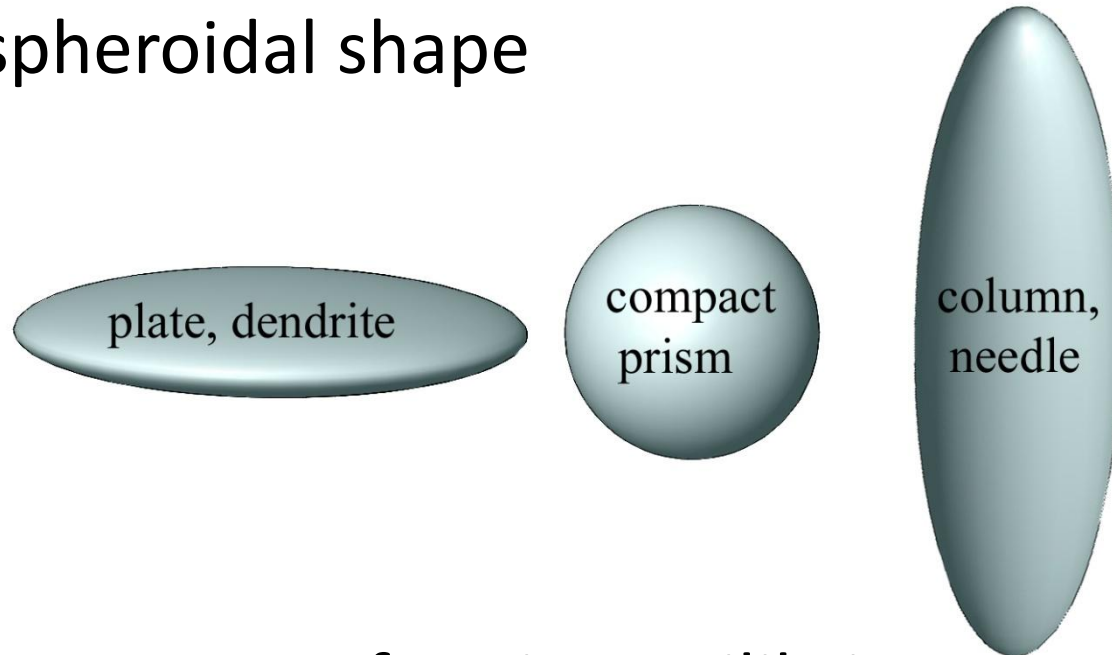


Order



Vapor growth in cloud models

- Assume spheroidal shape

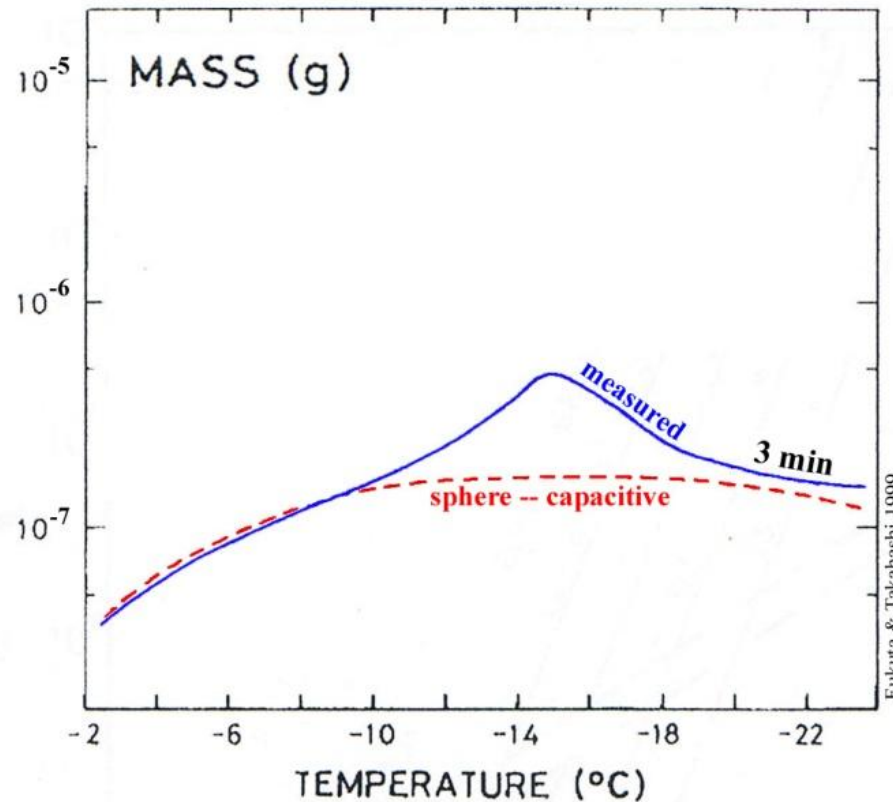


- Assume vapor at surface in equilibrium
("capacitance analogy")
- Rates depend only on vapor diffusive flux
→ No influence from crystal surface

