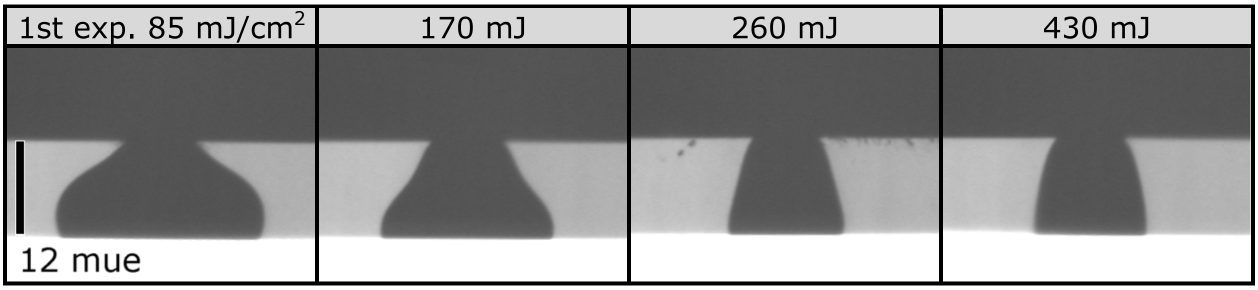
If the reversal bake temperature- and time is too low, the image reversal process will not be completed. As a consequence, the resist exposed during the 1st exposure shows a high 'dark erosion' during development, sometimes appearing as holes or bubbles in the resist. With increasing reversal bake temperature/-time, the reversal process improves, and dark erosion is reduced.
At reversal bake temperatures/-times chosen to high, even the parts of the resists exposed by scattered light during the 1st exposure (in regions where no light should be) are reversed. As a consequence, the profile might change from the desired undercut to a typical positive profile.
® **High reversal bake temperature/-time: Reduced undercut**

3. Developer/Development time

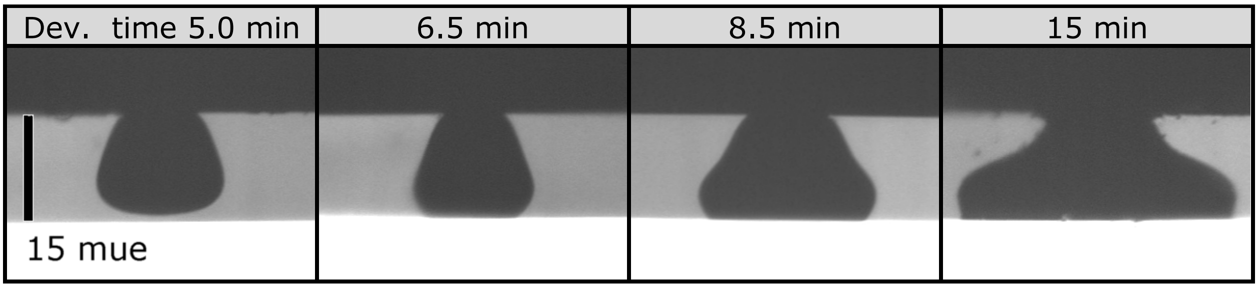
With increased developing time, or by the usage of strong developers (like AZ 400K in dilutions of 1:3.5 and stronger), also the parts of the resist are developed, where the image reversal process has been performed.
® **High developing time: Increased undercut**

Appendix B: Parameters and profile

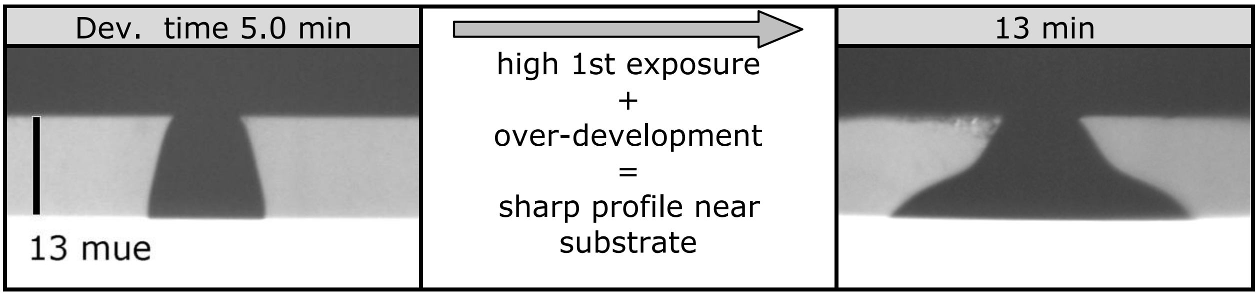
Example I: Varying the **first exposure dose** at 30% 'over-developing'
(Thickness 12 µm; Rev. bake 130°C 2min; Flood exp. 1.000 mJ; Dev. AZ400K 1:3, 8 min)



Example II: Varying the **development time** at low first exposure dose
(Thickness 15 µm; 1st exp. 240 mJ, Rev. bake 130°C 2min; Flood exp. 1.200 mJ; Dev. AZ400K 1:2.5)



Example III: Varying the **development time** at high first exposure dose
(Thickness 13 µm; 1st exp. 310 mJ, Rev. bake 130°C 2min; Flood exp. 1.200 mJ; Dev. AZ400K 1:2.5)



Example IV: Varying the **reversal bake**
(Thickness 11 µm; Rev. bake 130°C; Flood exp. 1.000 mJ; Dev. AZ 826MIF)