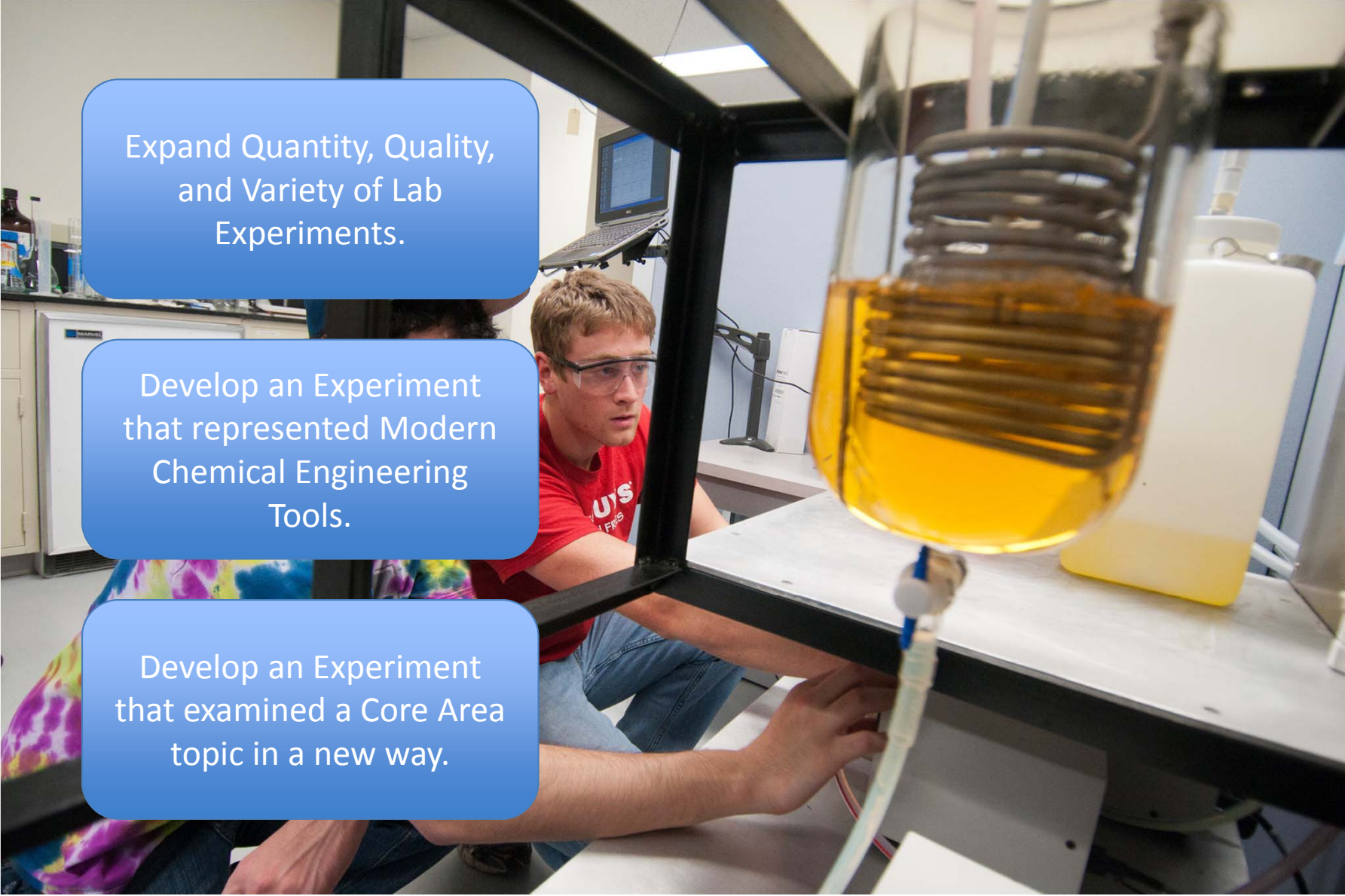


Initiated Chemical Vapor Deposition (iCVD) as a New Take on a Kinetics Lab

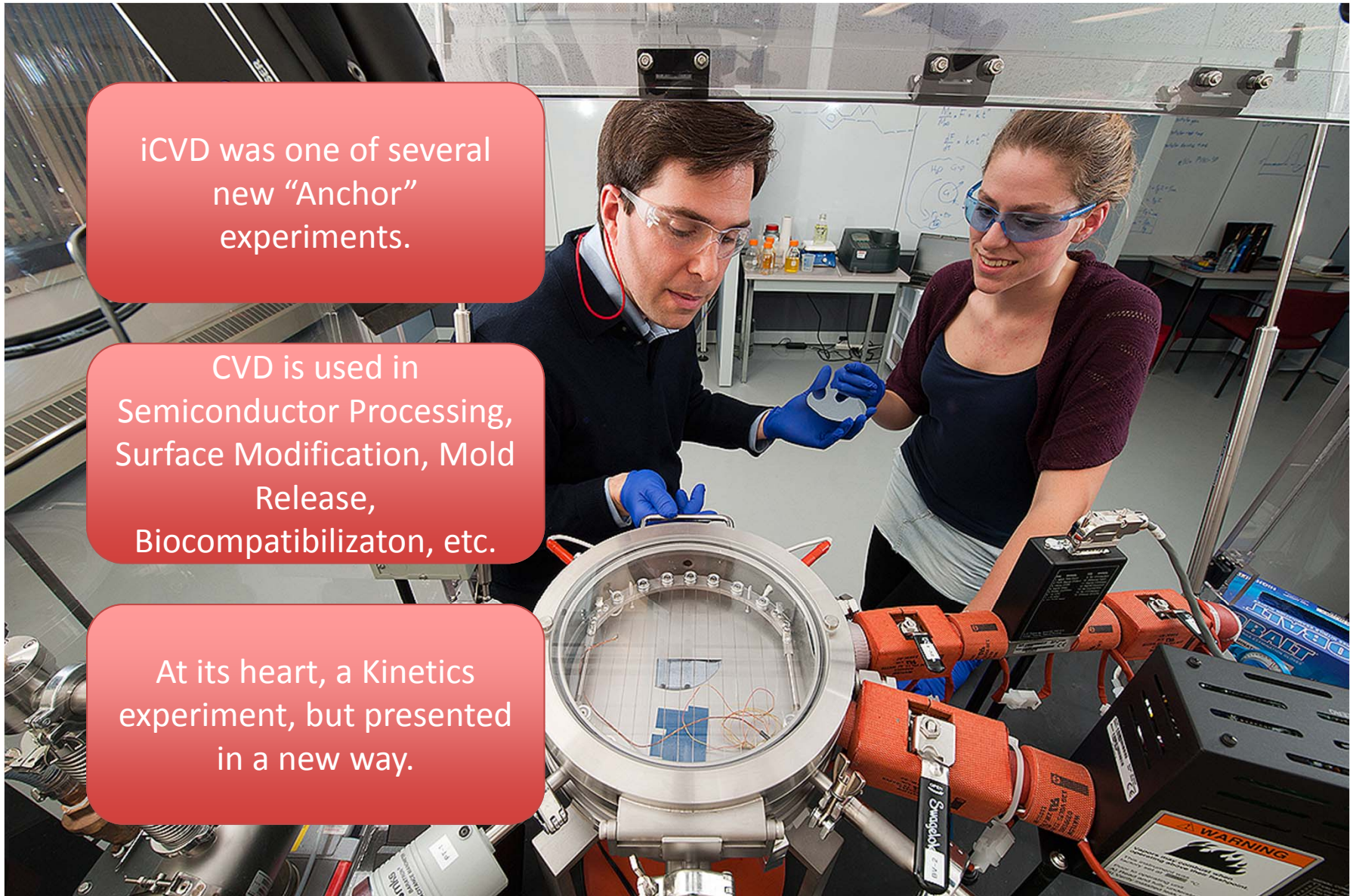
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Department of Chemical and Biomolecular Engineering
University of Connecticut, Storrs CT
428c – Wednesday November 6th, 2013
Union Square 25 (Hilton)