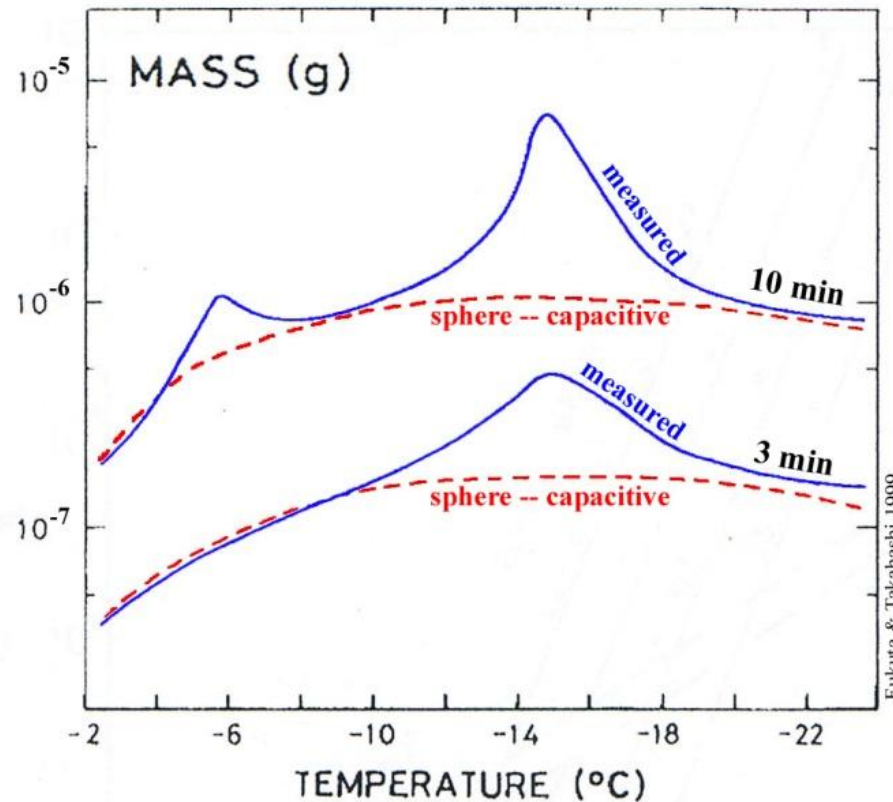


Mass uptake influence from habit

Growth along water saturation line



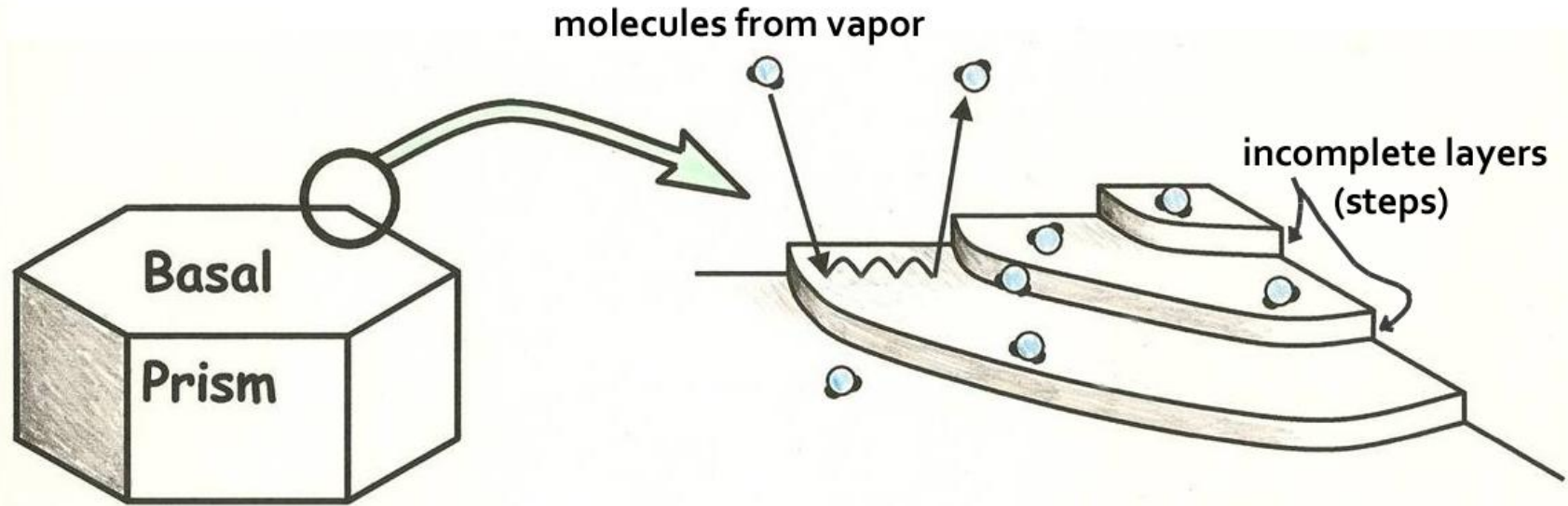
Mass uptake influence from habit



Crystal surface clearly influences growth



On the surface: growth by layers



vapor molecules \rightarrow surface

surface molecules \rightarrow edge of incomplete layers (step edge)

steps sweep across surface \rightarrow growth normal to surface



Growth by layers

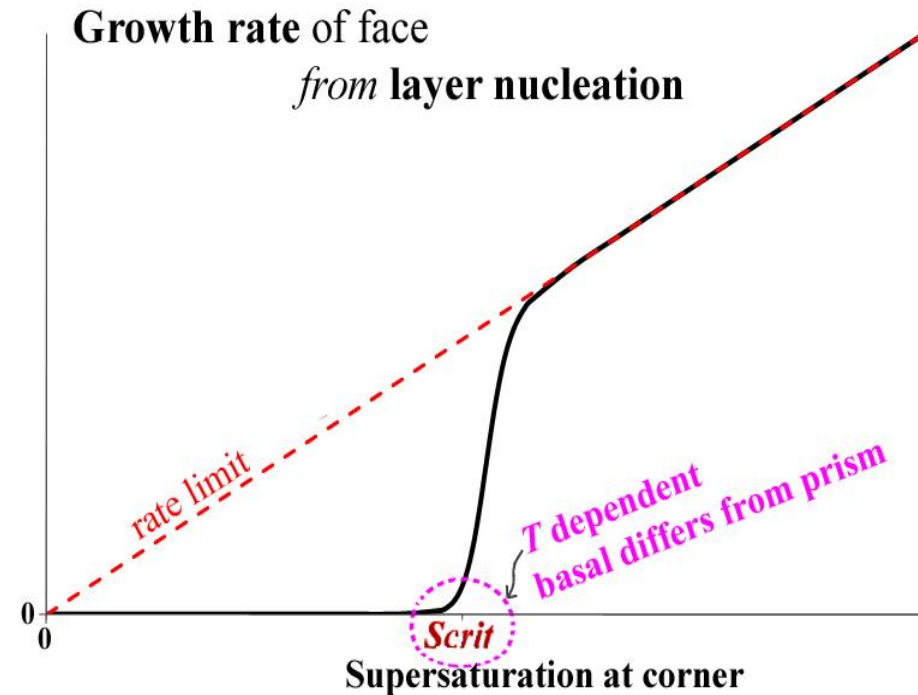
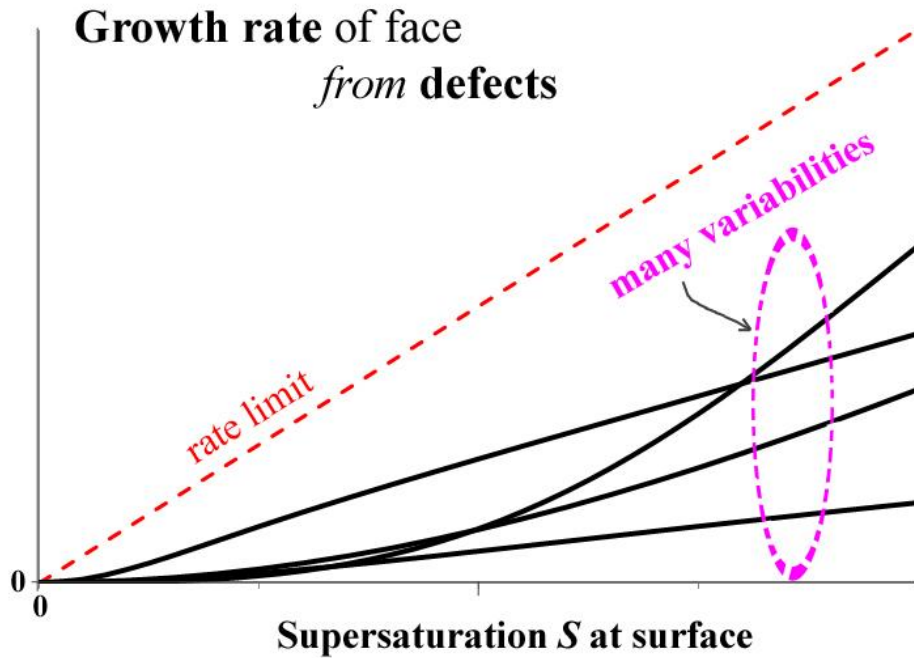


