Hypothesis Generation

Part 1

1

1

What is a hypothesis?

- Hypotheses are *much more* than educated guesses
  - They are guesses about _____ or ____ something happens
  - They are based on _____ and _____
- The **best research** is hypothesis-driven
- If we wish to do the best research, we must understand ***proper hypotheses***

2

2

Hypotheses and Research Plans

- In a sound research plan, ***hypotheses*** are the _____
  - The research plan exists to _____
  - The hypothesis can be falsified or supported
  - Whether the hypothesis is supported or falsified, the information generated is important and should be viewed as progress
  - An improvement over most research approaches

3

3

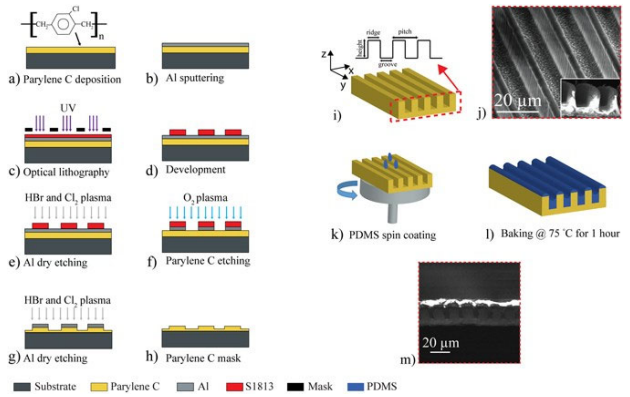
A cautionary example

Example

- Topic: etching of polymer dielectrics
- You ignore advice and set your own direction
- Your **project goal:** ***achieve patterning resolution of 0.15 microns***
  - You make a 0.15 micron pattern on parylene-N by exposing it to UV light
    - you try a **30** minute exposure to a 254 nm radiation source
  - You develop the pattern using oxygen plasma
  - You ***fail*** to make your 0.15 micron resolution
  - This took several days

4

4



Sanzari, I., Callisti, M., Grazia, A.D. *et al.* Parylene C topographic micropattern as a template for patterning PDMS and Polyacrylamide hydrogel. *Sci Rep* **7,** 5764 (2017). https://doi.org/10.1038/s41598-017-05434-6

5

5

Cautionary example, continued

- You make a 0.15 micron pattern on parylene-N by exposing it to UV light
  - You try a **60** minute exposure to a 254 nm radiation source
- You develop pattern using oxygen plasma
- You ***fail*** to make your 0.15 micron resolution.
- This took several more days.

- You make a 0.15 micron pattern on parylene-N by exposing it to UV light
  - You try a **90** minute exposure to a 254 nm radiation source
- You develop pattern using oxygen plasma
- You ***fail*** to make your 0.15 micron resolution.
- By now you have invested (wasted?) several weeks.

6

6

Why did this fail?

- You do not know ***why*** your approach does not work
  - You could keep trying for years and learn nothing except that a large set of independent experiments failed
  - The _____approach is not a sound one
- **The implicit hypothesis being pursued was actually a combination of hypotheses:**
  - exposure to light at 254 nm will crosslink parylene-N
  - crosslinked parylene-N will etch at a different rate than non-crosslinked paralyene-N
  - Oxygen plasma etching is appropriate for this
  - the etch rate differences will be significant enough
  - others?

7

7

Good Hypotheses

- To formulate a good hypothesis, we require _____, *which comes* from
  - Literature review
  - Preliminary experiments
  - Anecdotes, talking to others
- Based on this knowledge, we may ***guess*** what happens or ***why***
  - How does this make good research?
  - How do we live with apparently *improbable* hypotheses?
  - How do we *ensure sound hypotheses*, even if improbable?
- Based on this knowledge, we may ***design better experiments***

8

8

The End

9