Soft Materials Research Center

Education Outreach, Human Resources Development, Diversity

Christine Morrow

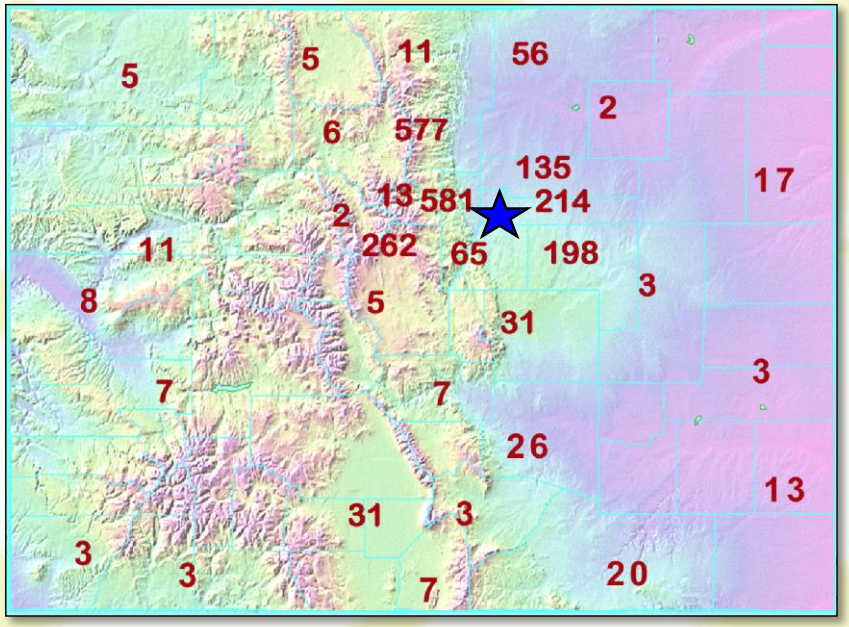
Director

Joseph Maclennan

Associate Director

Materials Science From CU

- uses materials as a context to teach physical science
- >2500 classes to >90,000 Colorado K-12 students since 1998
- schools pay modest fee/sliding scale
- topics developed during previous Grants
  - States of Matter
  - Light and Lasers
  - Light, Polarization & LCs
  - Magnets and Electricity
  - Electronics Lab
  - Traveling Kit-Ups and Downs
  - Forces and Motion
  - Cool & Creative Chemistry
  - For the Love of Polymers
  - Light, LEDs and Energy
  - Exploring the Nanoworld Series
  - Tricks with Water
- topics under development
  - Polymers Science for High School
  - Small forces and self assembly



map of Colorado showing number of MSFCU classes delivered, by county

Patricia Medve, elementary School Principal, Pueblo, CO:

"I hope I can convey how tremendous this was for these children…."

development of an MSFCU class

an iterative process

idea, e.g., "polymer science"