Expand Quantity, Quality,
and Variety of Lab
Experiments.

Develop an Experiment
that represented Modern
Chemical Engineering
Tools.

Develop an Experiment
that examined a Core Area
topic in a new way.

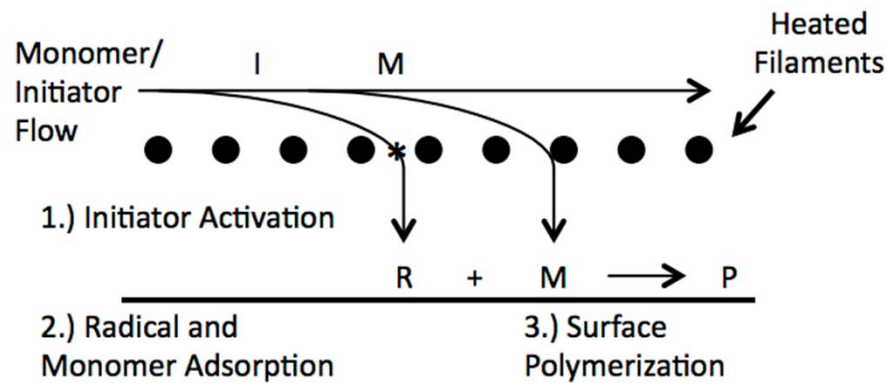


iCVD was one of several new “Anchor” experiments.

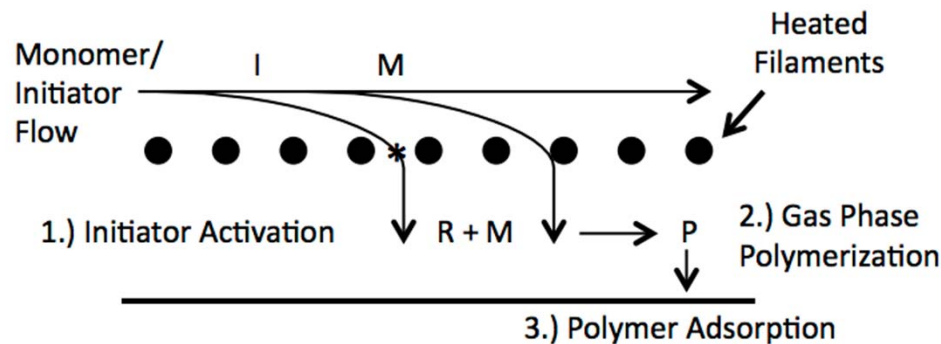
CVD is used in Semiconductor Processing, Surface Modification, Mold Release, Biocompatibilization, etc.

At its heart, a Kinetics experiment, but presented in a new way.