crystal thickness
shown by its color

- 1) Basal face advances (crystal thickens) by the spreading layers.
- 2) Some crystals only grow laterally; their basal faces don't grow.



But how do new layers start?



Layer nucleation on snow:

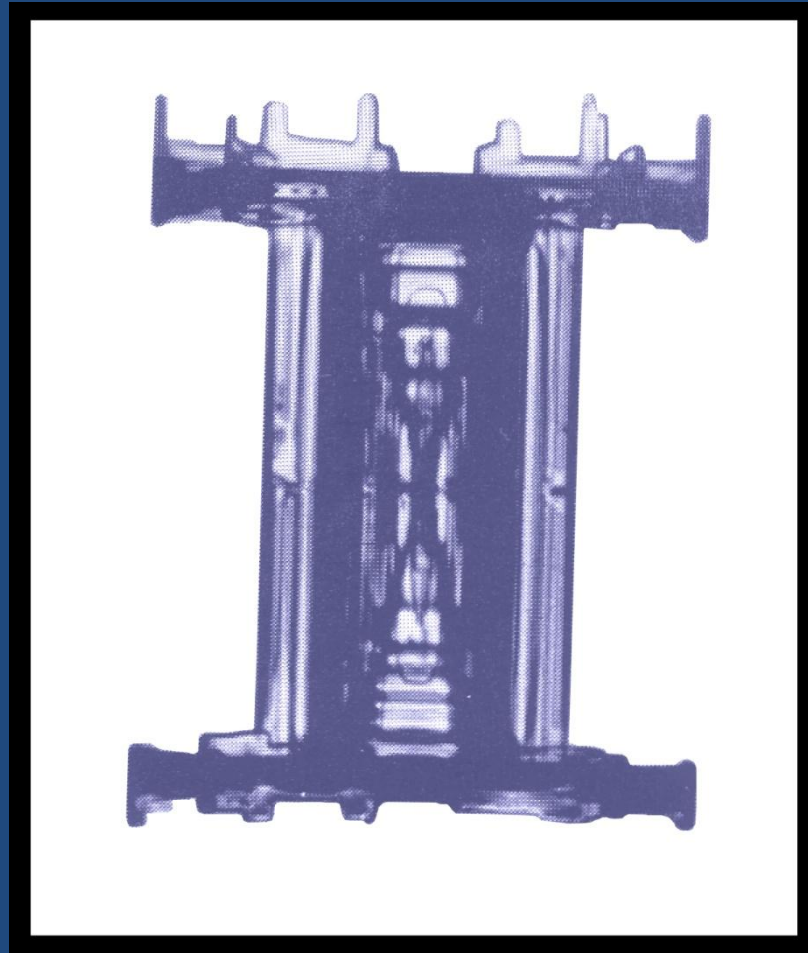
- Nucleate at corners, where S is highest
- S_{crit} differs between basal and prism
- S_{crit} depends on temperature