Center SIs and students provide science input

align with standards

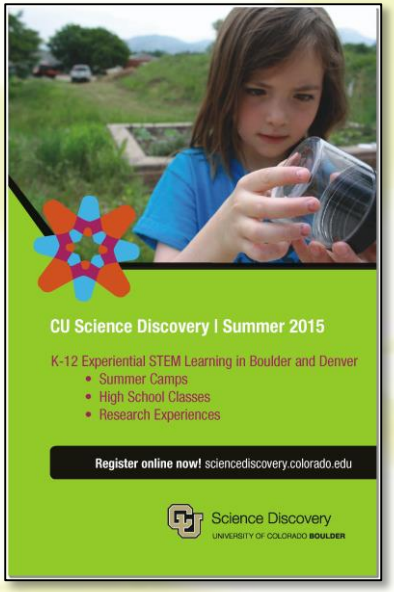
consult with classroom teachers

Polymer Science for High School

manmade and natural polymers

lesson to support existing curriculum

chemistry, physics (high school), societal issues



try out on classroom teachers

inquiry-based, novel, hands - on activities

Center members in the classroom to test with students and train instructors

Discussion about how to use polymers to make zombie make up

pilot tests and fine tuning

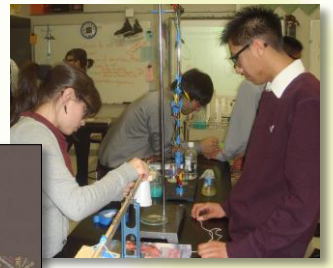
broad dissemination

partnership with Arrupe Jesuit High School

Goal: attract and interest students in STEM education and STEM careers

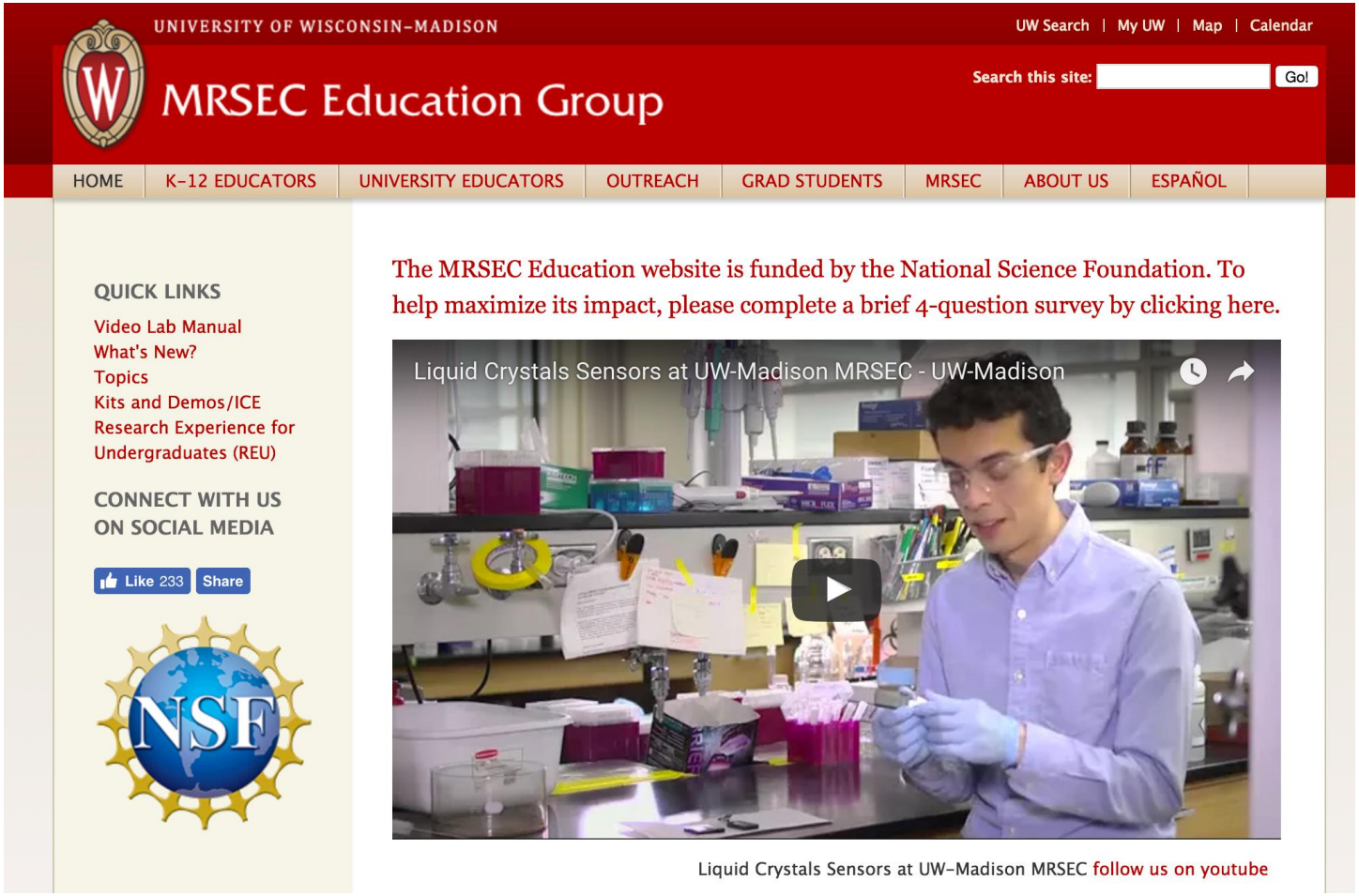
GoldShirt students
Fall 2014
Monica Robles,
Laura Rodriguez

- urban Denver school
  - low-income population
  - primarily Hispanic population
- Corporate Work Study Program (2009-)
  - host senior class student in SMRC lab 5 days/month /AY
- Materials Science from CU
- Science Capstone projects
- seminar series
  - taught by Center and MSU Denver students
    - » Science in Motion
    - » Exploring the Nanoworld series
    - »
- Family Science Evenings



Developed at MRSEC Wisconsin Madison

Liquid Crystal Activity

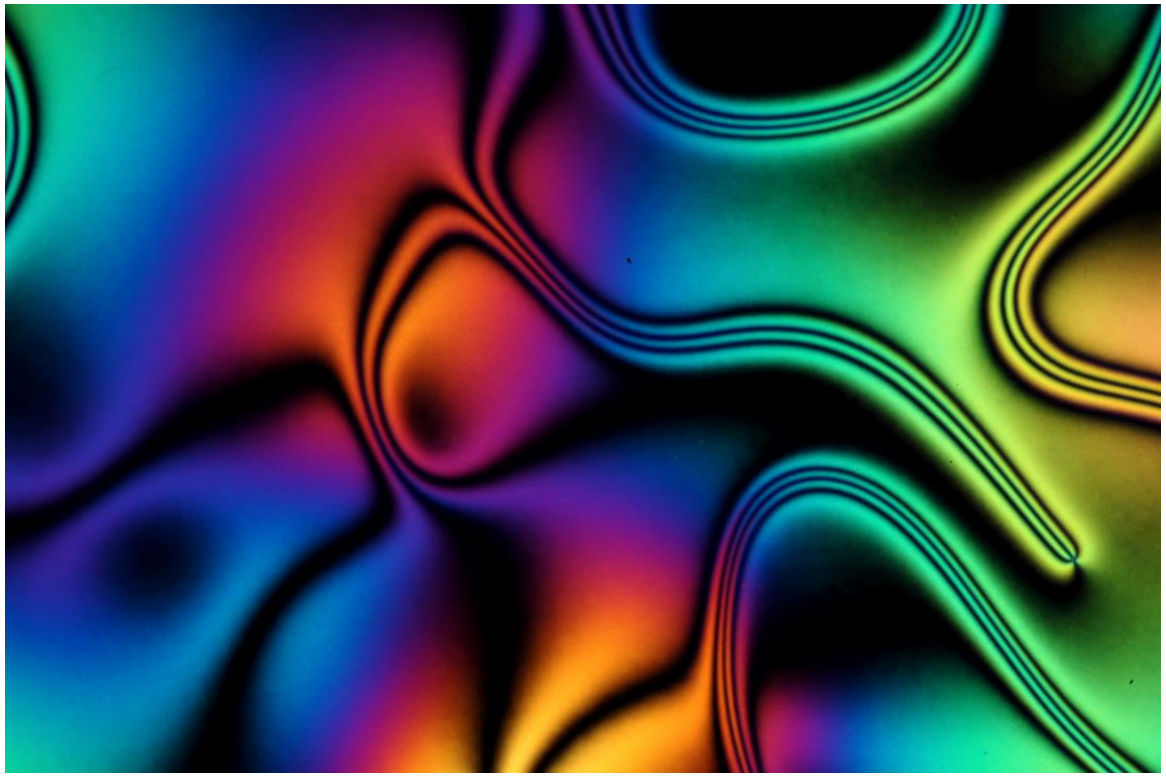


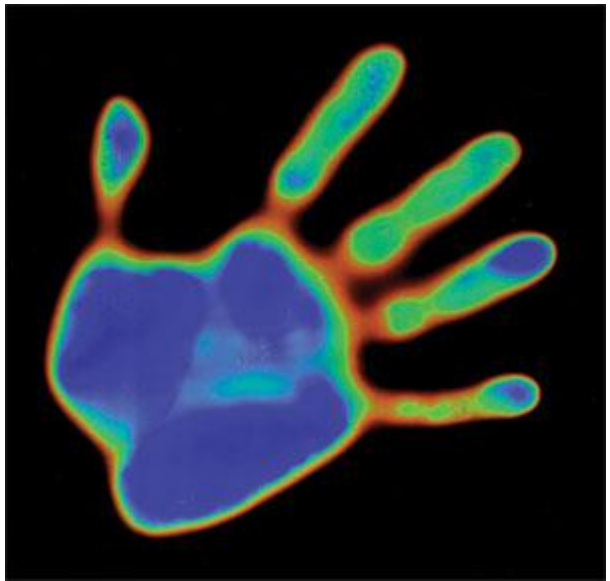
Extended by SMRC

Colorado Boulder

Liquid Crystal Sensors :

Detection of volatile analytes using a liquid crystal based sensor





What is a sensor?

