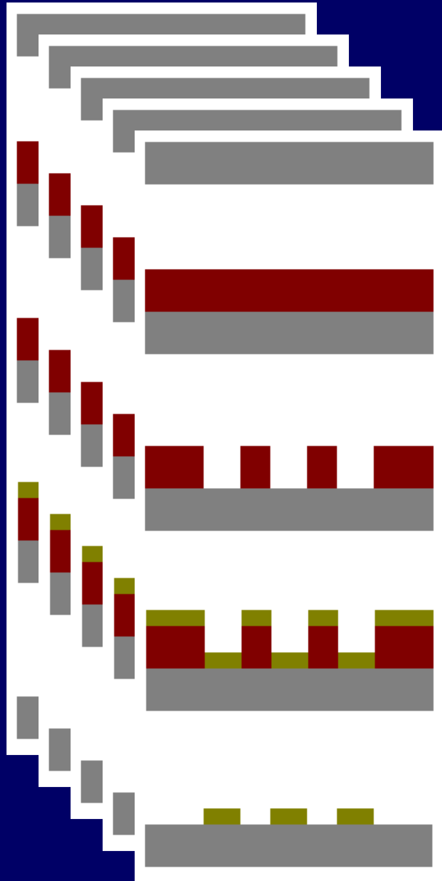
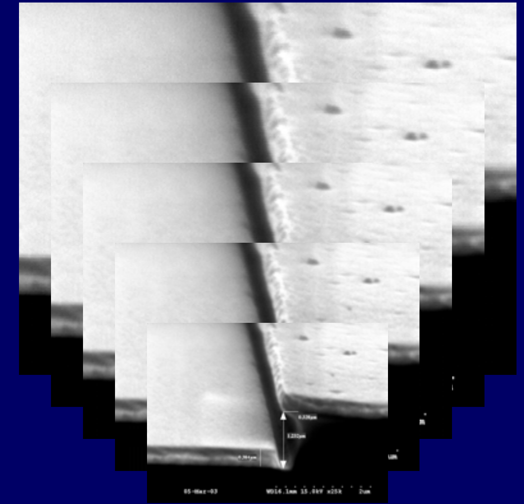


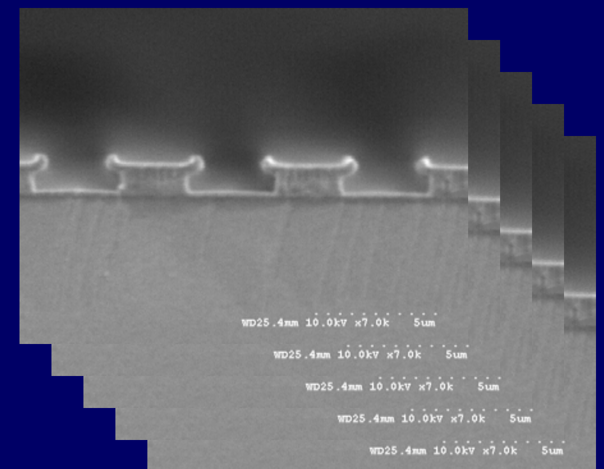
Liftoff Process Using Positive Photoresist