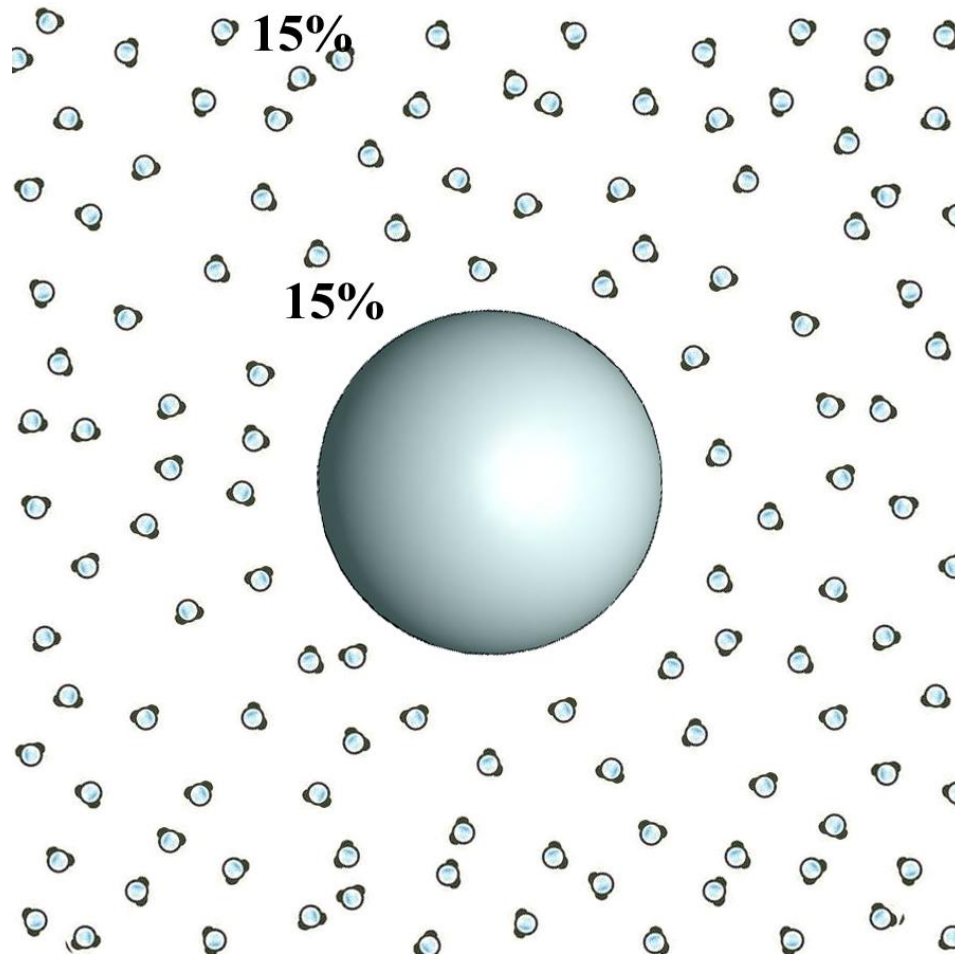
How layer nucleation can explain habit



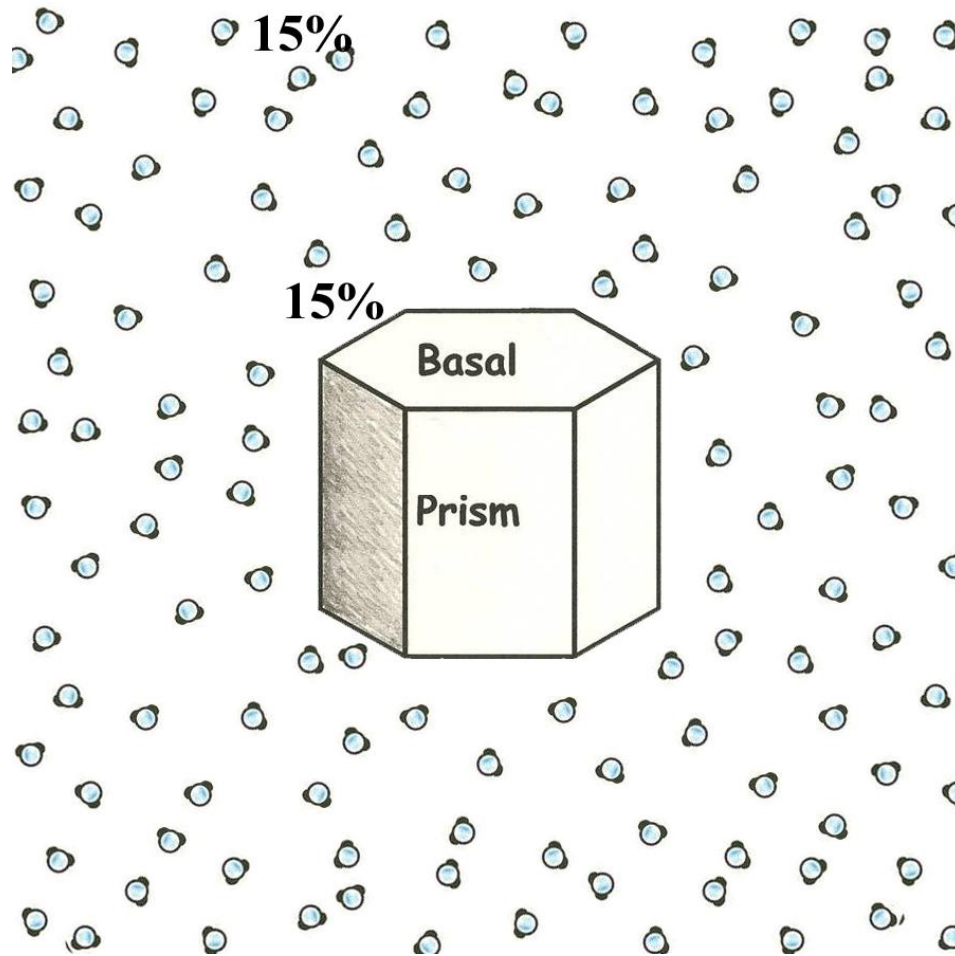
1) Tabular-columnar transitions



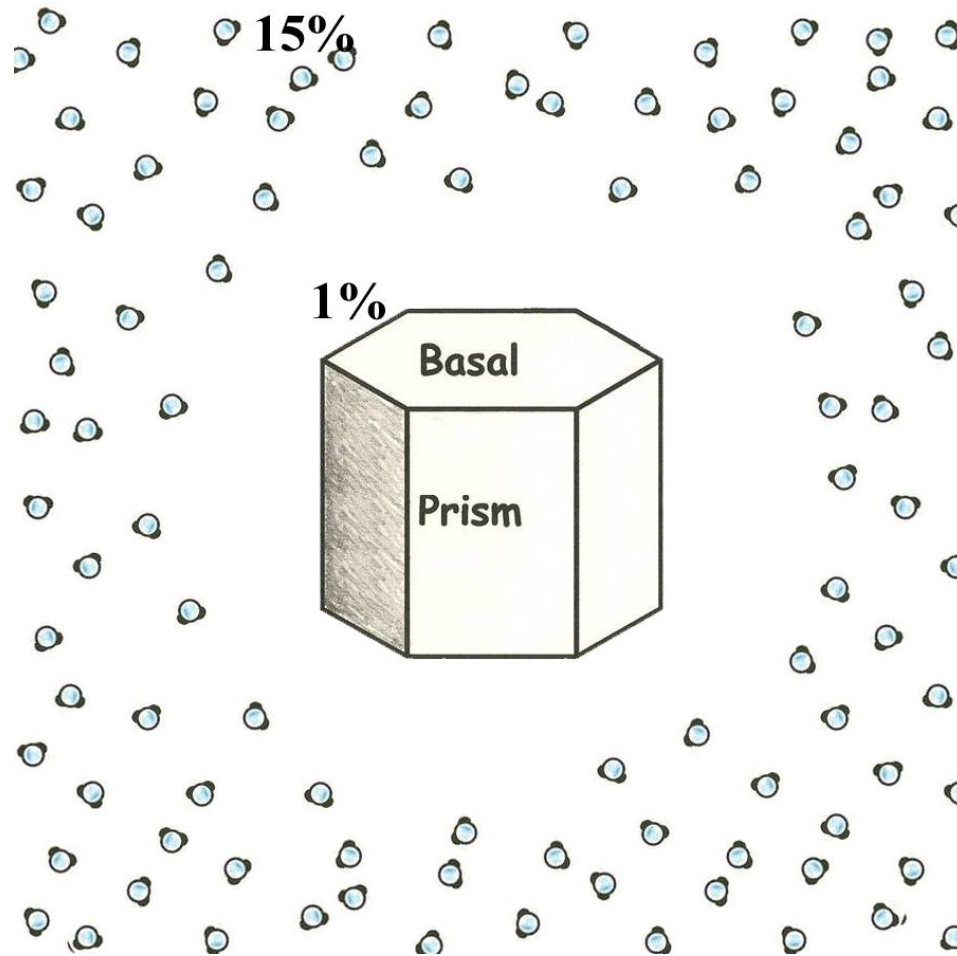
The crystal begins...