- A device that detects some kind of input from the physical environment and responds to it.

Input

sensor

Output

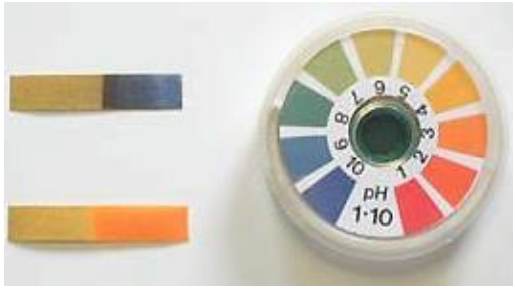
- Light - in
- Sound - in
- Temperature - in

⋮

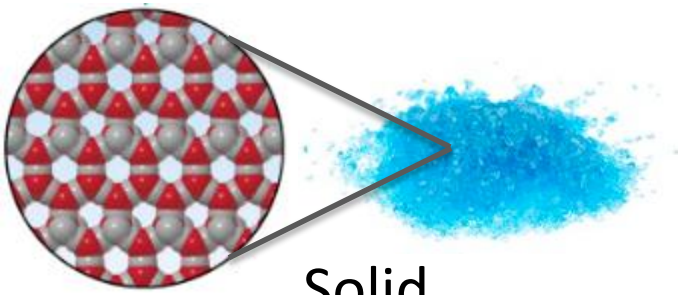
- Electrical Signal - out
- Light - out
- Sound - out

⋮

Types of Sensors

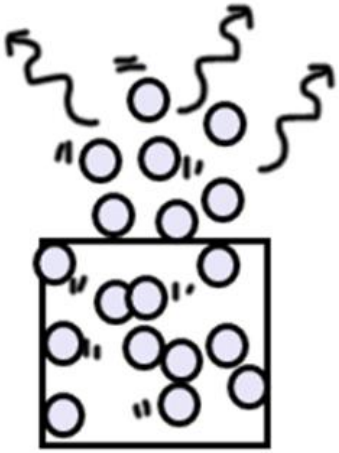


What are Liquid Crystals?