March 6, 2003

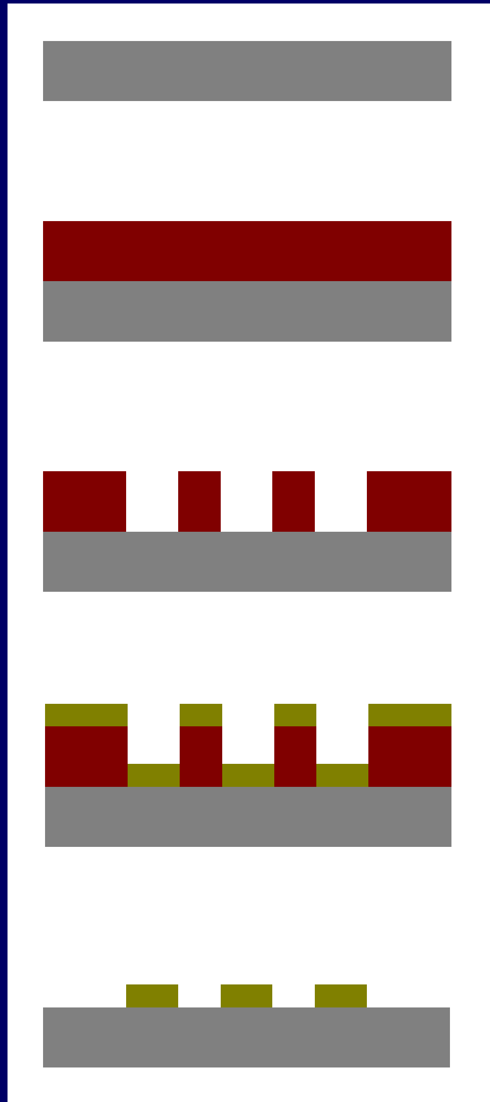


Biren Patel, Akil Sutton, Leslie George

Advisor: Dr. James Zhou



Ideal Liftoff Process



Substrate

Spin Photoresist

Pattern Photoresist

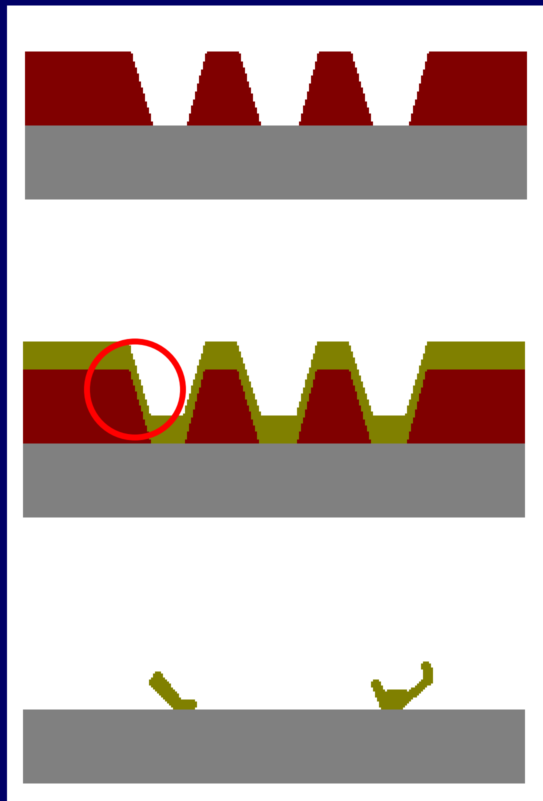
Deposit Metal

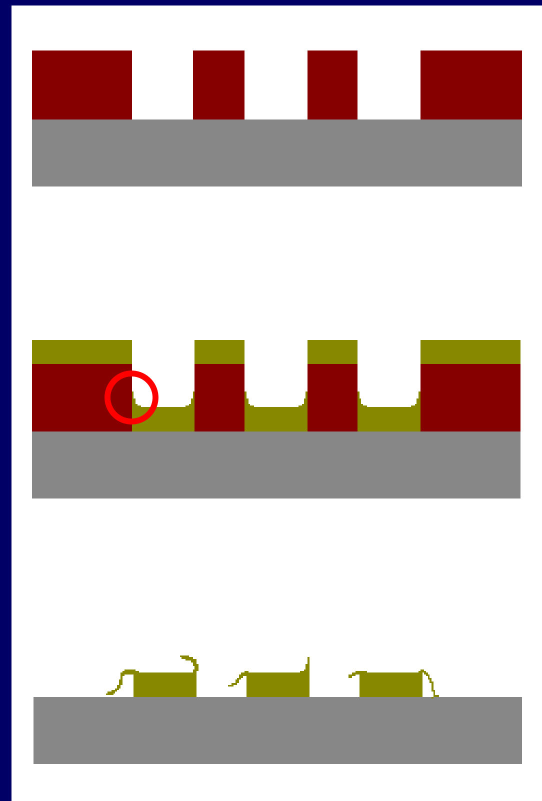
Remove Photoresist

