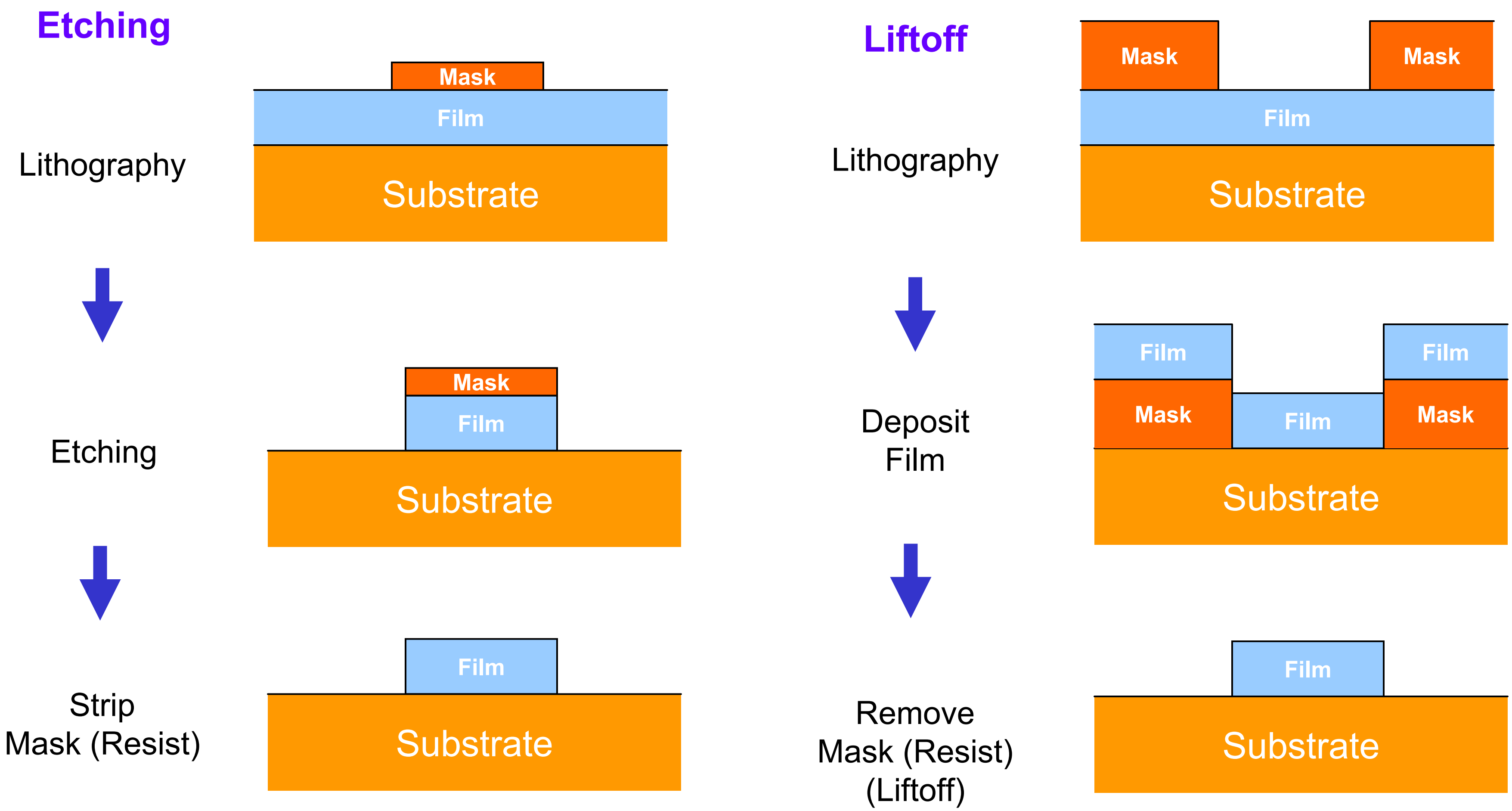
III. Wet and Dry Etching

	Wet	Dry
Method	Chemical Solutions	Ion Bombardment or Chemical Reactive
Environment and Equipment	Atmosphere, Bath	Vacuum Chamber
Advantage	1) Low cost, easy to implement 2) High etching rate 3) Good selectivity for most materials	1) Capable of defining small feature size (< 100 nm)
Disadvantage	1) Inadequate for defining feature size < 1um 2) Potential of chemical handling hazards 3) Wafer contamination issues	1) High cost, hard to implement 2) low throughput 3) Poor selectivity 4) Potential radiation damage
Directionality	Isotropic (Except for etching Crystalline Materials)	Anisotropic

Pattern Generation (Transfer): Etch vs. Liftoff



Isotropic vs. Anisotropic Etching