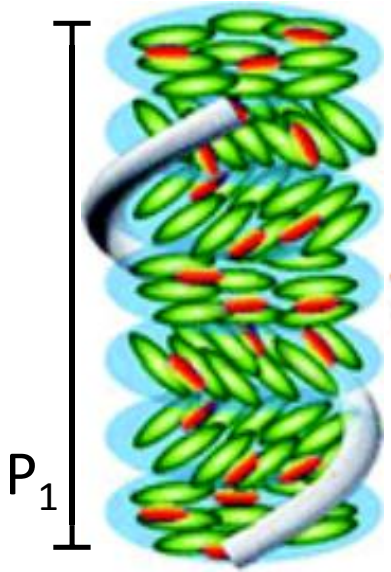


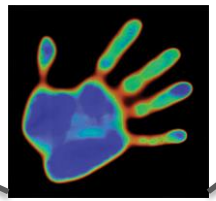
Solid

Liquid



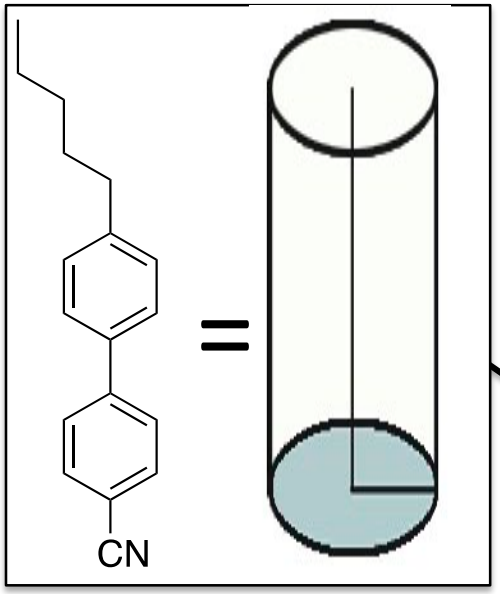
Gas



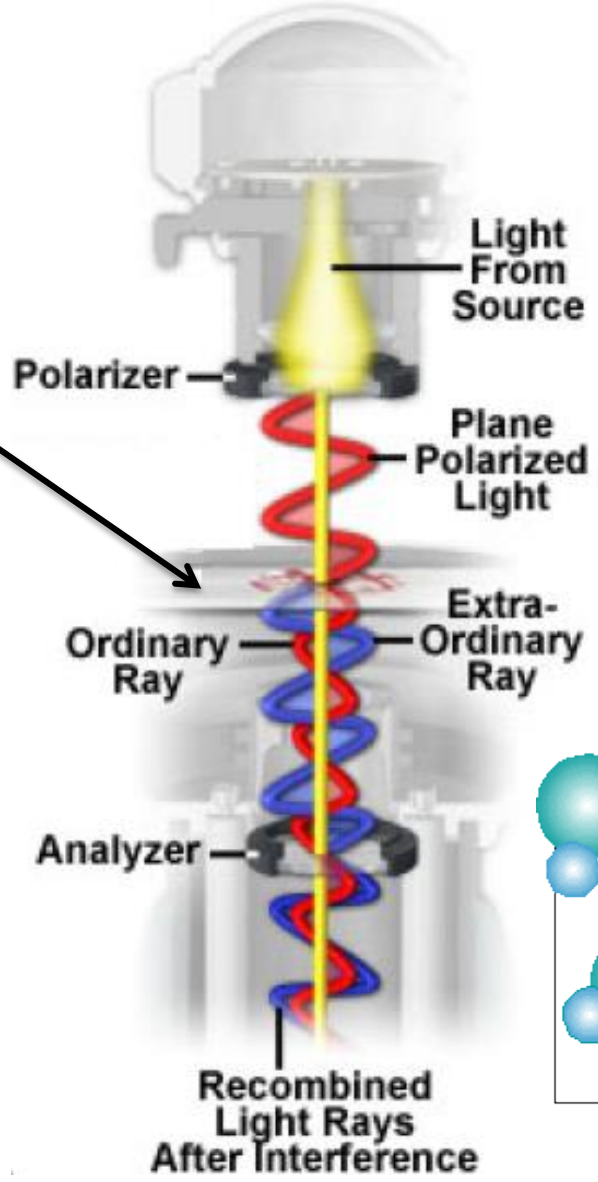


Liquid Crystal

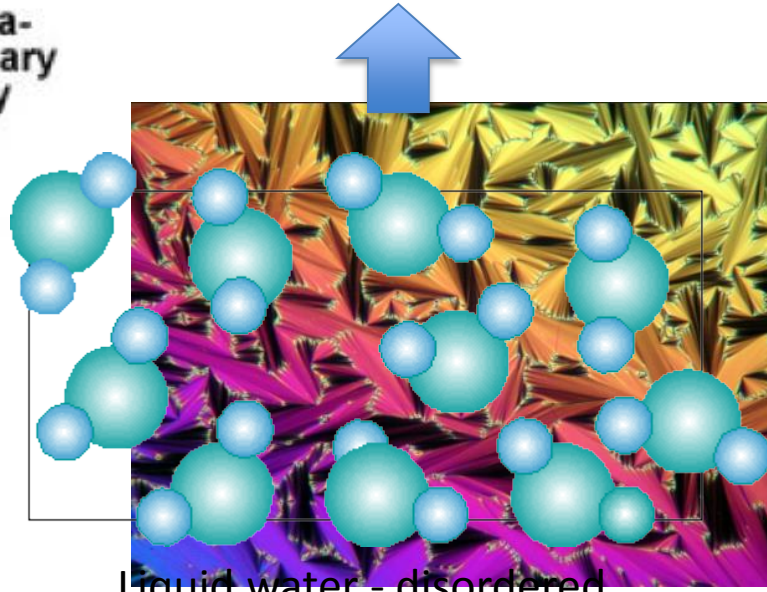
Birefringent Materials



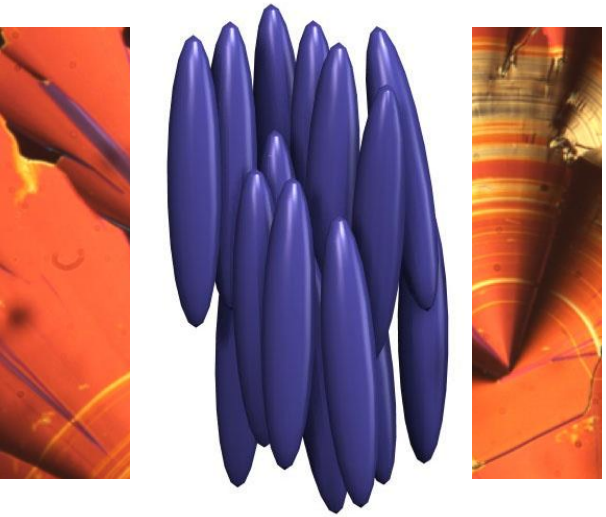
Birefringent Material