A. Adsorption Limited/Surface Polymerization



B. Gas Phase Polymerization

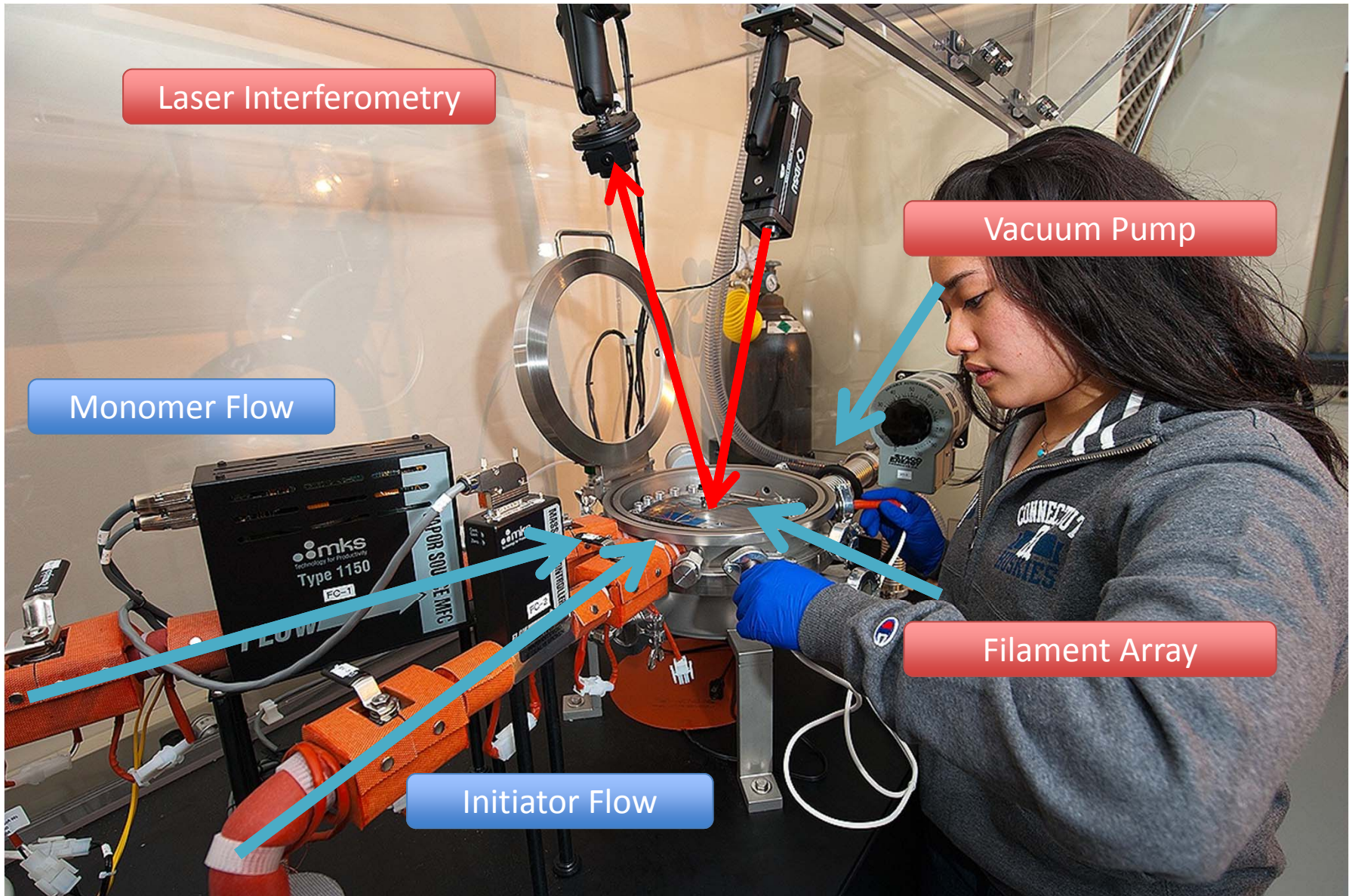


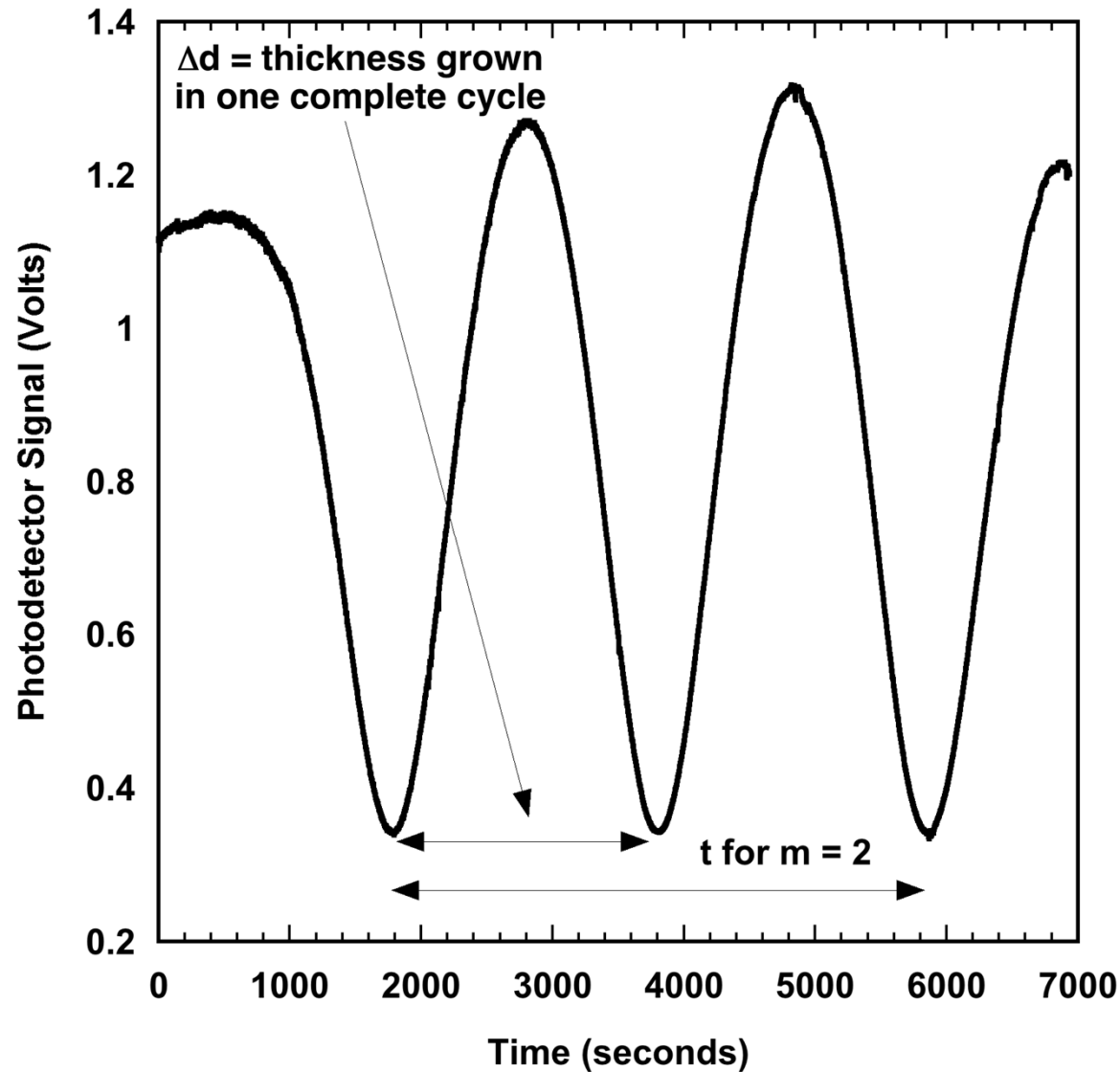
- iCVD = Initiated Chemical Vapor Deposition
 - Heated Filaments or other Initiation Source (e.g. UV light)
 - Decomposition of Initiator
 - Polymerization of Monomer
 - High structural fidelity to traditionally polymerized materials.



Photo courtesy of GVD Corporation

- Turn-key system from GVD Corporation.
 - Vacuum System
 - Laser Metrology
 - Source containers, heaters, flow controllers
 - Filament Array
 - Computer Control and Monitoring

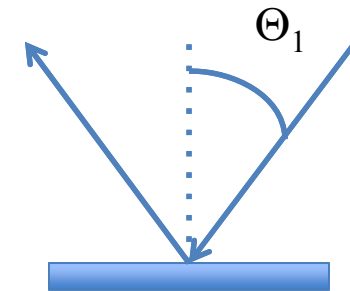




$$rate = \frac{m\Delta d_{film}}{t}$$

$$\Delta d_{film} = \frac{\lambda}{2n \cos(\theta_2)}$$

$$\cos(\theta_2) = \sqrt{\left(1 - \left[\frac{\sin(\theta_1)}{n}\right]^2\right)^2}$$



- “What can you tell me kinetically and mechanistically about the polymerization reaction you are going to carry out?”

$T_{\text{substrate}}$

P_{reactor}

T_{filament}

Monomer
(type and flow)

Controlled by Reactor Pressure

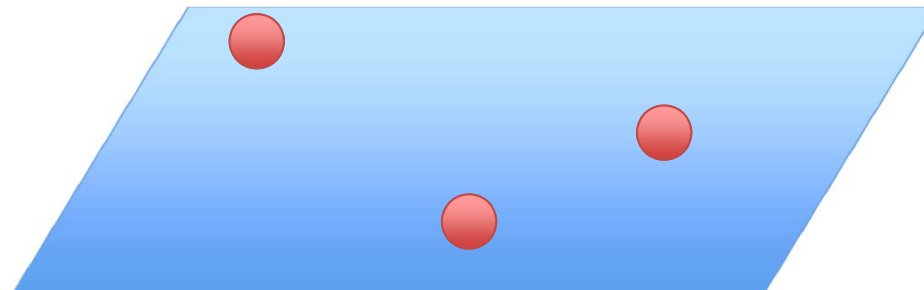
$$\frac{P_M}{P_{sat}}$$



0

Controlled by Substrate Temperature

$$P_{sat}$$



Surface 'Concentration' approaches zero; No reaction!

