

Atomic Layer Deposition Fundamentals & Applications

HBRL Research Group

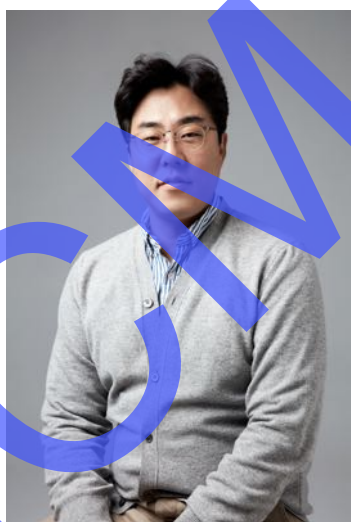
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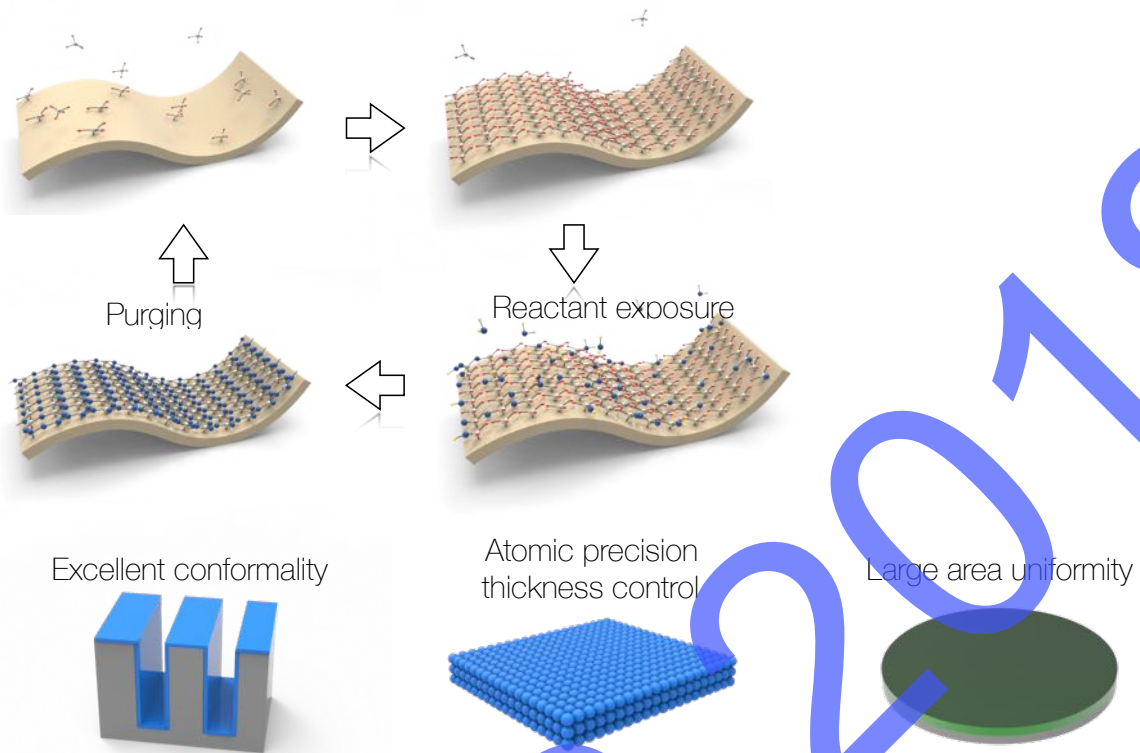
(lee-office@cm.acs.org, <http://pubs.acs.org/journal/cmtext>)

• Postdoc in ChemE of Stanford, 2010-2013

• PhD in MSE of POTTECH, 2005-2009

• 85 SCI papers, 27 h index

Atomic Layer Deposition (ALD)



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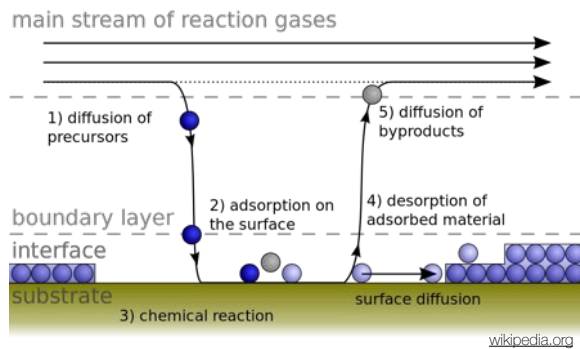
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Chemical Vapor Deposition (CVD)

- Chemical vapor deposition (CVD)
 - Use chemical precursor to deposit thin films through chemical reaction
 - Slowest process determines overall process (rate limiting step)