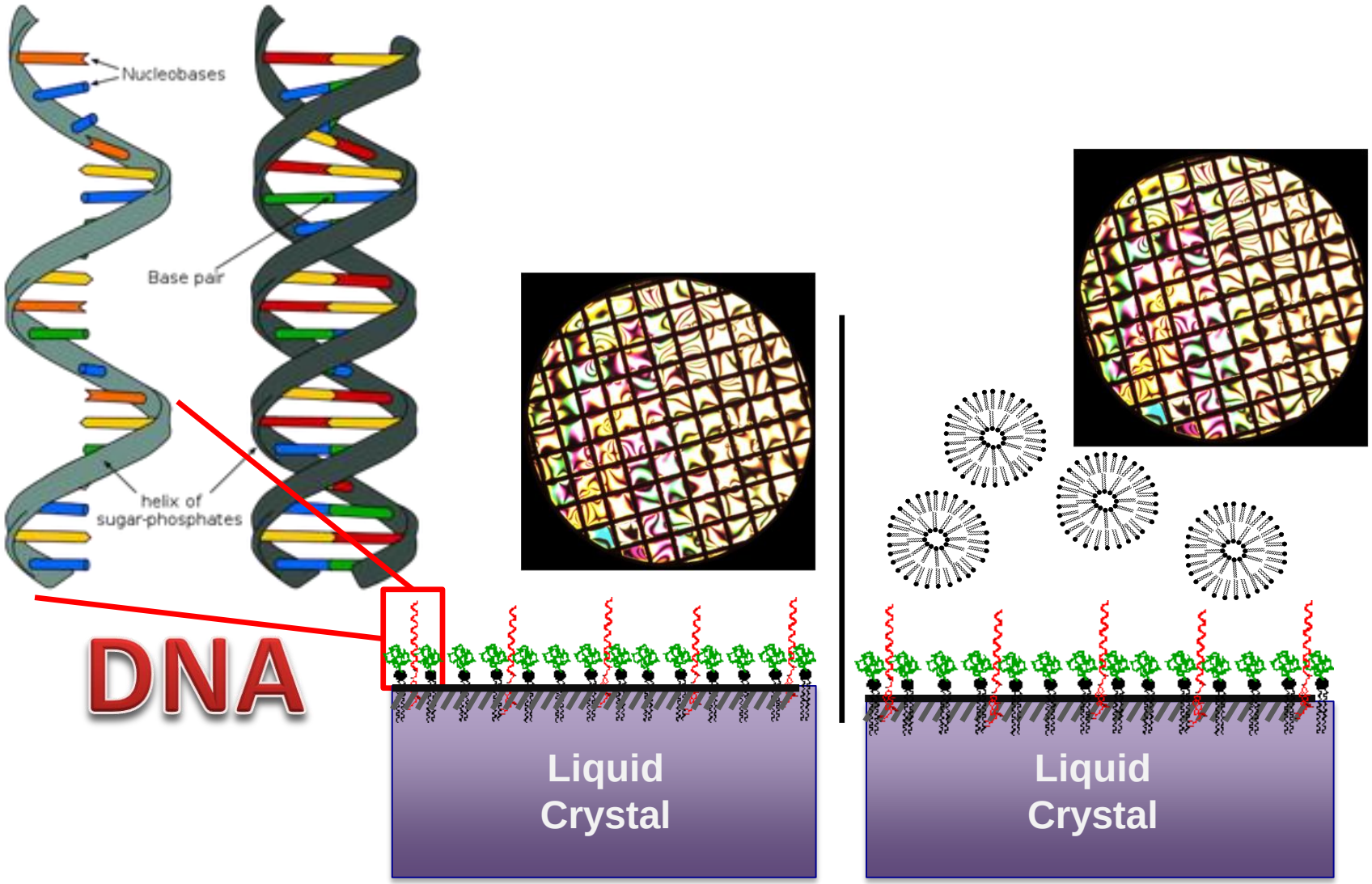
disordered



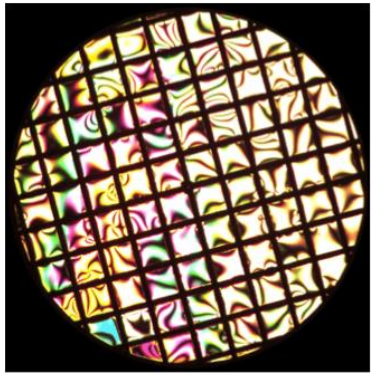
Liquid water - disordered

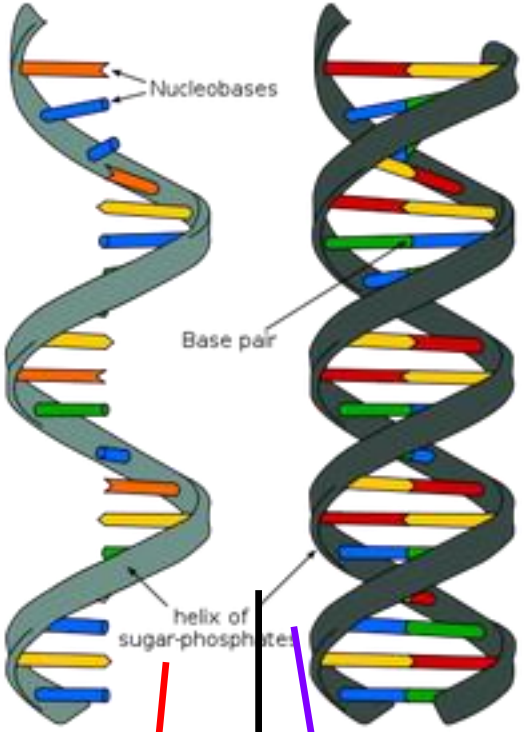


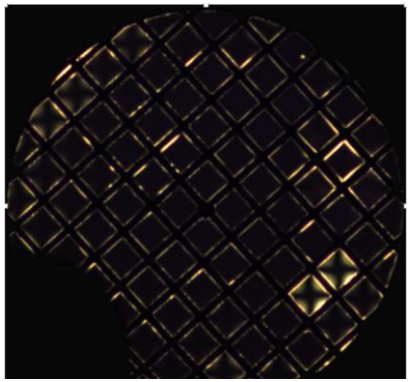
A liquid crystal sensor



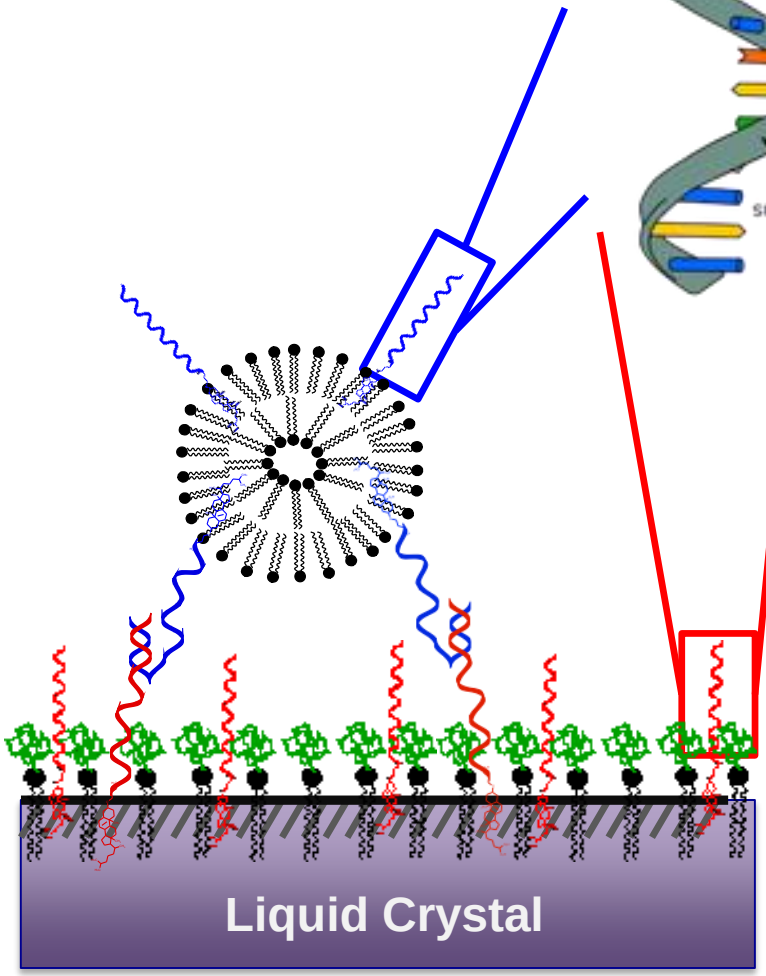
Noonan, PS, et. al.. (2014), Adv. Funct. Mater. 21, 3206-3212