Isotropic Etching: Etching rate is the same in both horizontal and vertical direction

Anisotropic Etching: Etching rate is different in horizontal and vertical direction

Lateral Etch Ratio:

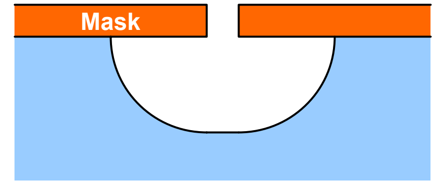
$$R_L = \frac{Horizontal\ \ Etch\ Rate\ (r_H)}{Vertical\ \ Etch\ Rate\ (r_V)}$$

Isotropic Etching: $R_L = 1$

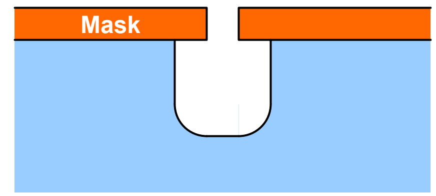
Anisotropic Etching: $0 < R_L < 1$

Directional Etching: $R_L = 0$

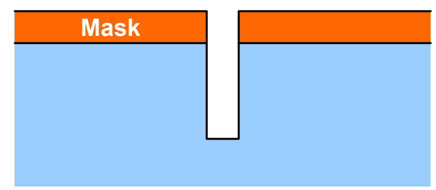
Bias: the difference in lateral dimensions between the feature on mask and the actually etched pattern
➡ smaller R_L results in smaller bias



$R_L = 1$

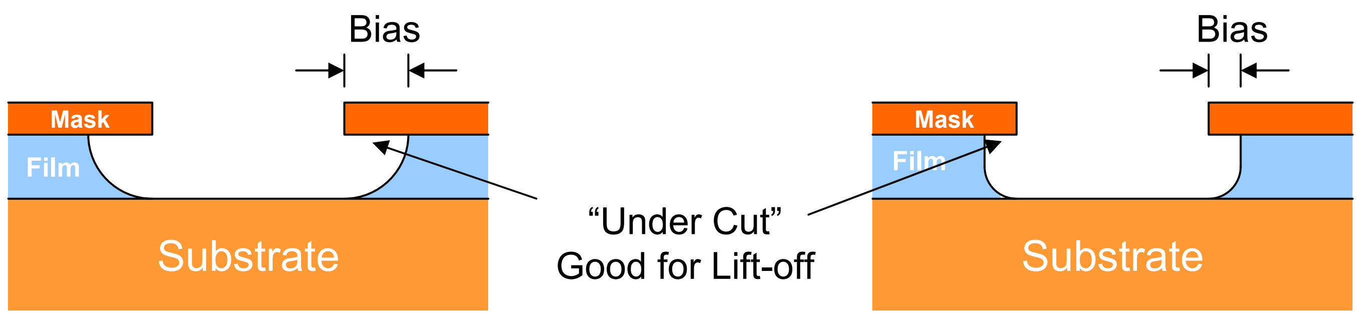


$0 < R_L < 1$



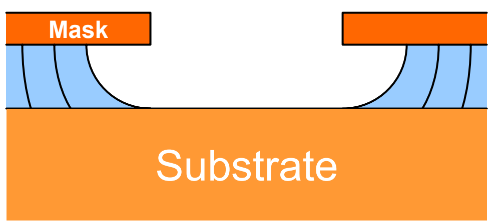
$R_L = 0$

"Under Cut" and "Over Etch"