Controlled by Reactor Pressure

$$\frac{P_M}{P_{sat}}$$



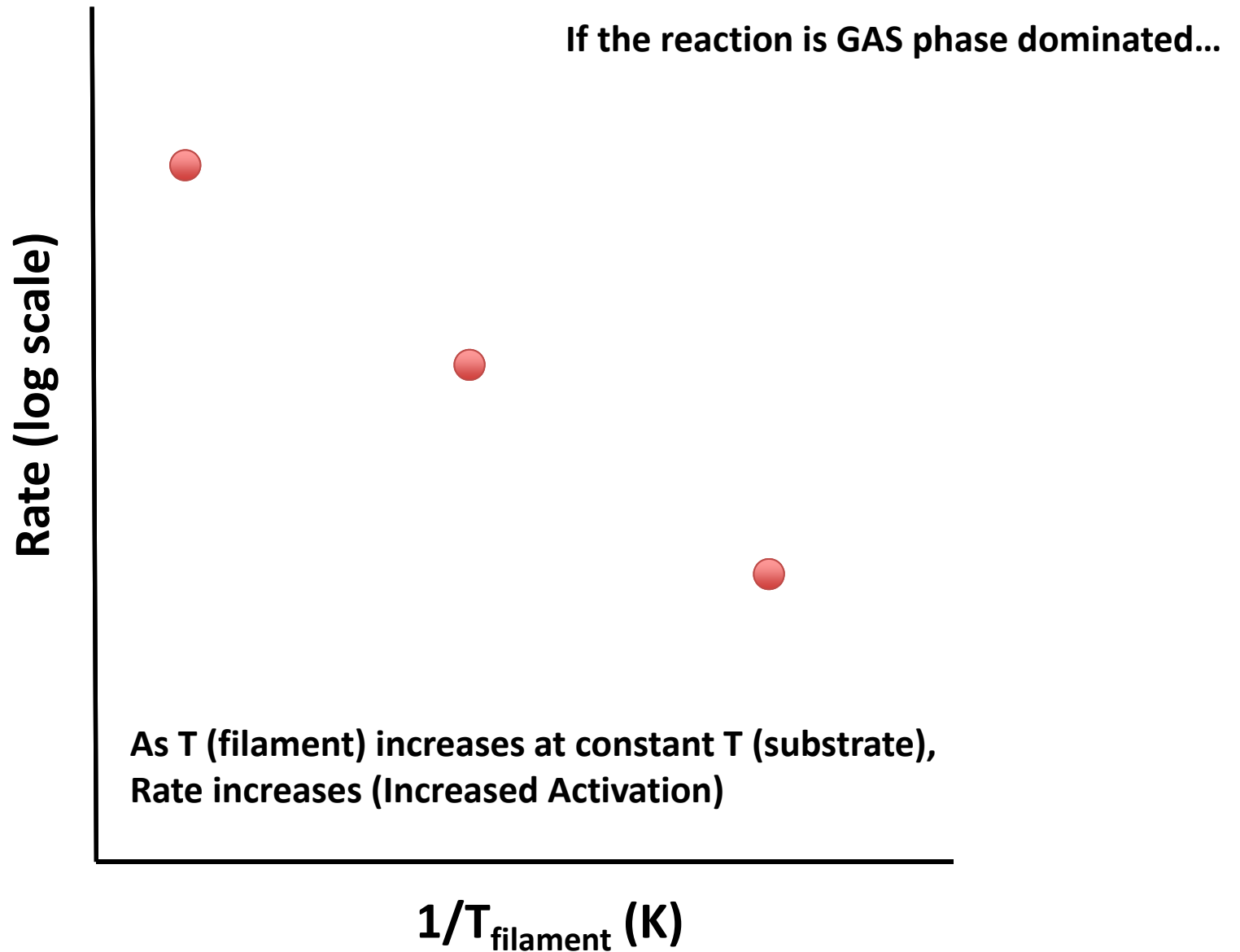
1

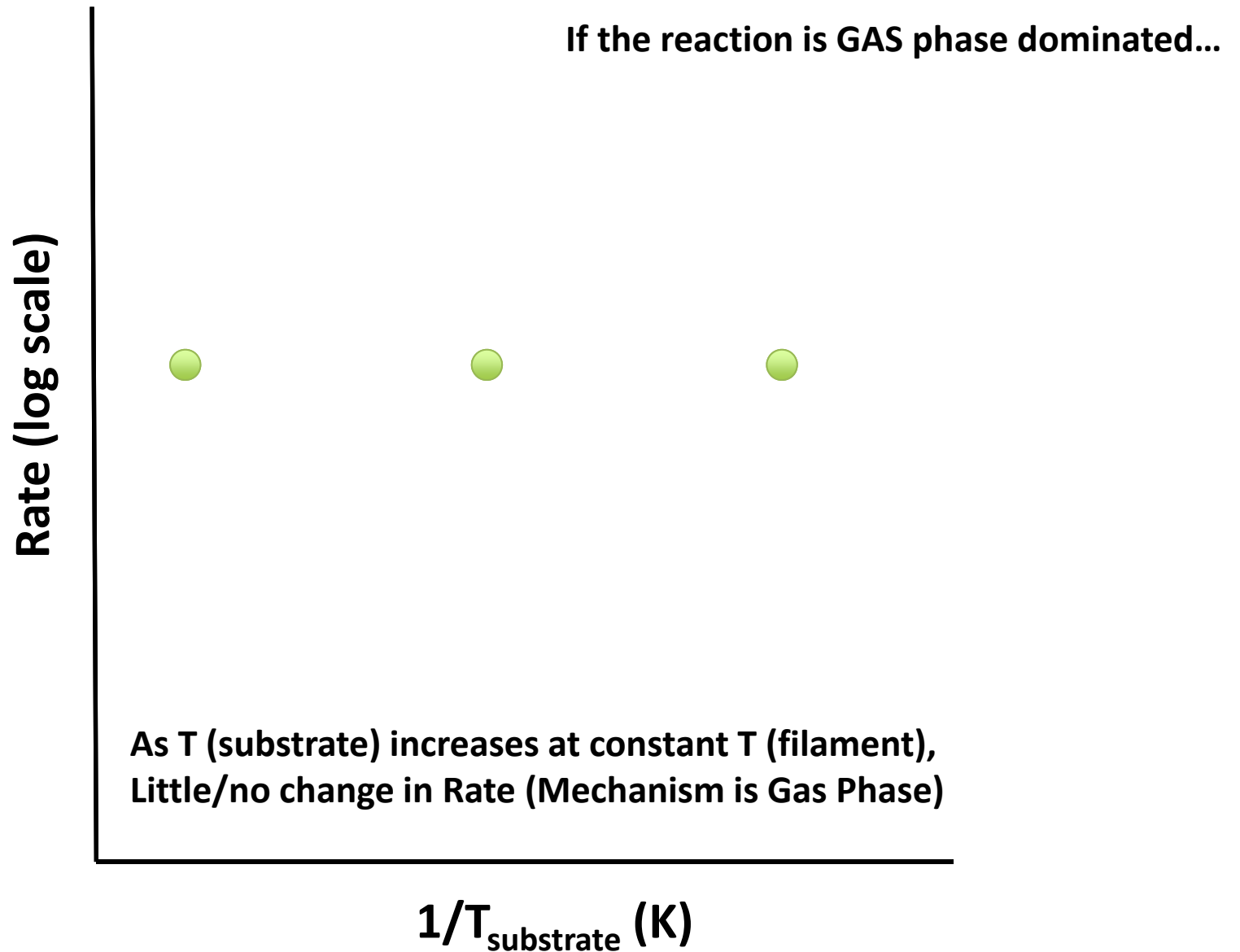