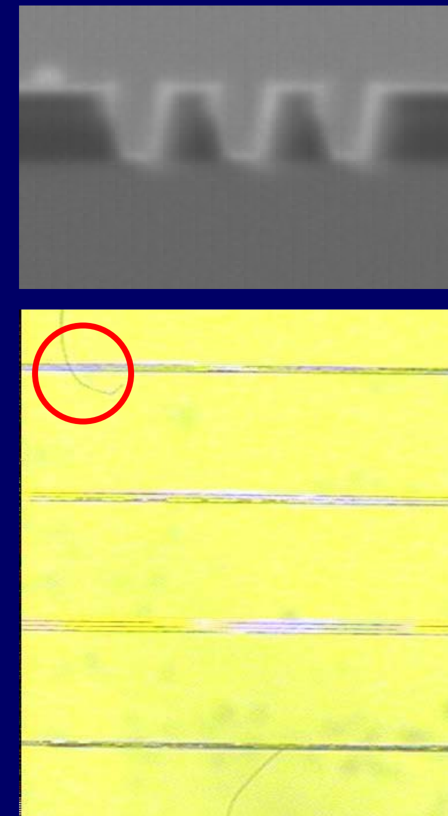
Problems

1. If sidewalls are not perpendicular, the metal is likely to be continuous. There is no separation between the undesired and desired metal.

2. Metal on substrate doesn't fall perfectly flat. Parts can also pile up and cling to the resist sidewalls. After the lift, unpredictable results will occur.