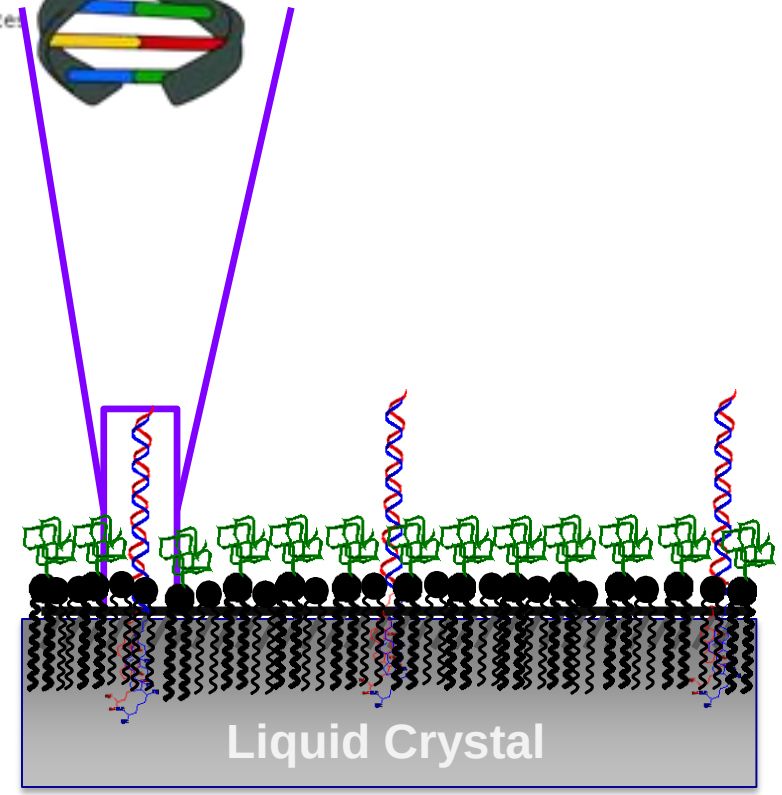






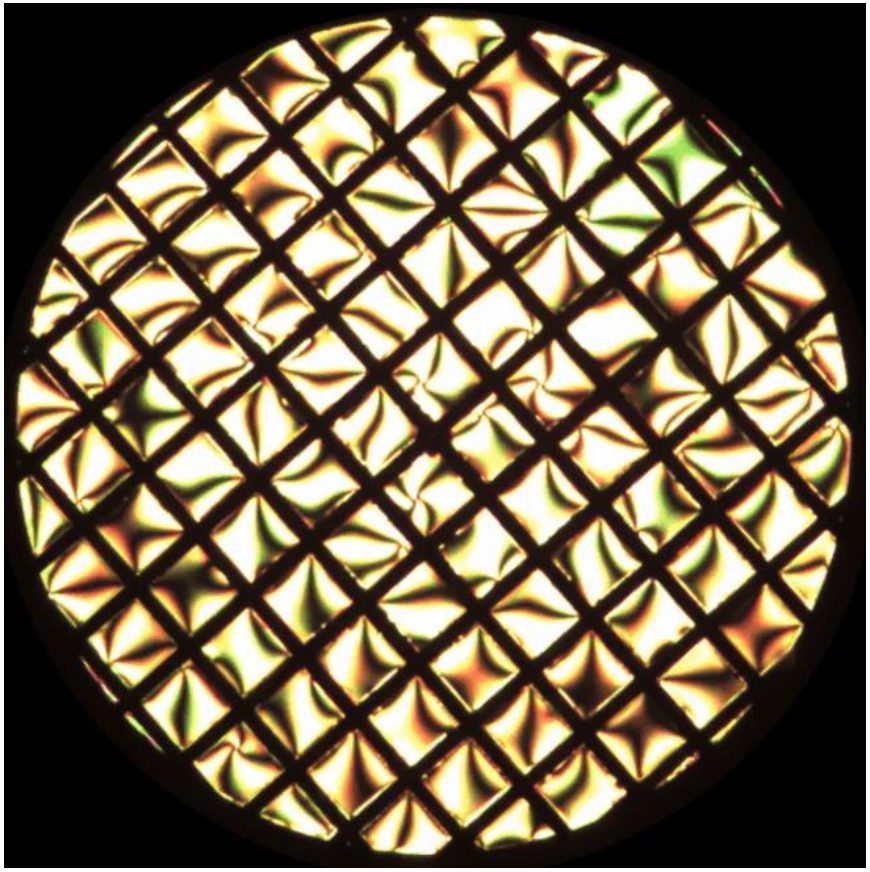
Birefringence = 0



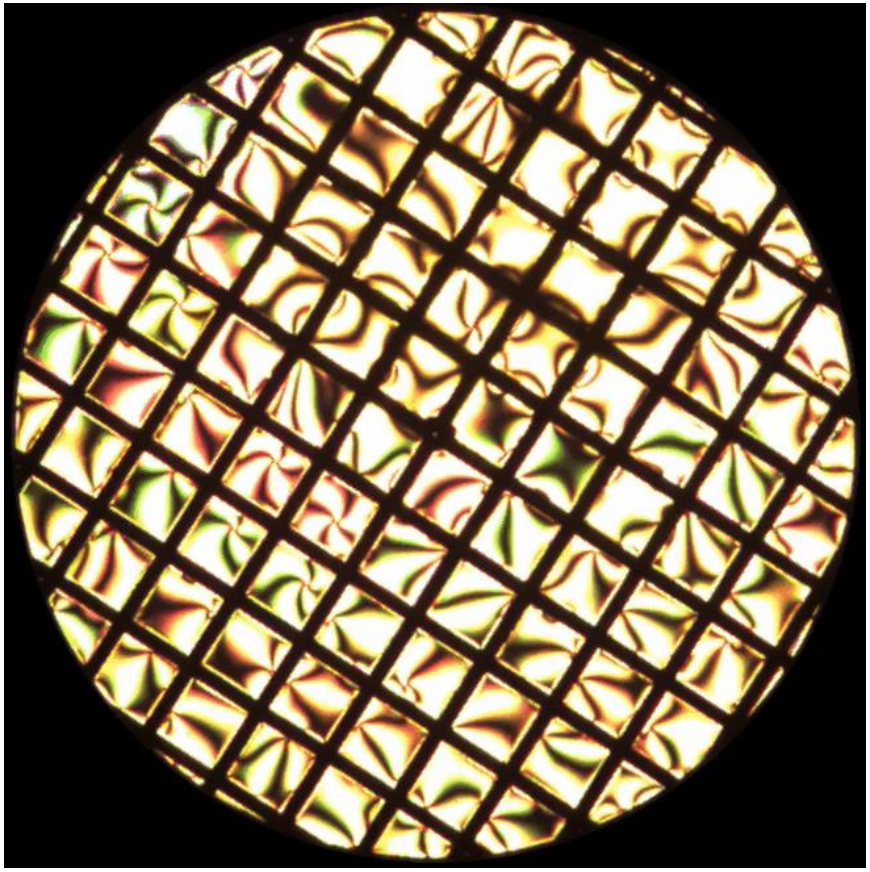


Watch the liquid crystal sense liposomes!