Controlled by Substrate Temperature

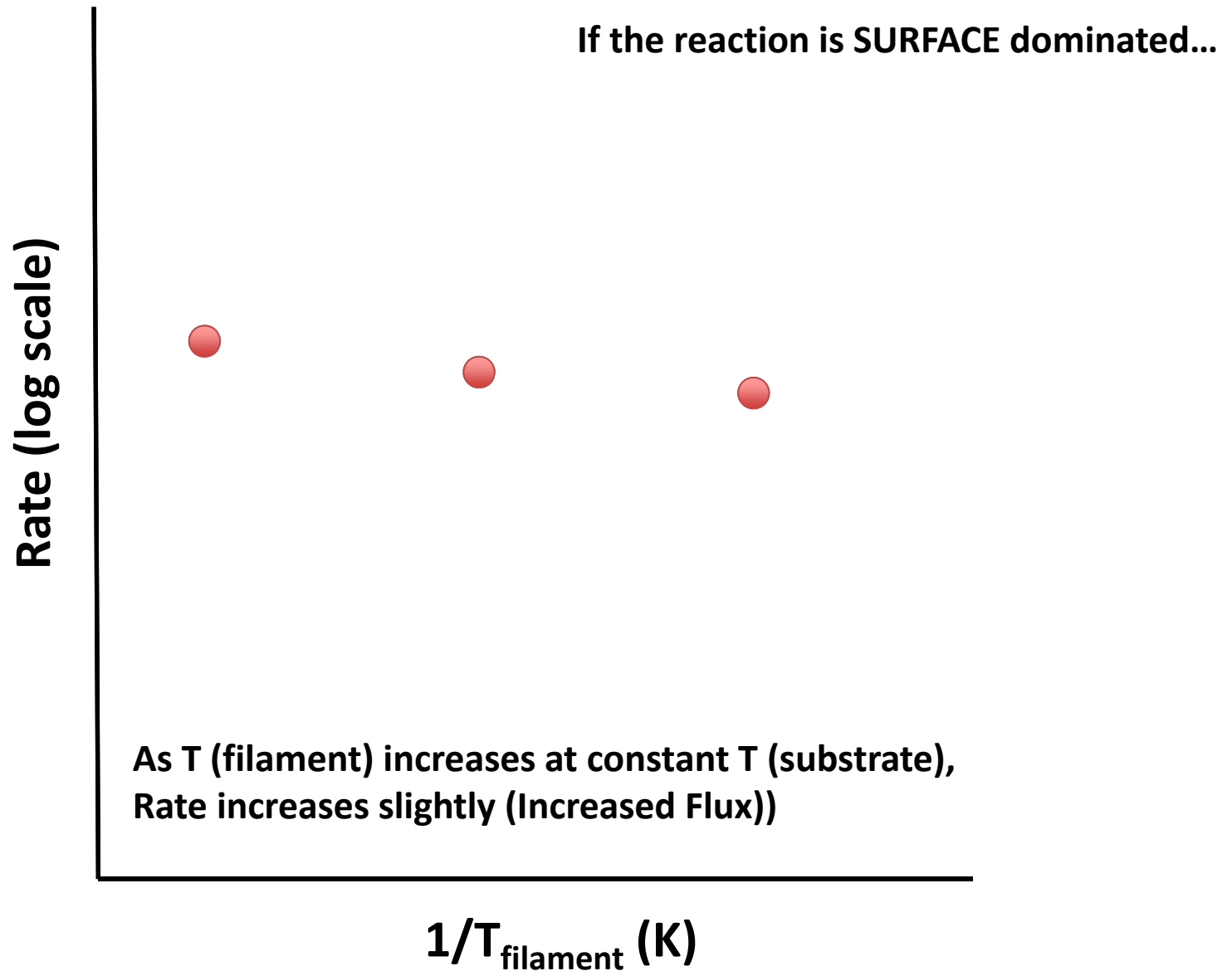
$$P_{sat}$$