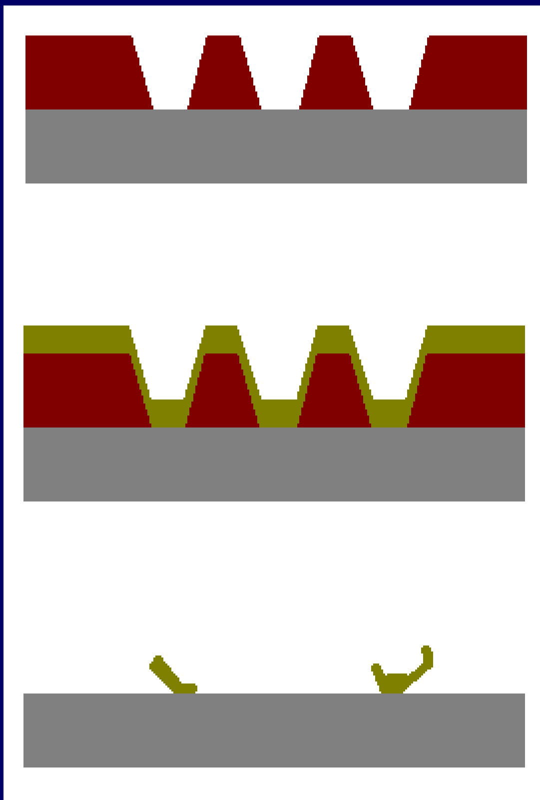


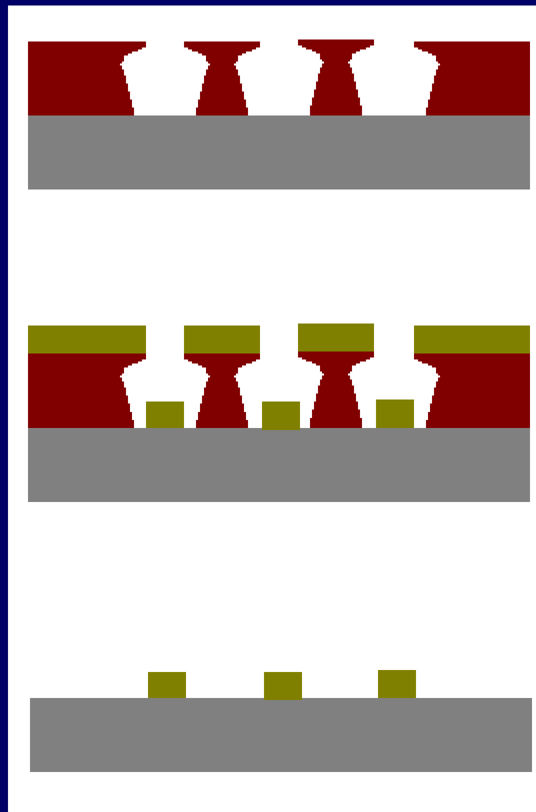


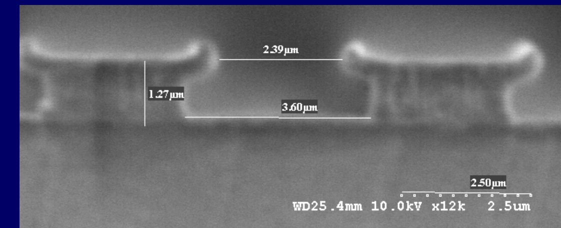
Solution

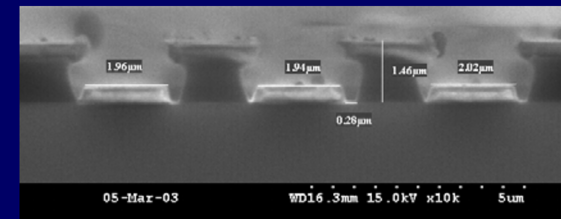
Create an overhang in the resist profile using chlorobenzene.

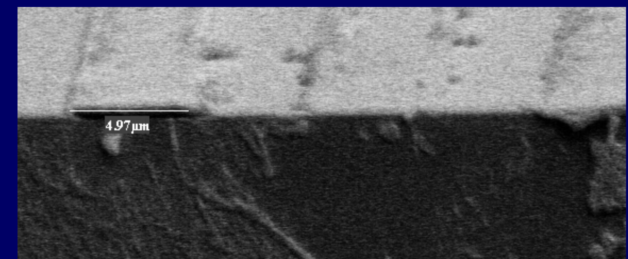
Soaking resist in chlorobenzene makes the resist harder, decreasing the development rate. Only the surface of the wafer is exposed to the chlorobenzene causing just the top layer of the resist to have a reduced development rate.