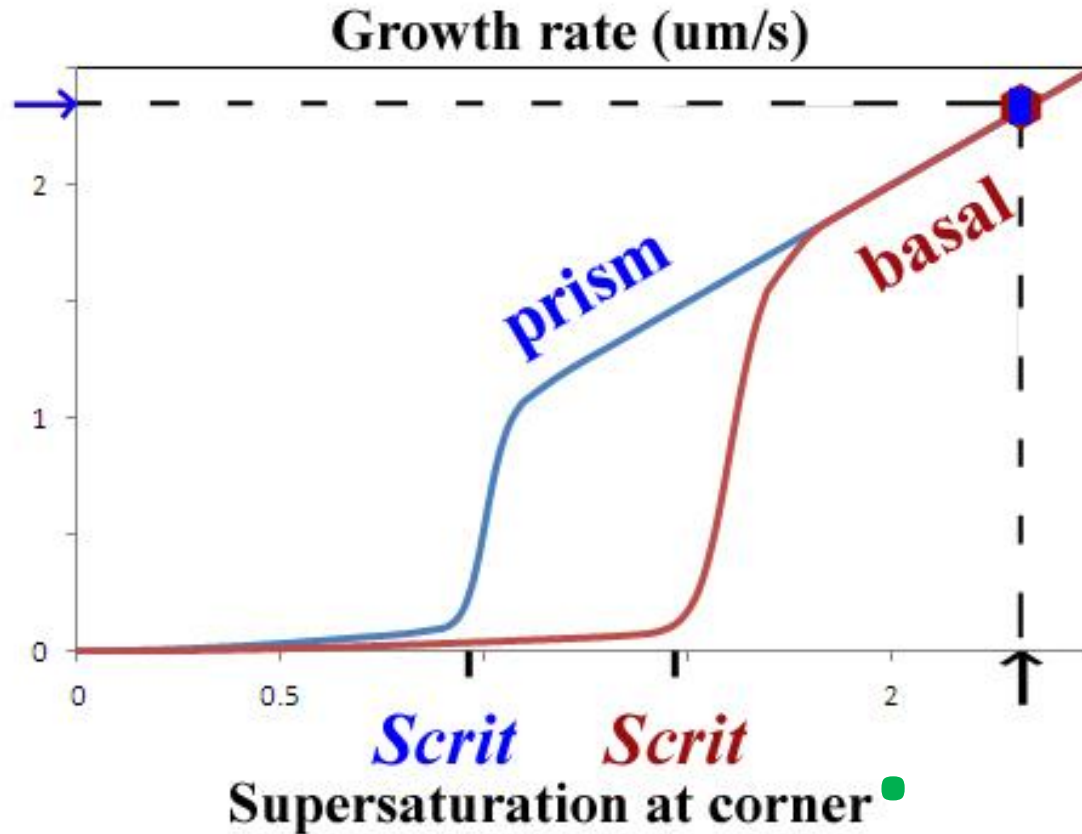
The crystal begins...



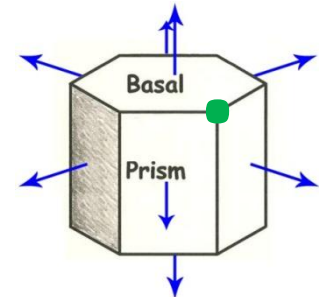
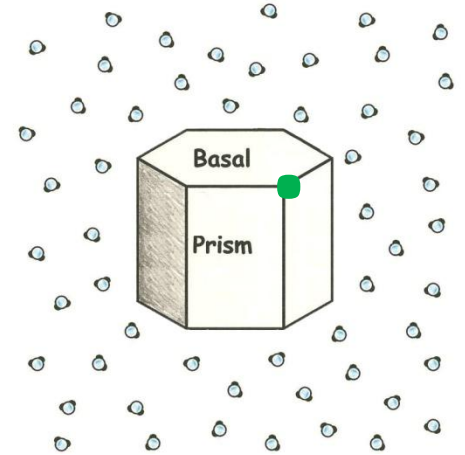
...and surface supersaturation drops



Why tabular? (1 of 3)



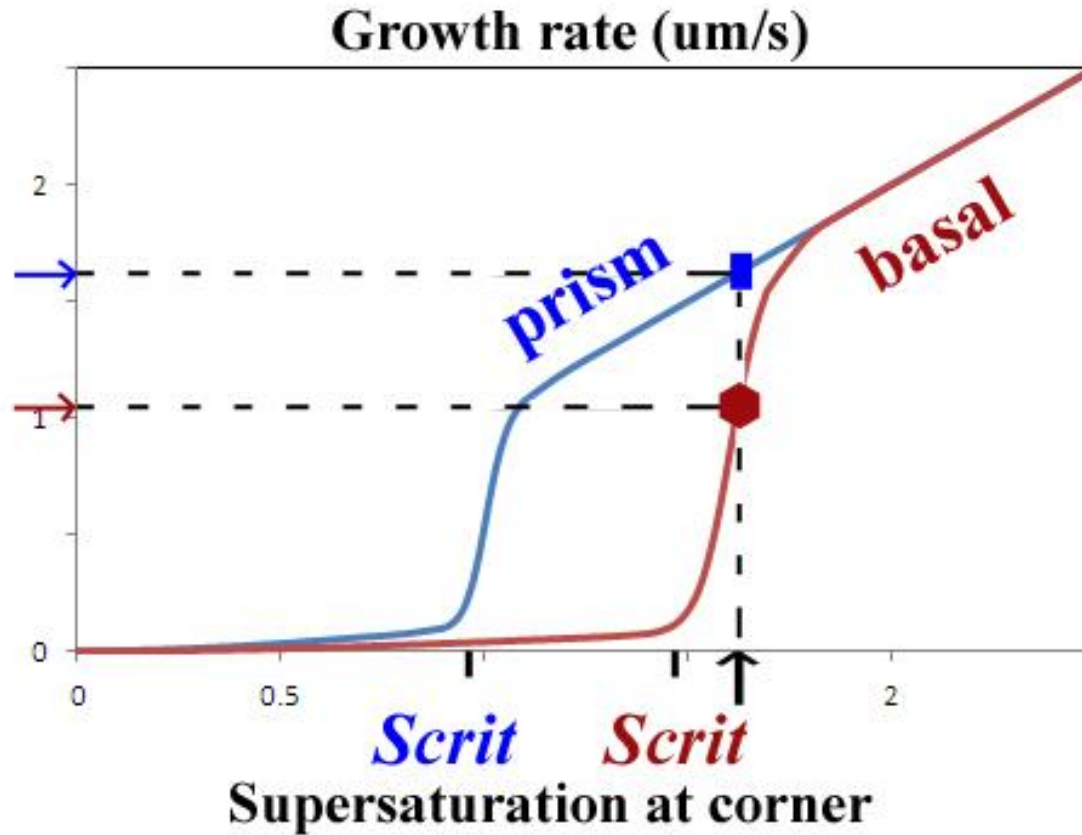
Just-frozen drop:
Initially high S
near surface