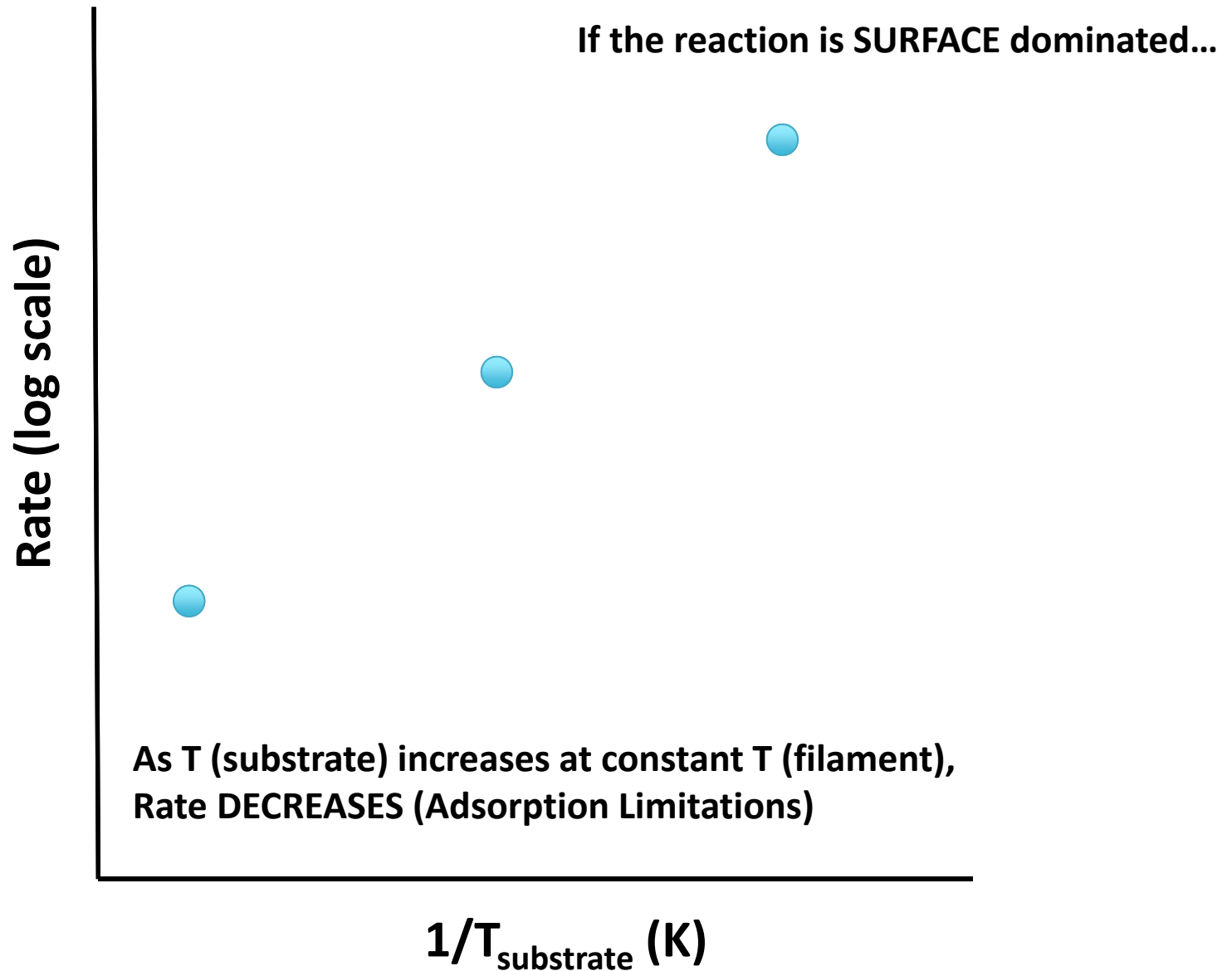


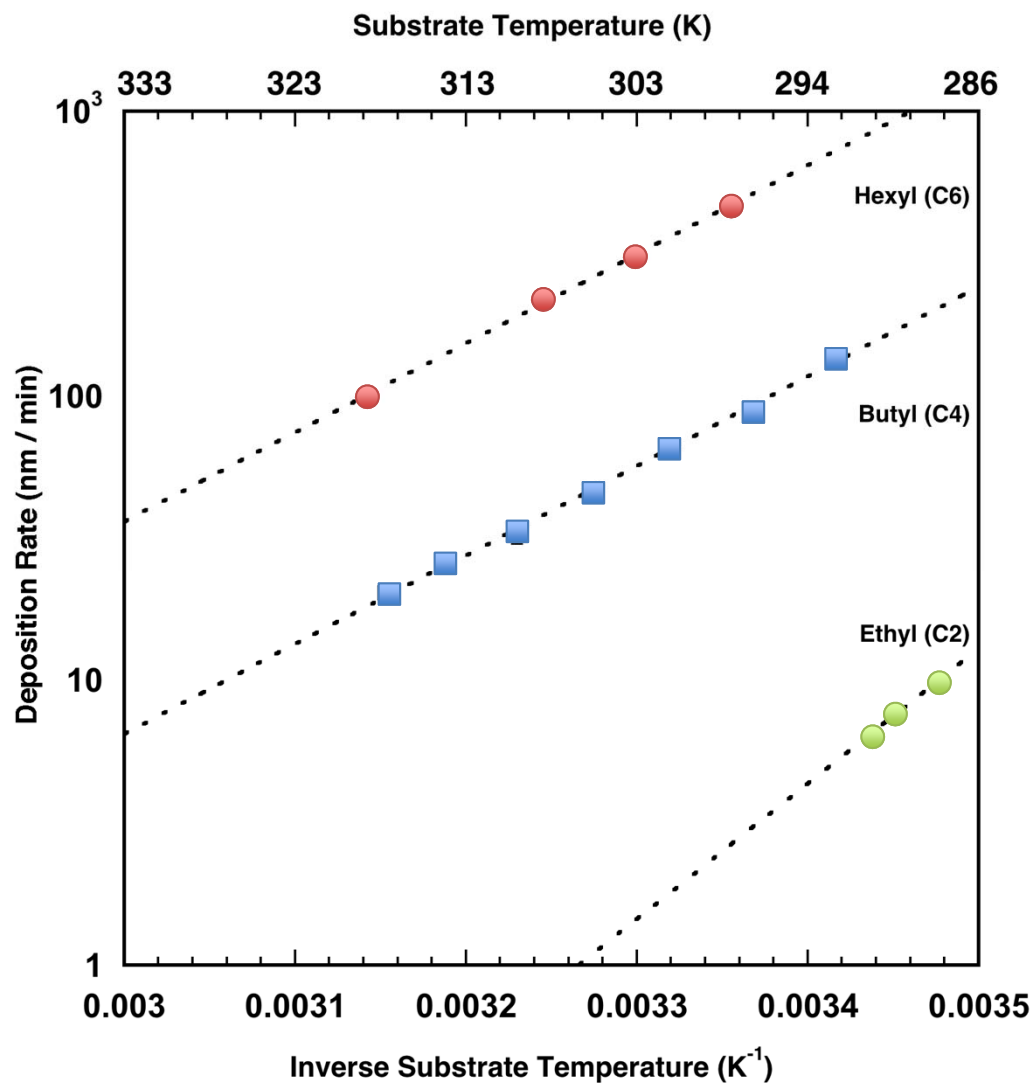
Surface 'Concentration' approaches one; Condensation!