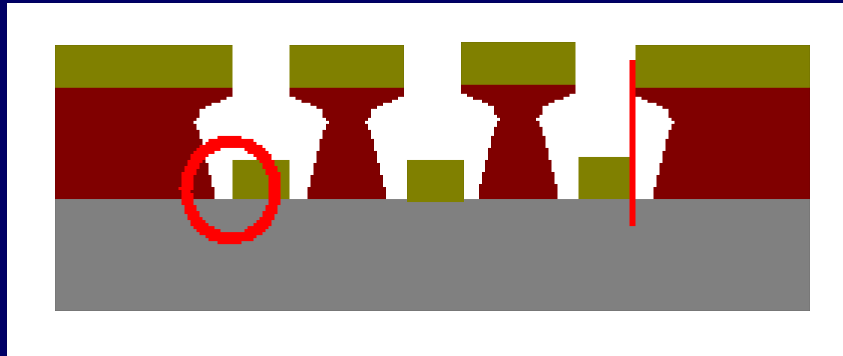


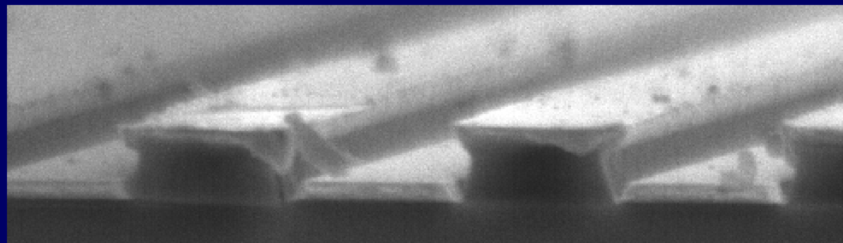


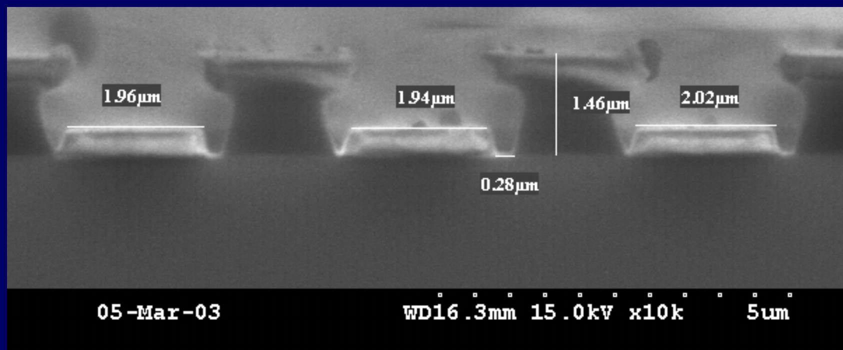


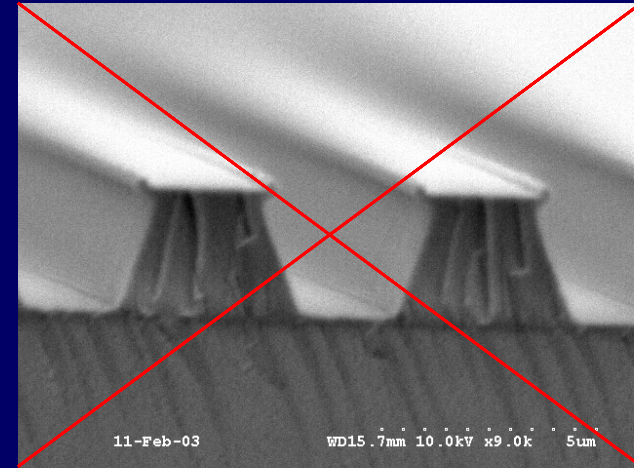
Important Points

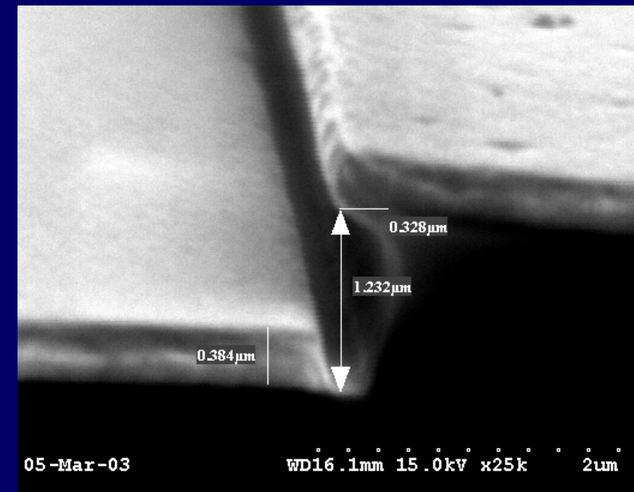
Even if not continuous, if the metal is piling up against the resist walls, the metal will fall back on the substrate in an unpredictable location after removing the resist.