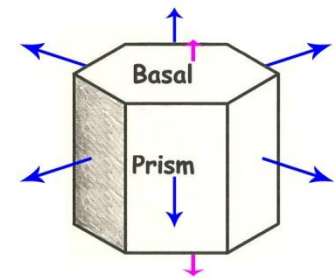
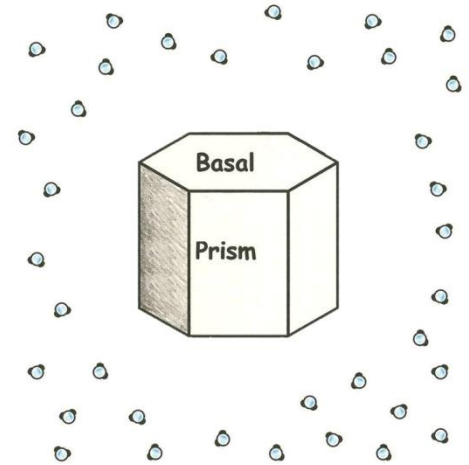
All faces grow at
maximum rate



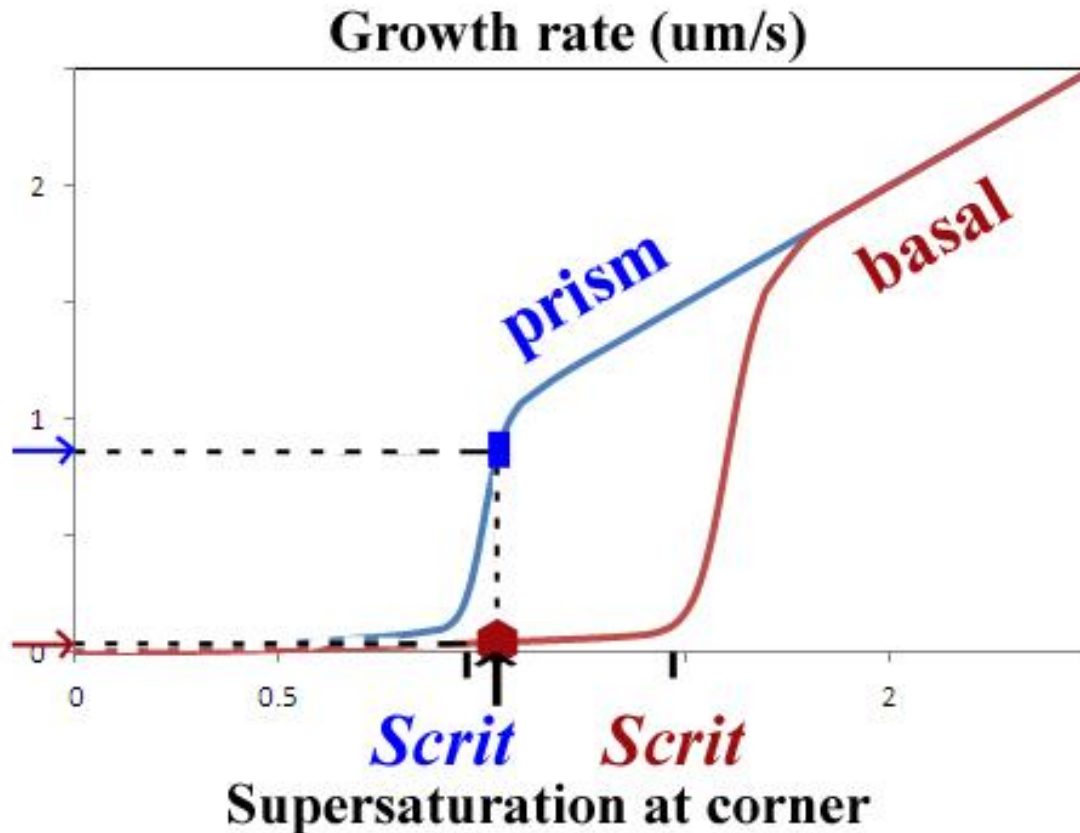
Why tabular? (2 of 3)



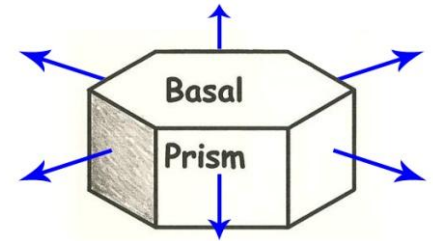
Brief period of fast growth:
S drops at surface



Why tabular? (3 of 3)

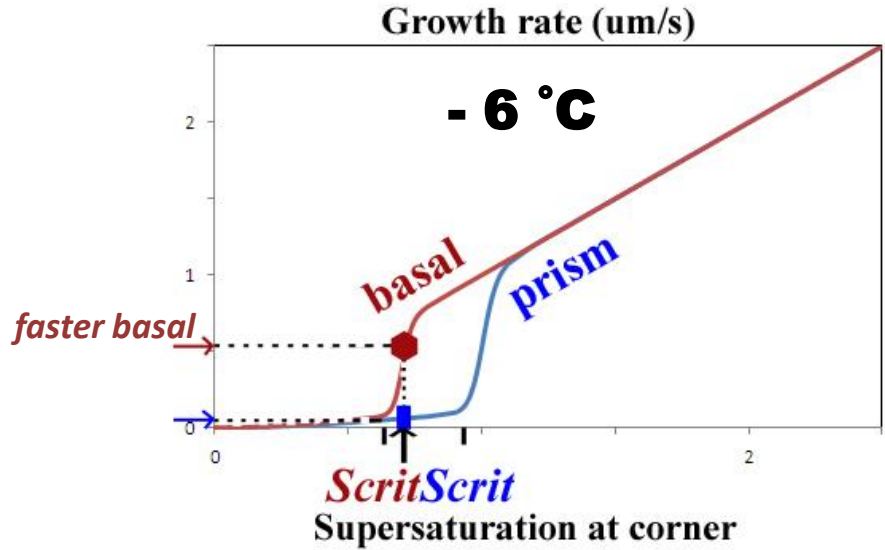
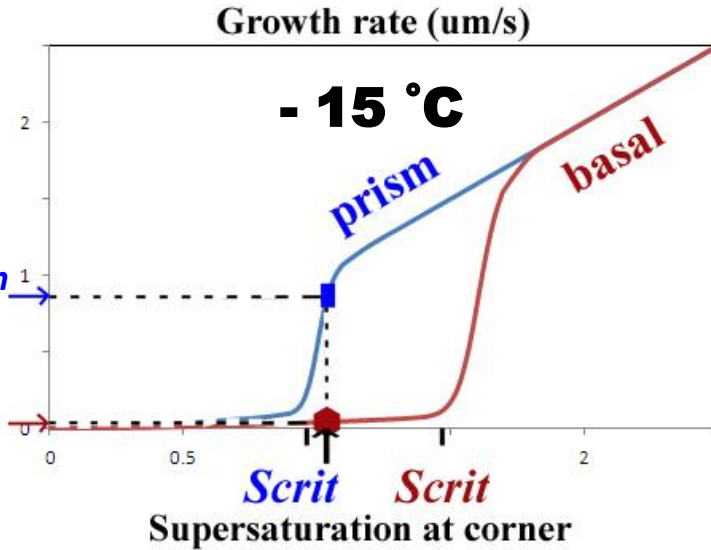