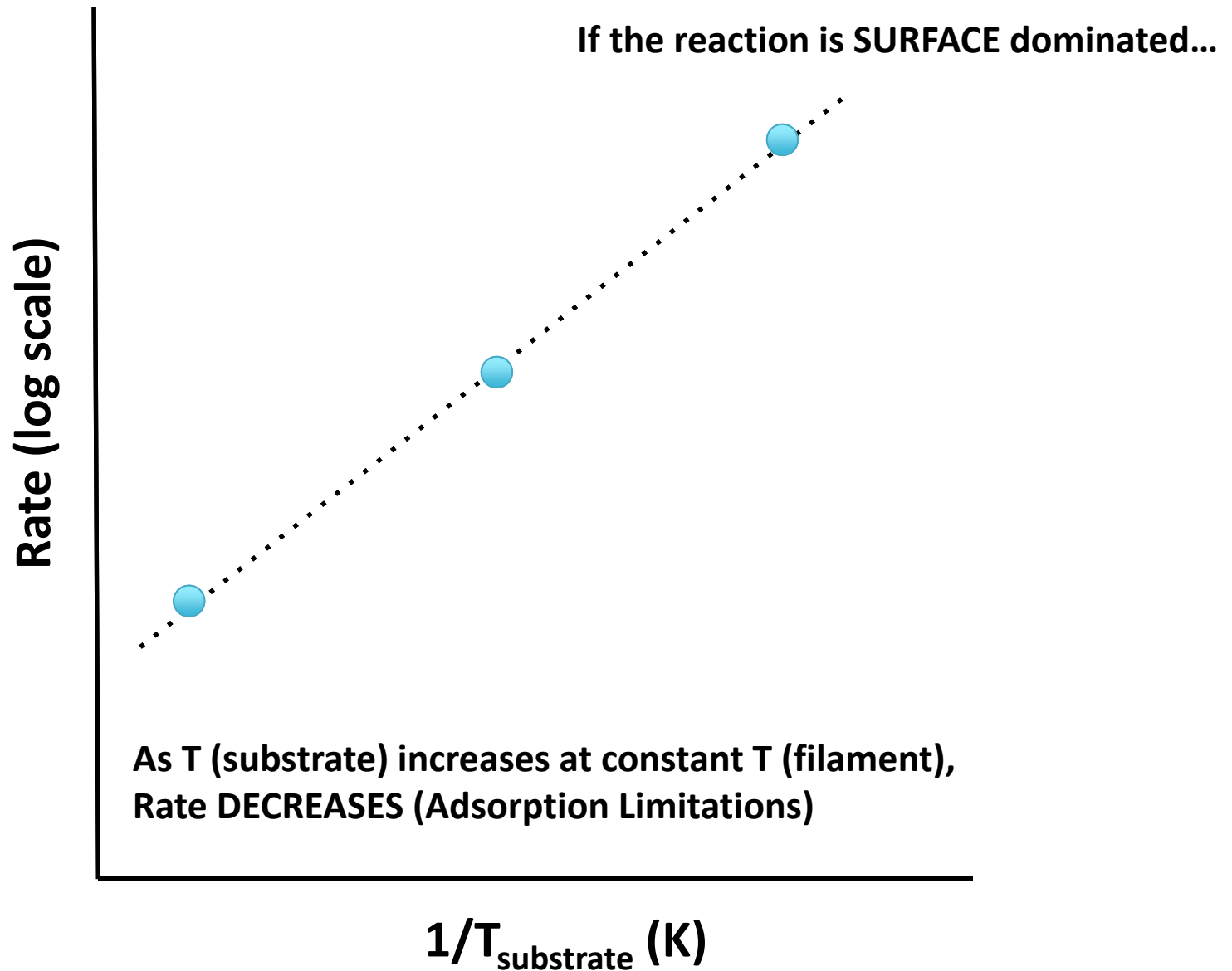


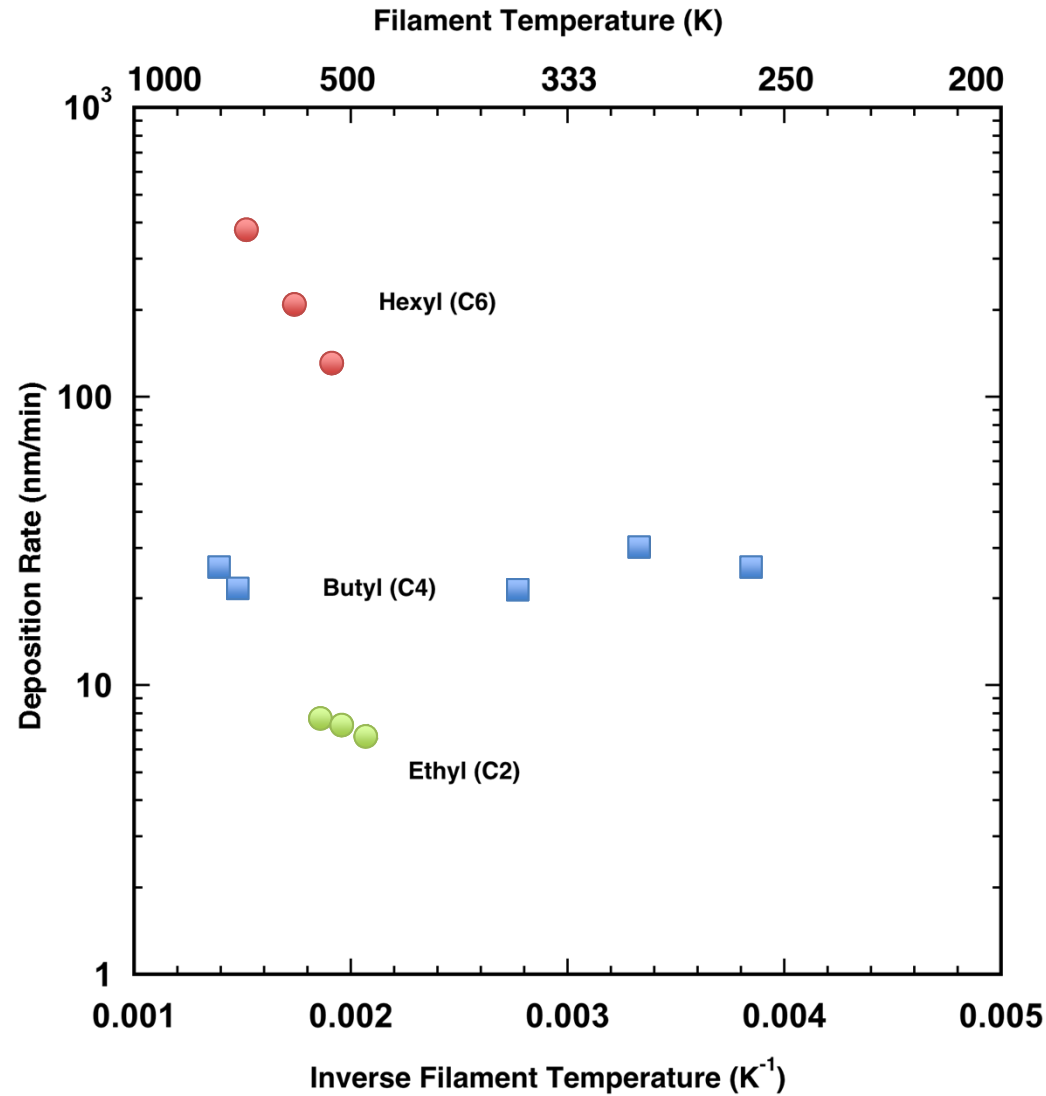


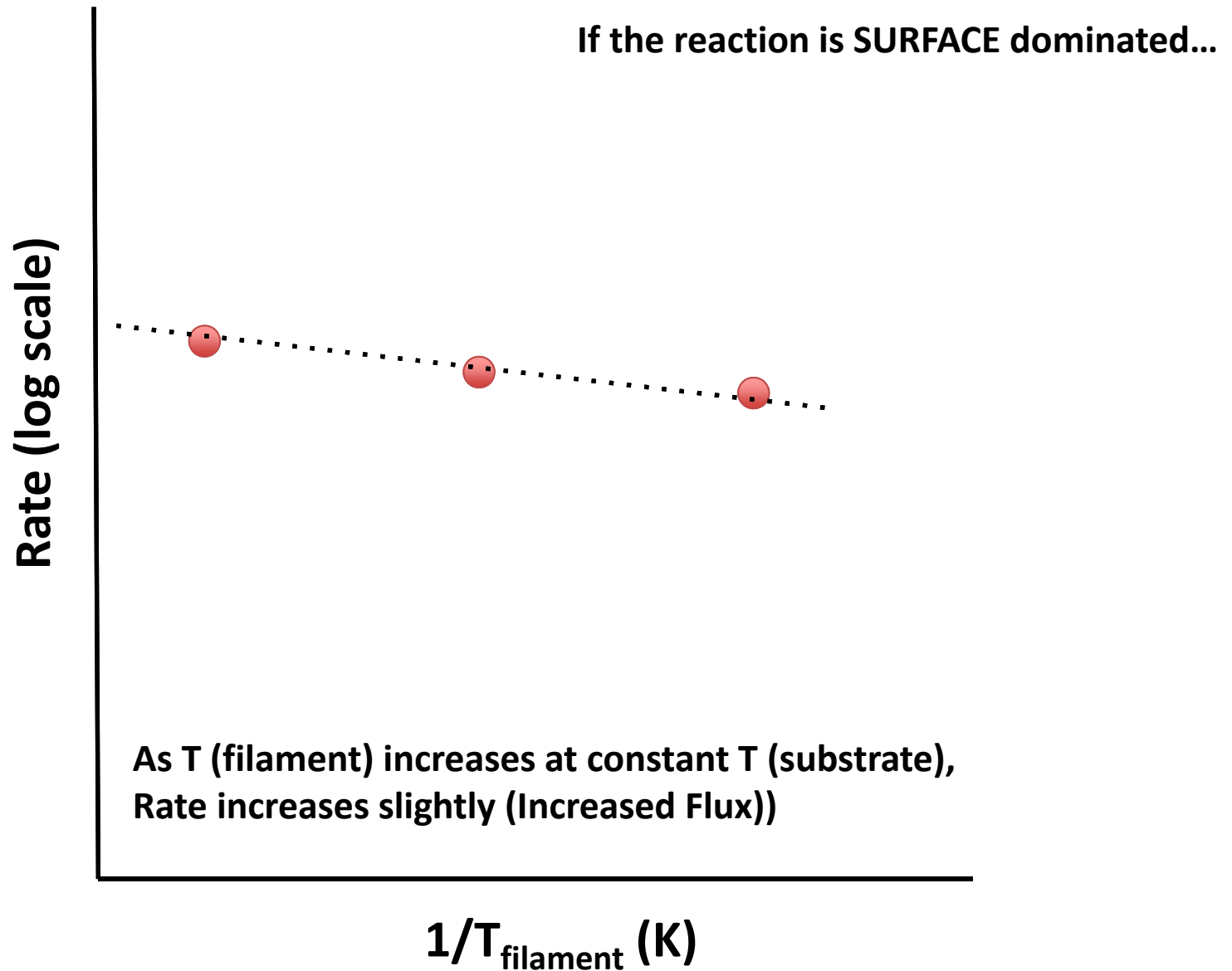


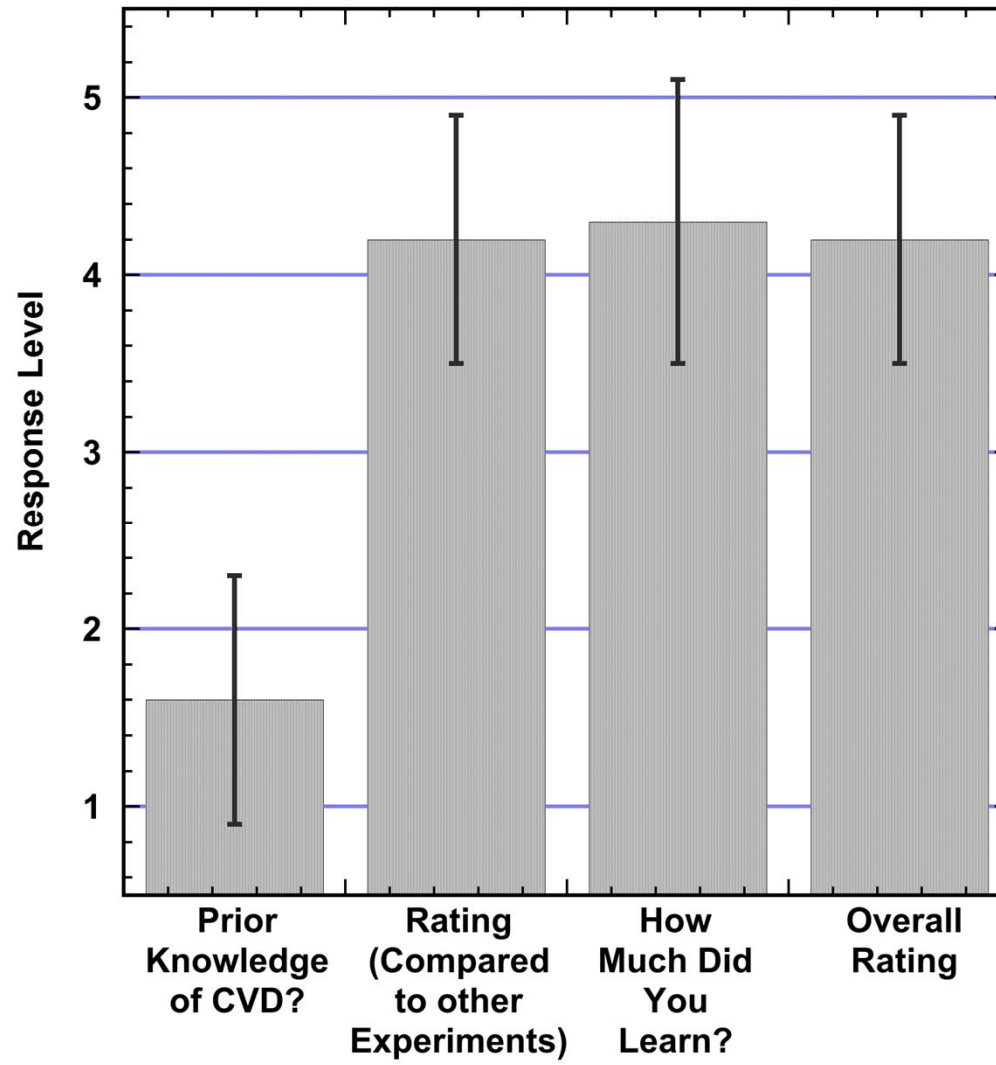












- Significant capital investment
 - Can ‘roll your own’, depending upon expertise
 - Additional use as a research tool
 - “Demonstration of Potential Opportunities in Photo-Initiated Chemical Vapor Deposition” – Gas Phase Deposition Processes; Friday 1:24 PM, Franciscan D; Aravind Suresh
- Some experimental conditions can be slow, leading to student disengagement
- Depending upon choice of reagents, can demonstrate mass-transfer limited as well as kinetically limited reactions.