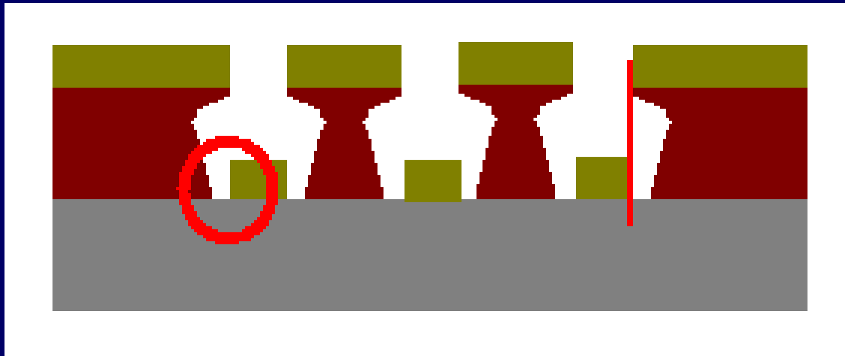


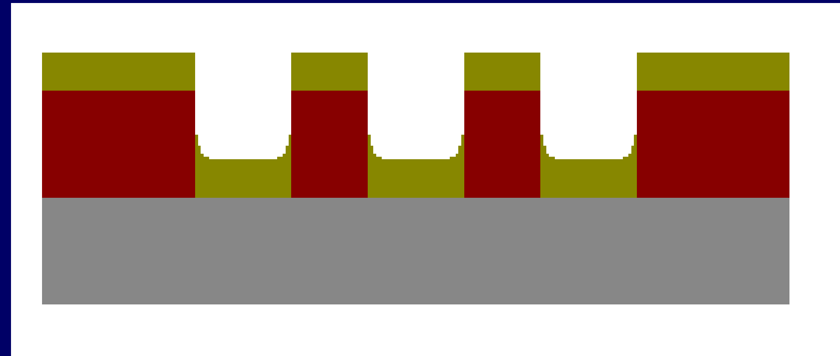


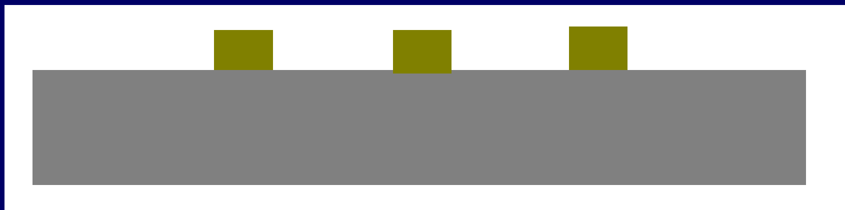


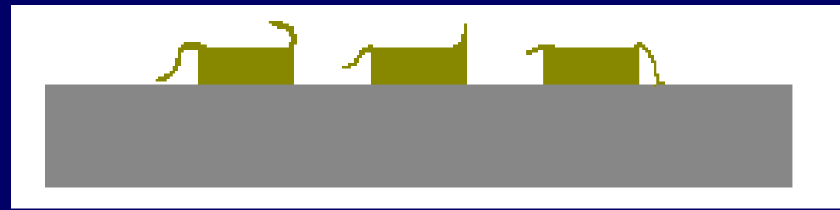
Important Points

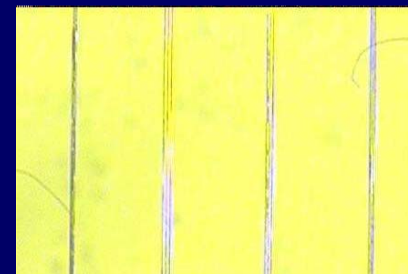
Even if not continuous, if the metal is piling up against the resist walls, the metal will fall back on the substrate in an unpredictable location after removing the resist.







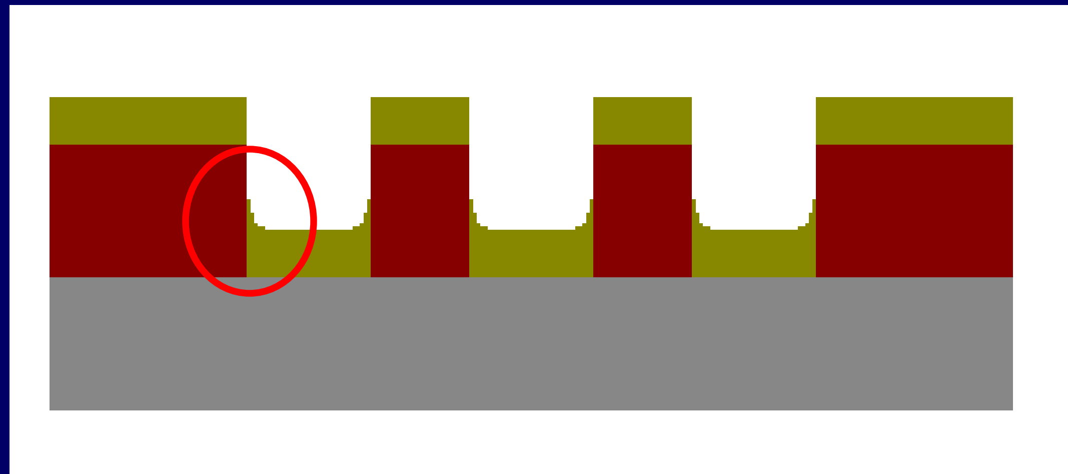




Important Points

Even if not continuous, if the metal is piling up against the resist walls, the metal will fall back on the substrate in an unpredictable location after removing the resist.

This is true even for perfectly isotropic development.