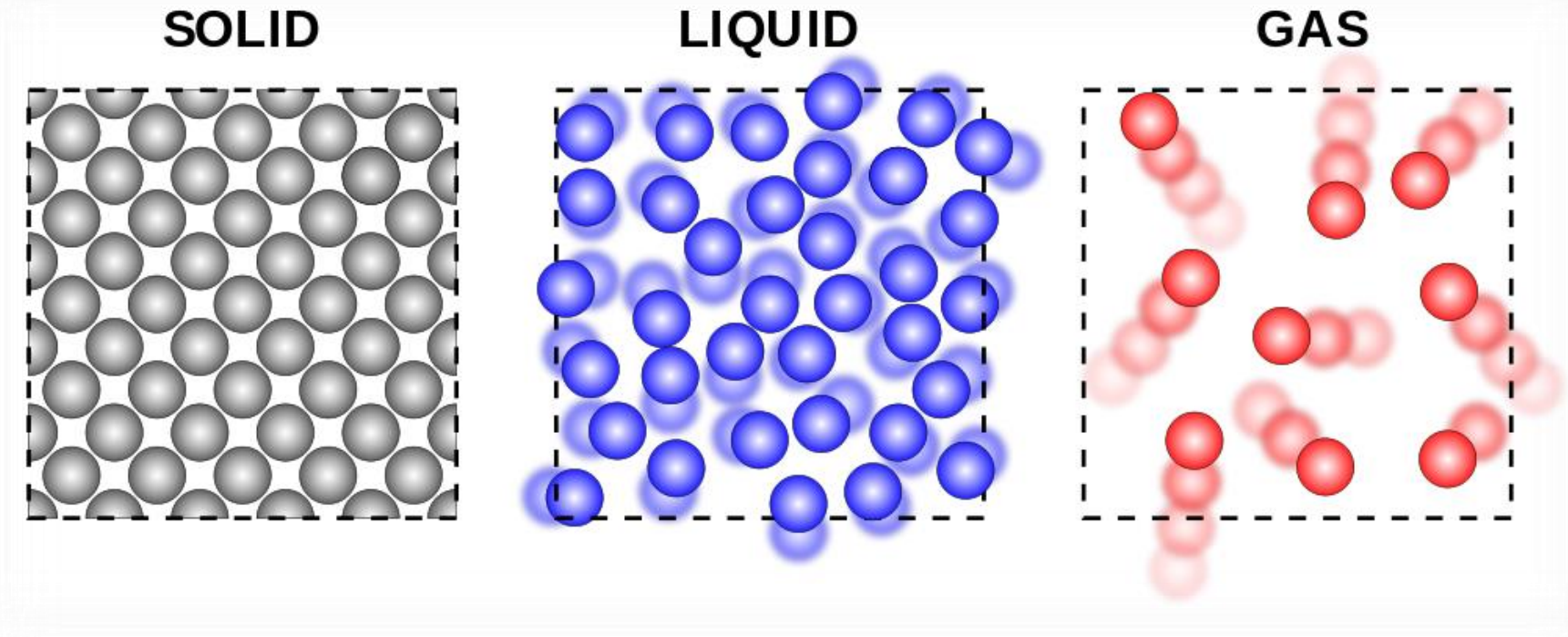
(+) DNA



(-) DNA

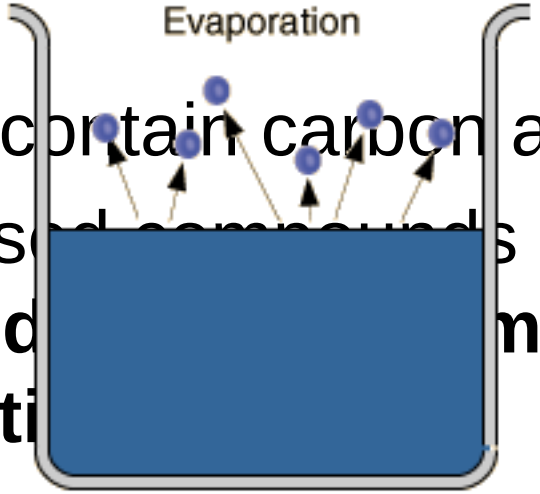


What if we want to use our liquid crystal sensor to detect gas molecules?



What are volatile organic compounds (VOCs)?