Steady state:
asymmetric growth



Basal face essentially stops nucleating layers: only prism can grow

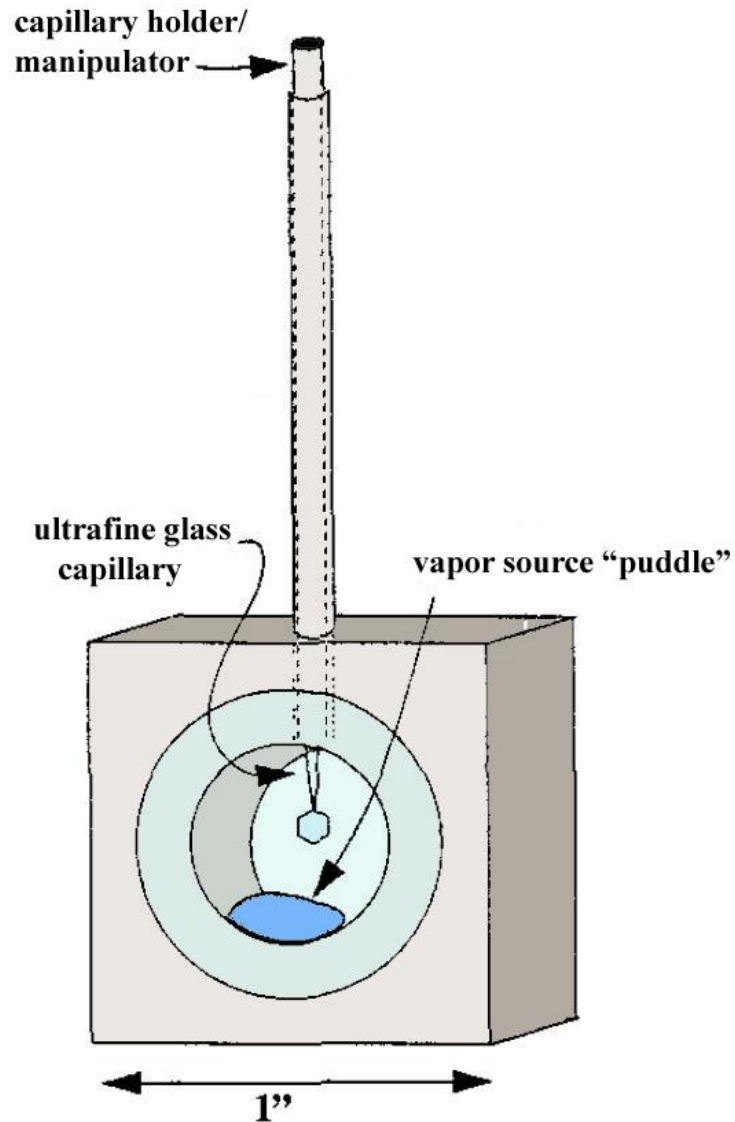
Tabular-columnar transitions



Small change in *Scrit* (from *T* change) changes dendrites to needles



Experimental test (1994-1996)