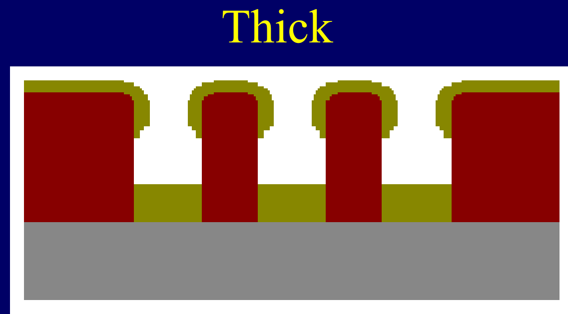
Resist Height

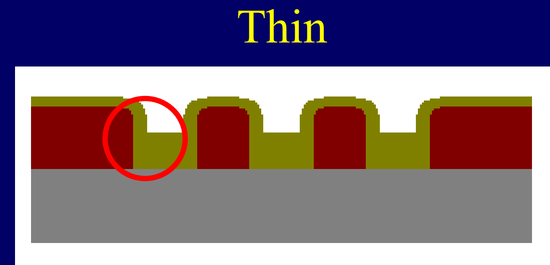
Except for conditions of very isotropic development, it is generally better to use a thicker resist such as Shipley 1827 instead of 1813. Using a thicker resist lowers the chances of the metal being continuous. However, if your development is more isotropic, then using a thicker resist requires a longer overhang.

Thick

Thin

Isotropic profile with untreated resist.

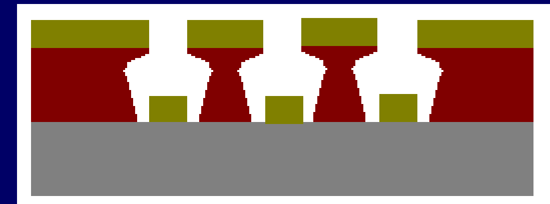




Not enough clearance between metal on substrate and metal on resist.

Anisotropic profile with chlorobenzene treated resist.

Overhang is not long enough.



Final Process Recipe

1000 Å of oxide thermally grown on 4” silicon test wafers using iniox.003.

Spin and expose using Shipley 1813 photoresist.

Speed: 5000 rpm

Acceleration: 2500 rps^2

Time: 30 seconds

Intensity: 16.5 mW/cm^2

Wavelength: 405 nm

Soak in Chlorobenzene for 20 minutes after exposure.

Note: Chlorobenzene is dangerous to inhale, keep well under fume hood.

Final Process Recipe

Develop using MF-319 developer for 70 seconds or until visually complete.

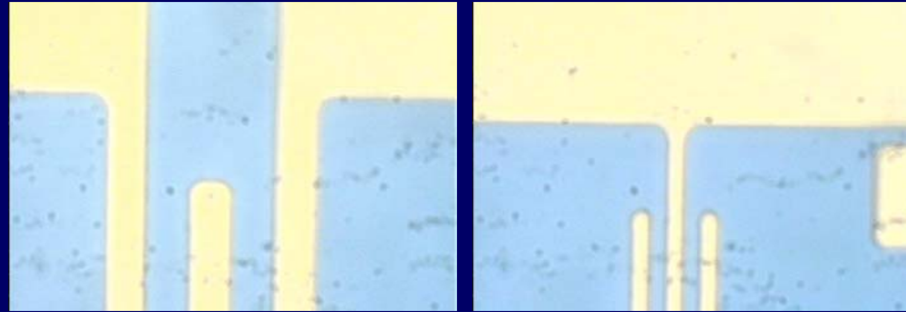
Deposit metal by evaporation.

1. 200 Å Ti at at 4.0 Å/s (Bottom)
2. 4000 Å Au at 3.0 Å/s (Middle)
3. 50 Å Ti at 4.0 Å/s (Top)

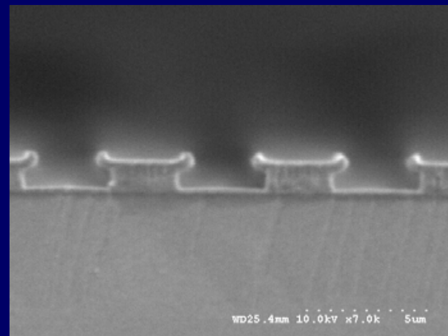
Perform liftoff using a photoresist solvent/stripper.

Use AZ400T PR Stripper at 80° C or acetone at room temperature, then rinse off carefully using acetone. No agitation is necessary if a good resist profile was achieved. AZ400T attacks resist faster than acetone.