<https://www.youtube.com/watch?v=iB0jsWFm8Lc>



wikipedia.org

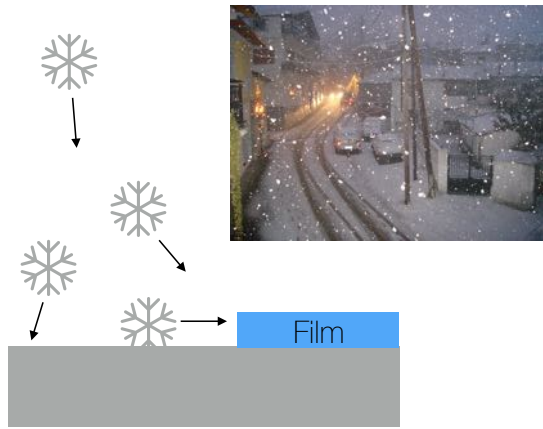
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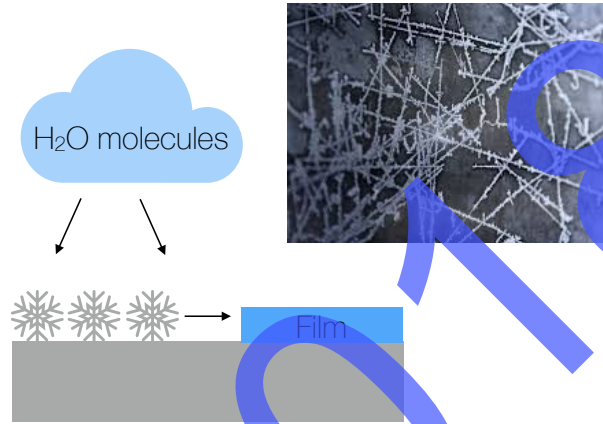
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Cousin of CVD

CVD



ALD

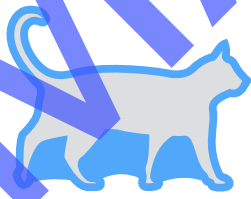


- CVD: gas phase reaction & surface reaction
- ALD: surface reaction only

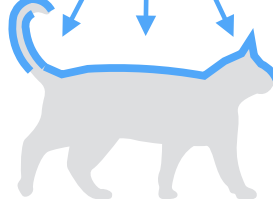
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Conformality in Various Methods

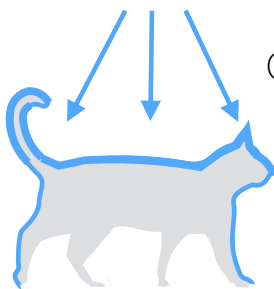
Sol-gel



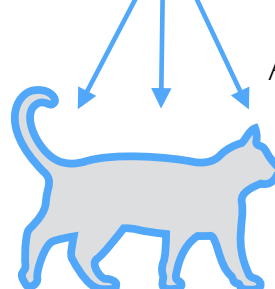
PVD



CVD



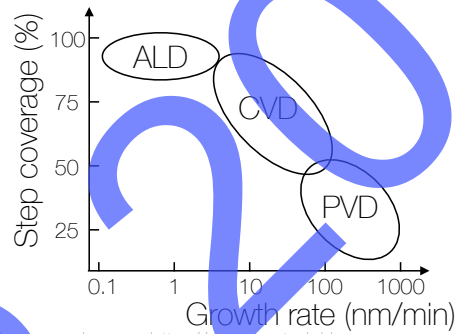
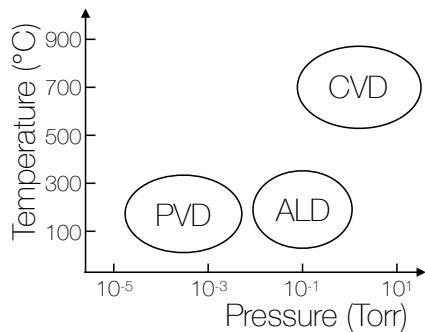
ALD



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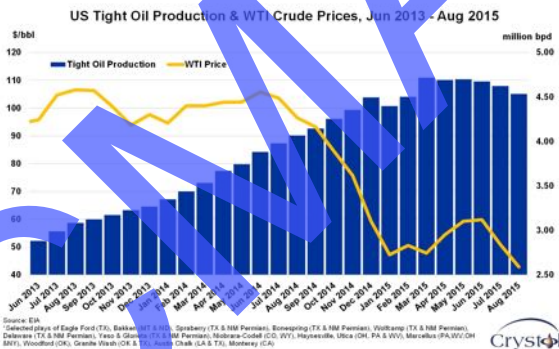
Stats of ALD

	PVD	CVD	ALD
Reaction	Physical adsorption	Surface + vapor phase reaction	Surface reaction
Growth temperature	Low (RT)	High to middle (600 °C ~ 300 °C)	Low to middle (< 500 °C)
Step coverage	Poor	Good	Excellent
Impurity	Very low (< 1%)	A few %	Low (< 1%)
Thickness control	> 50 Å	> 10 Å	< a few Å
Wafer uniformity	Good	Good	Excellent
Growth rate	Fast	Middle	Slow



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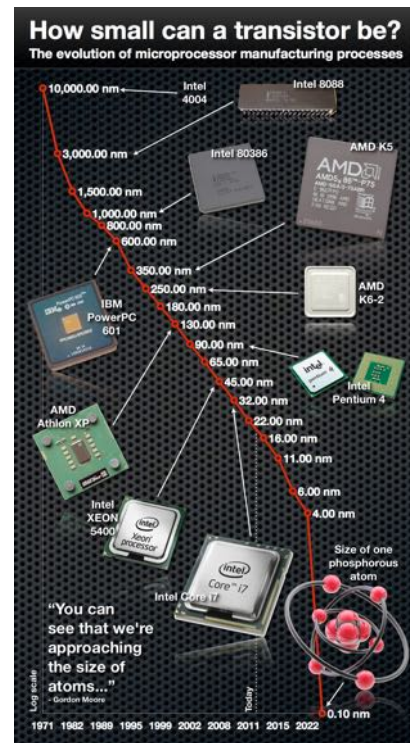
Not Too Thin and Slow Anymore



• The Shale oil was developed tens of years ago but now very popular due to the rising of conventional oil price

• 100 nm
 = 1 Å/cycle × 1000 cycle × 10 s/cycle
 = 10,000 s ~ 2 h. 40 min.

• 1 nm
 = 1 Å/cycle × 10 cycle × 10 s/cycle
 = 100 s ~ 1.5 min.



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