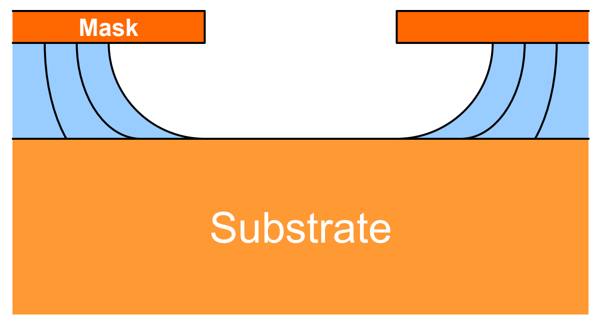
(R_l = 1, pattern dimension is poorly defined)

(R_l = 0.5, pattern dimension is better defined)



Over-Etch

➥ results in more vertical profile but larger bias



Worse in thick film

➥ Poor CD control in thick film using wet etch

Mask Erosion: Film-Mask Etching Selectivity

1) film horizontal etch rate (r_{fh}) < mask horizontal etch rate (r_{mh}):

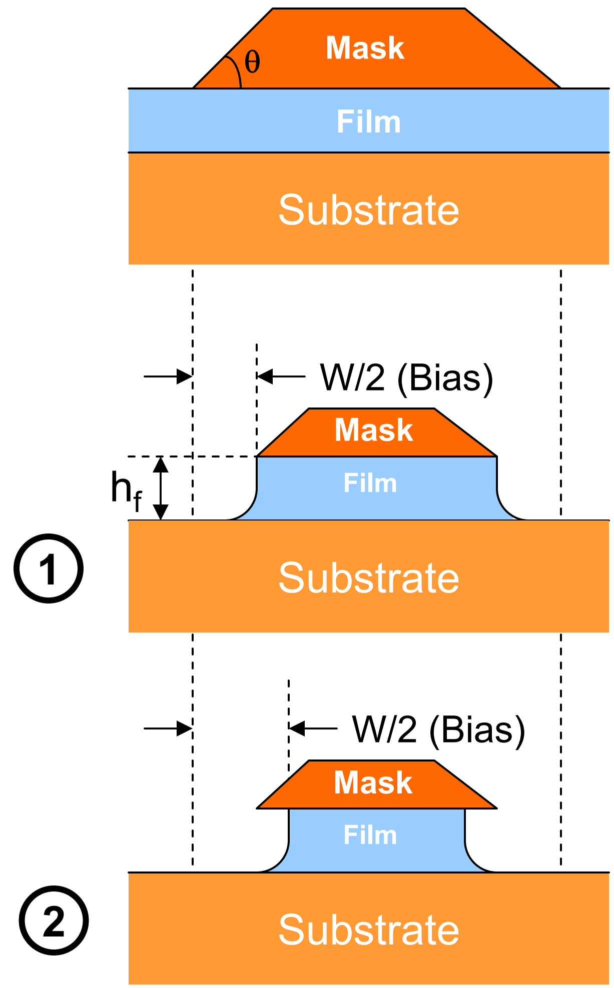
$$\frac{W}{h_f}(\%) = \frac{2}{S_{fm}}(\cot\theta + R_m)$$

$$R_{mL} = \frac{r_{mH}}{r_{mV}}$$ (mask lateral etch ratio)

$$S_{fm} = \frac{r_{fV}}{r_{mV}}$$ (ratio of film and mask vertical etching rate – **selectivity**)

2) If film horizontal etch rate (r_{fh}) > mask horizontal etch rate (r_{mh}):

$$\frac{W}{h_f}(\%) = 2R_m$$



DOCKET ALARM

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts

Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research

With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips

Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS

Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS

Sync your system to PACER to automate legal marketing.