Results

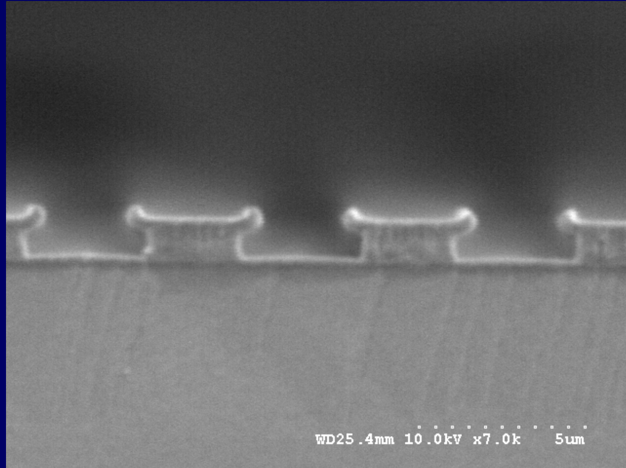


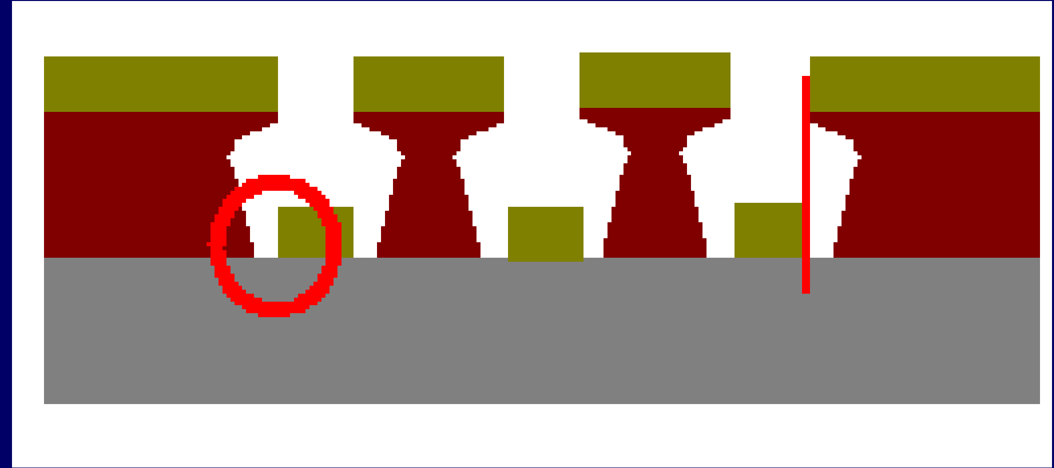
Visually, the 5 µm (left) as well as the 2 µm (right) lines are clean and continuous over most of the wafer.



The key to the successful liftoff was achieving a good overhanging resist profile.

Results





A resist profile such as this one will:

1. Prevent the deposited metal from being continuous.
2. Prevent the metal from piling up on the edges of the resist walls.

Special Thanks:

James Zhou

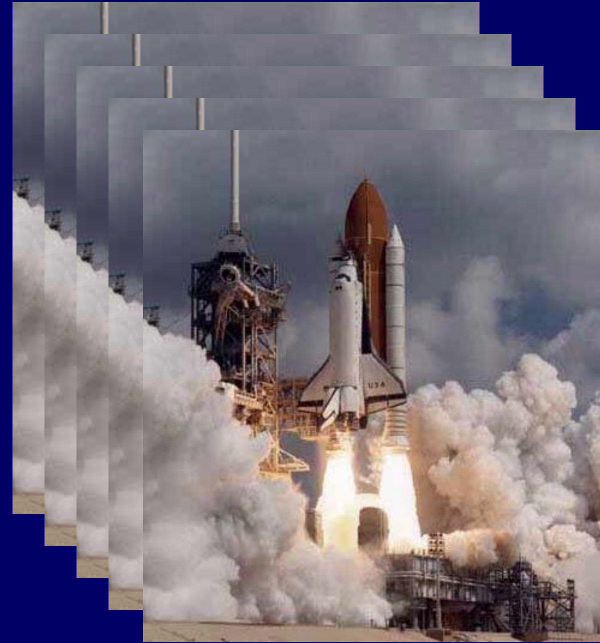
Akil Sutton

Leslie George

Fredrick L'Hereec

Demetris Geddis

Christophe Courcimault



Reference:

Campbell, Stephen. The Science and Engineering of Microelectronic Fabrication. Oxford University Press; 2nd edition.