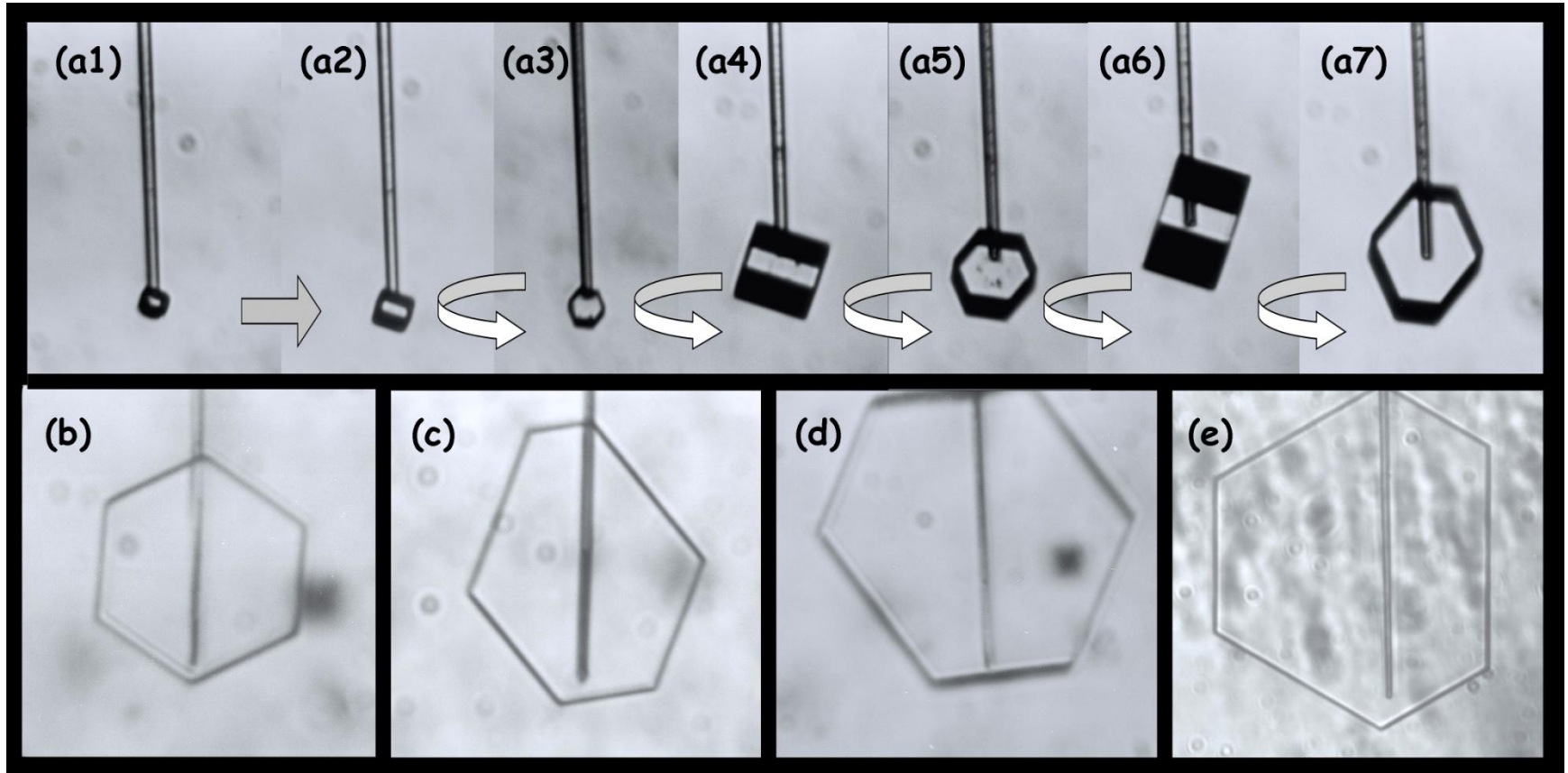


- isolate crystal

- sensitive control of T, S



Results

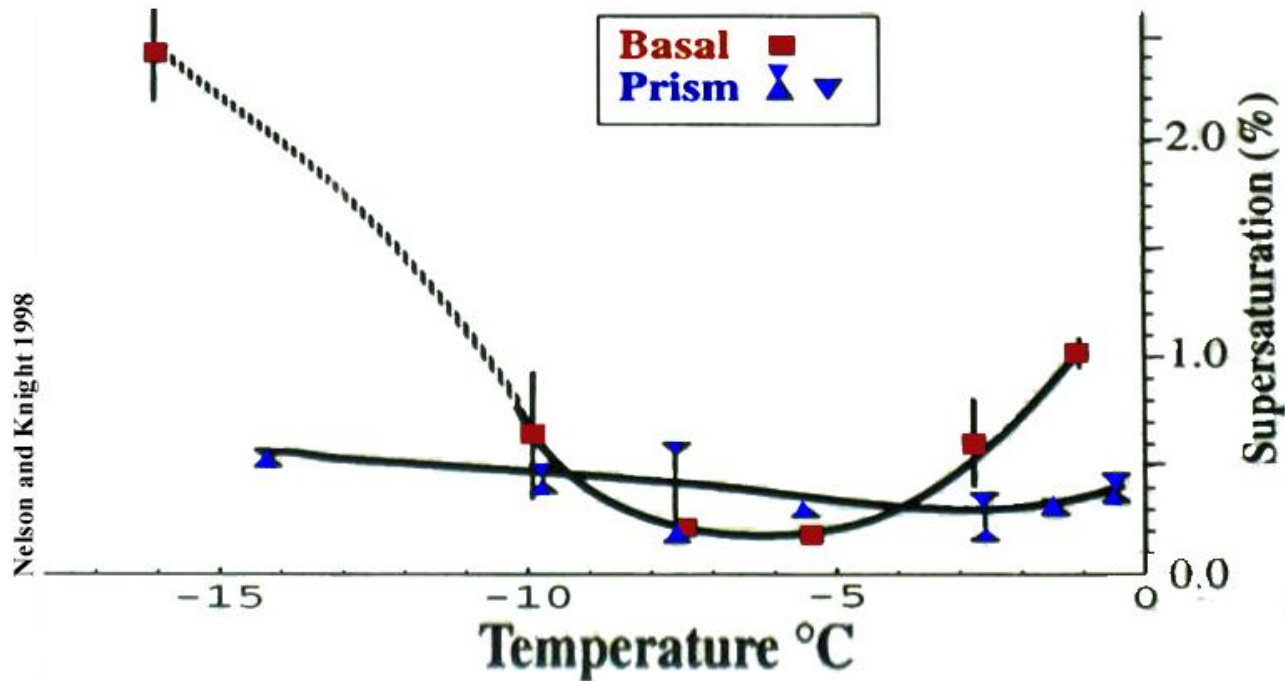


Defect-free faces common: exhibit reproducible Scrit



Supporting data

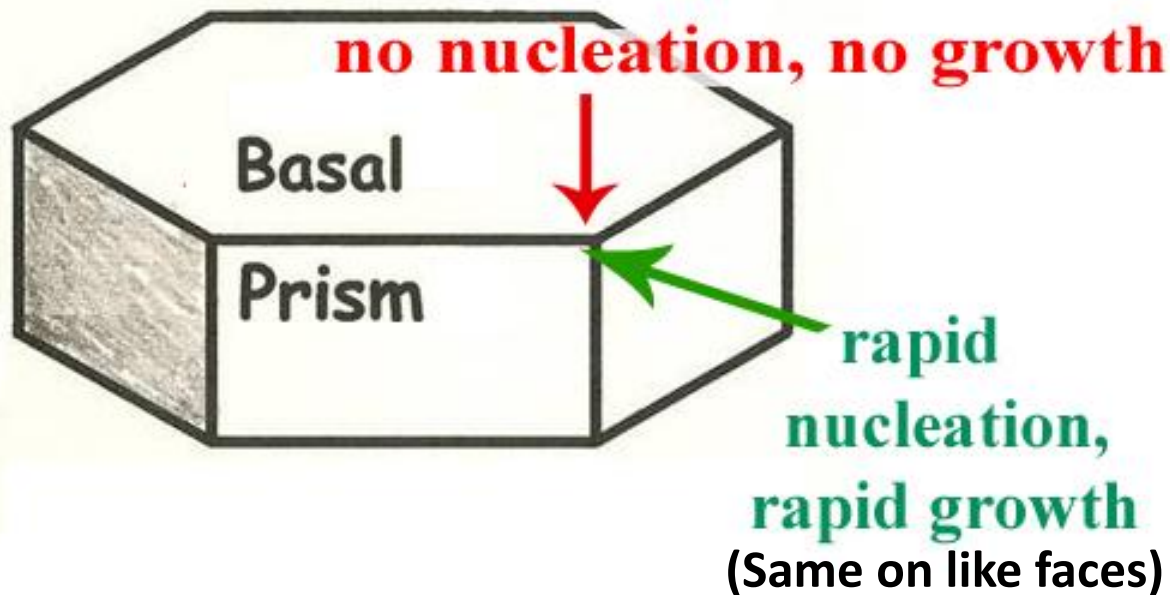
measured Scrit values



Prism Scrit nearly constant, basal Scrit has minimum near -6°C , below prism Scrit, leading to the observed habit transitions



And so, for example, the dendrites are extremely thin and flat because near $-15\text{ }^{\circ}\text{C}$ the basal face cannot nucleate any new layers.



Direct observation of layer nucleation



Direct observation of layer nucleation



2) Branching and sidebranching

