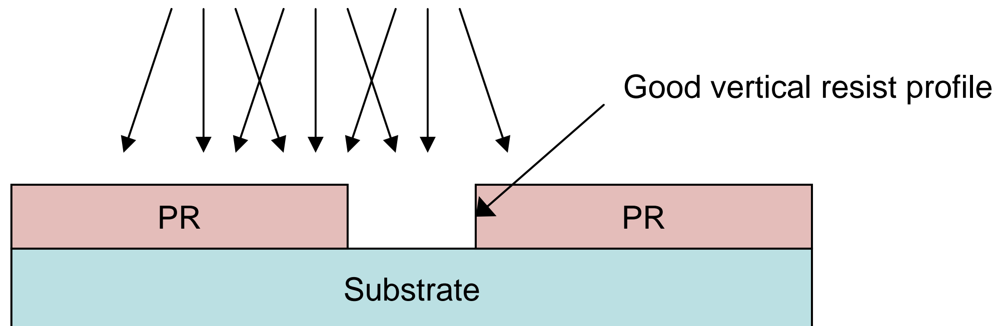
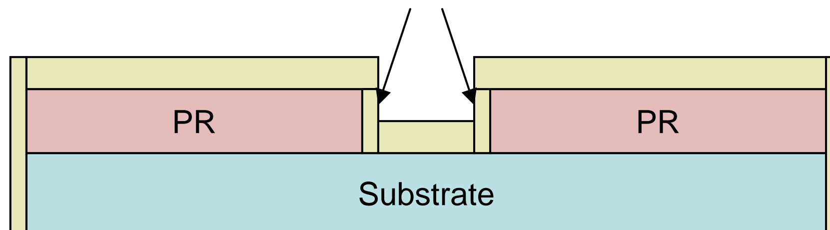
Lift-Off Techniques

Lift-off refers to the process of exposing a pattern into photoresist (or some other material), depositing a thin film (such as a metal or dielectric) over the entire area, then washing away the photoresist (or other material) to leave behind the film only in the patterned area.

The following process sequence illustrates the problem with using a positive tone photoresist alone for lift-off:





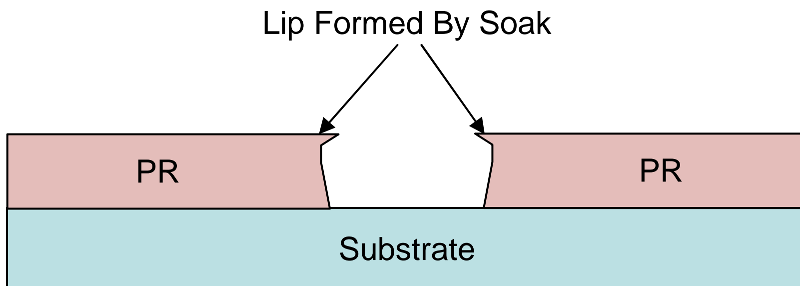
Bad Lift-Off Ultrasonic Agitation can help, but not enough in general

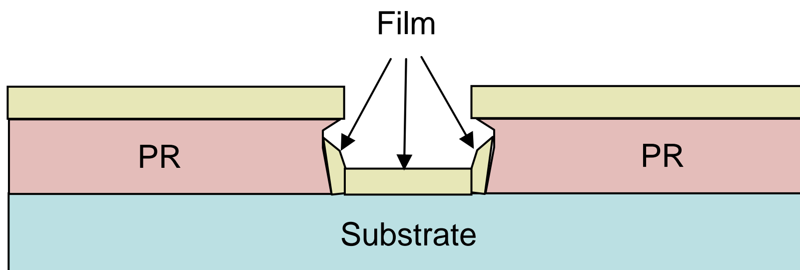
The following slides illustrate solutions to this problem.

Lift-Off Techniques

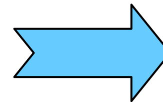
Method #1 (Toluene Soak) : Before developing the photoresist, after exposure, you can soak the sample in Toluene for 5 minutes. This creates a hardened layer in the photoresist surface that resists developing. A deep UV exposure can also lead to this effect.

Once hardened, you can develop the resist with a slightly longer than normal time. The following profile is obtained:

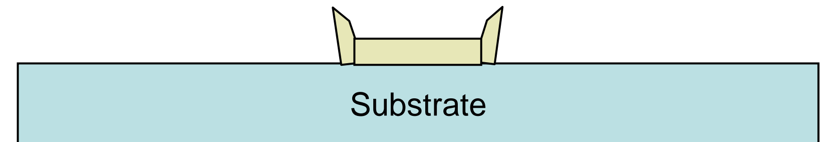




Lift-Off

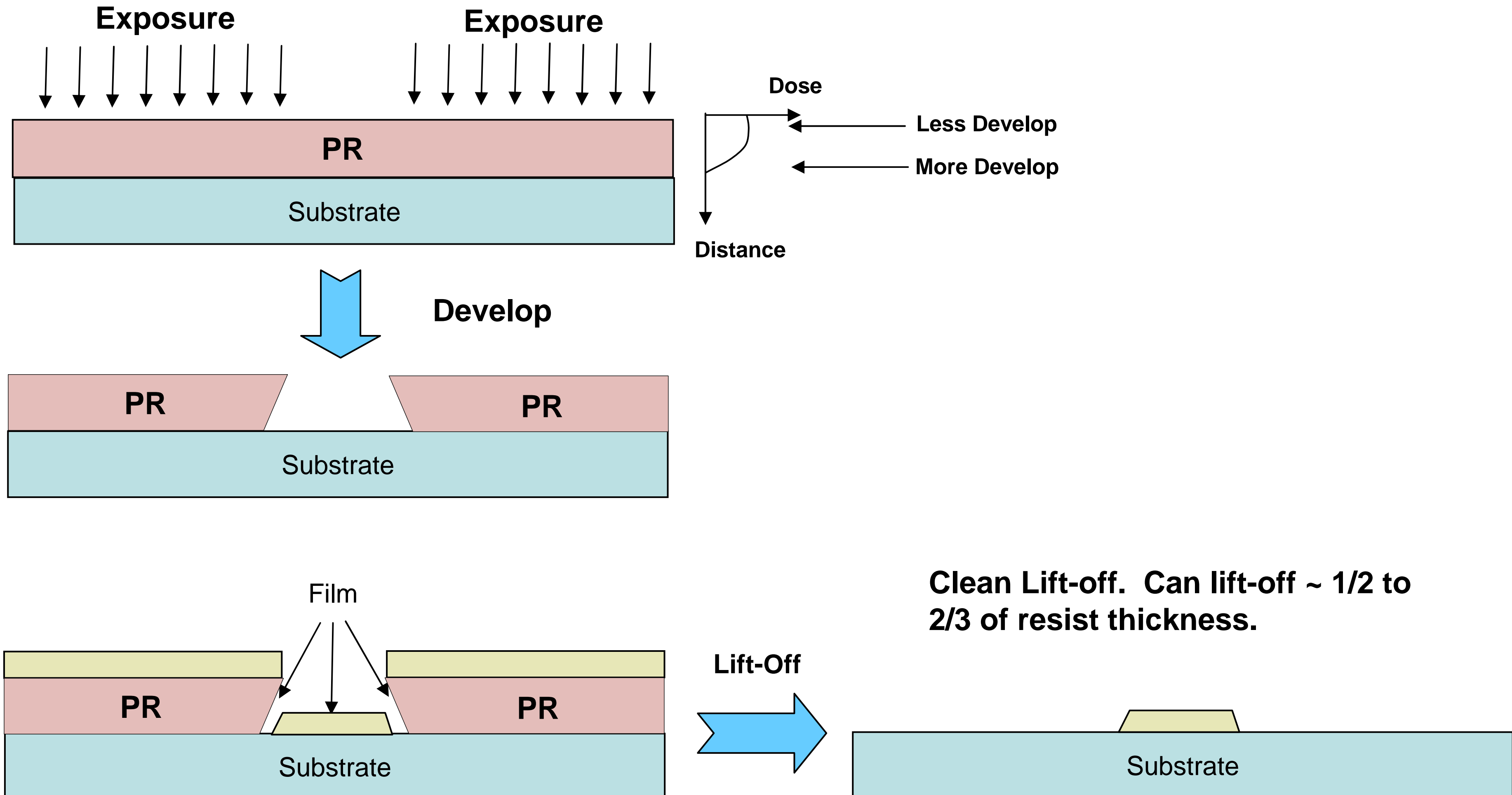


Can Still have "wings" at edges due to resist wall coverage



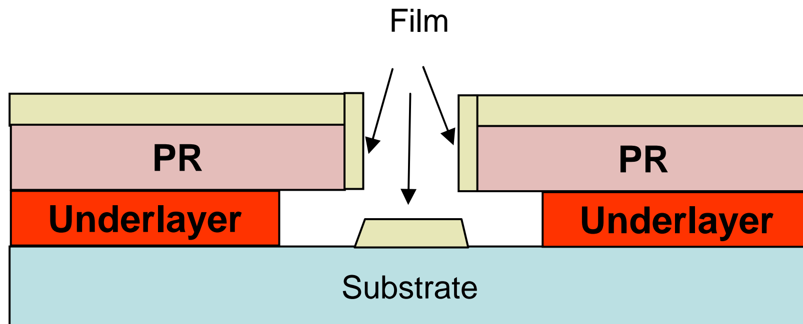
Lift-Off Techniques

Method #2 (Negative/Image Reversal Resist) : By using a negative resist and adjusting the exposure and develop time, one can obtain a retrograde profile. This is much better for lift-off than positive resist which gives a straight or slightly graded profile. Remember, with a negative resist, less exposure means more developer attack which means more undercut.

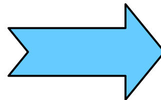


Lift-Off Techniques

Method #3 (Bi-layer method) : By using a two different types of resist on top of each other, one can precisely pattern the top resist and then undercut the bottom resist to form a very nice lift-off profile. You must use resists with different solvents/chemistries to avoid intermixing which will make the process inconsistent. PMGI, Shipley LOL, and LOR series resists work well as underlayers for i-line and broad-band lithography. With PMGI, the resist serves as a mask for DUV (250nm) exposure and development of the PMGI. The Shipley LOL and the LOR resists use bake temperature to control undercut rate using standard resist developers. The top layer can be positive or negative tone and you can lift-off up to ~2/3 of the bottom layer thickness. This process allows for very clean lift-off using positive tone resist. Lift-off is performed in resist strippers.



Lift-Off



Clean Lift-off. Can lift-off ~ 1/2 to 2/3 of resist thickness.