- Volatility is the tendency for a substance to vaporize.
  - high vapor pressure
- Organic compounds contain carbon atoms.
- VOCs are carbon based compounds that evaporate quickly **under normal temperature and pressure conditions**



What are some examples of products that contain VOCs?

http://hyperphysics.phy-astr.gsu.edu/hbase/kinetic/vappre.html


GASOLINE


FORMALDEHYDE


5

Health Effects

- Depend on toxicity and exposure time (some VOCs are not toxic, some are very toxic)
- With longer exposure, some VOCs can cause:
  - Eye, nose, and throat irritation
  - Headaches, dizziness, trouble breathing
  - In some cases, liver damage, cancer

Air quality sensors

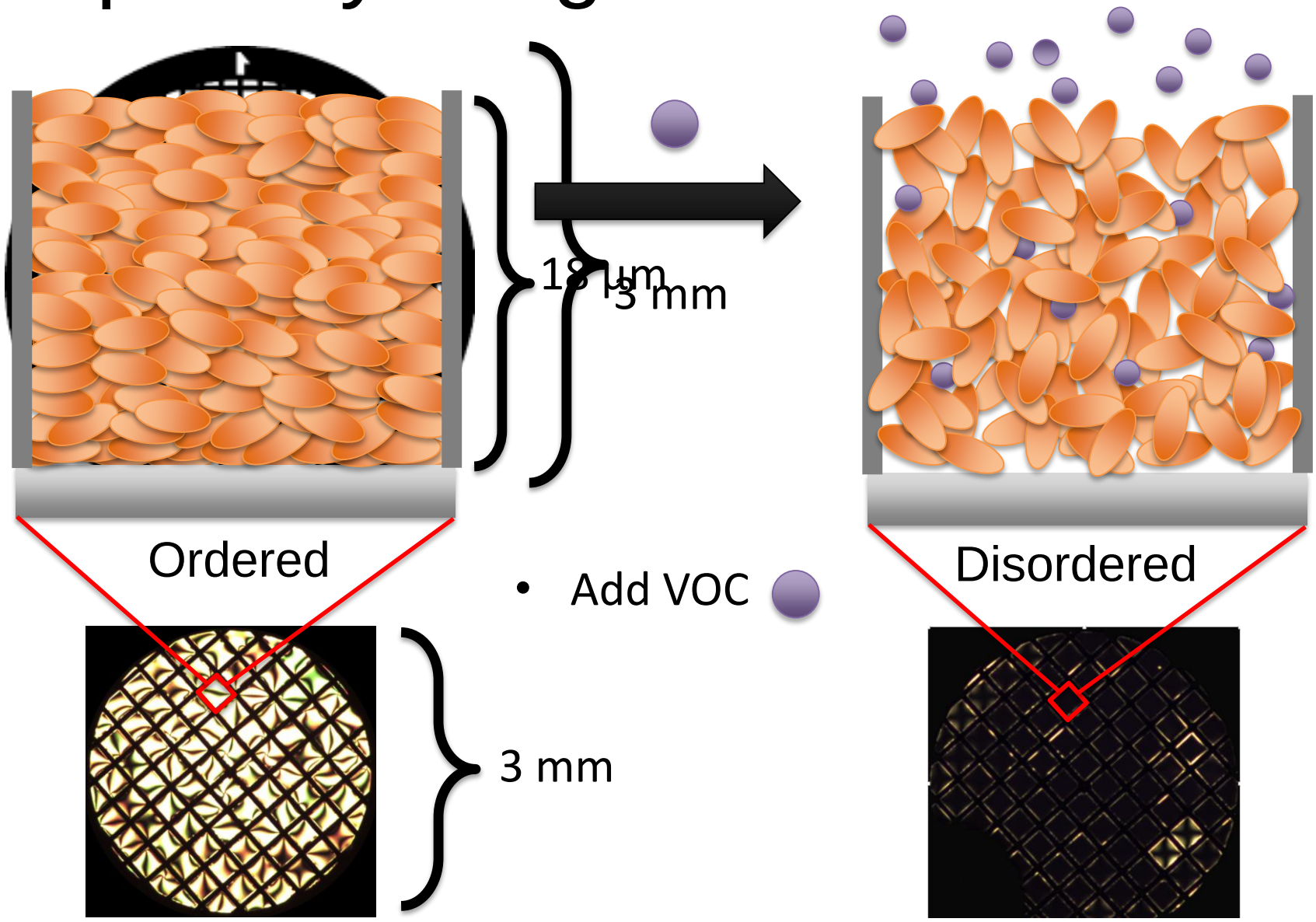
- Usually use electricity as the detection method.
  - Battery powered
  - Sensitive
  - Expensive

Can you think of other detection methods?

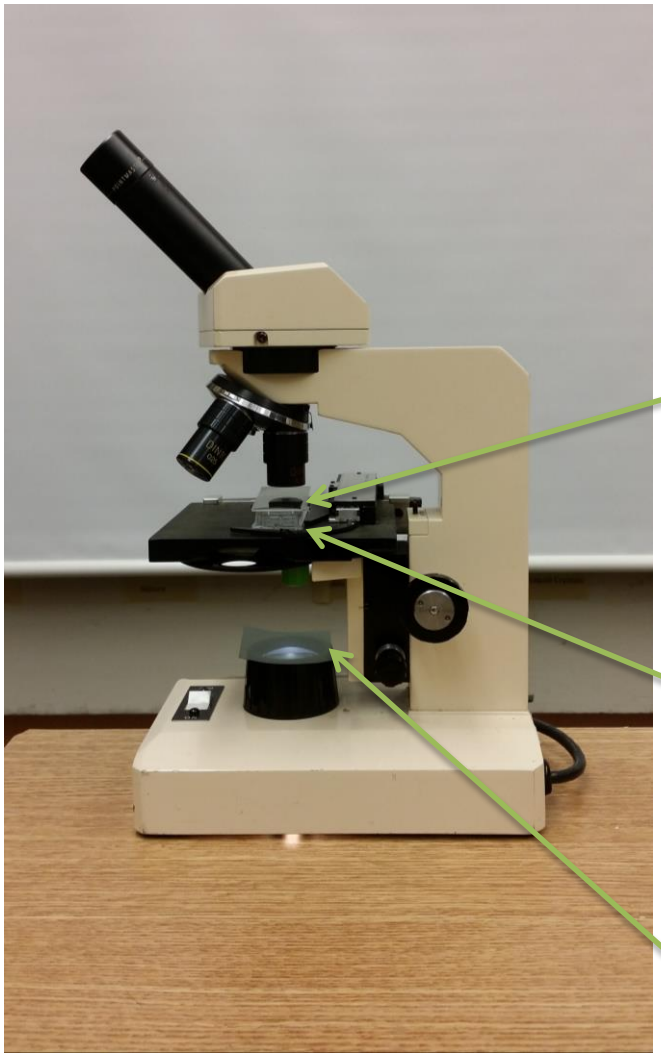
Liquid crystal gas sensors

ClearSense™ USB reader (

Liquid crystal gas sensors



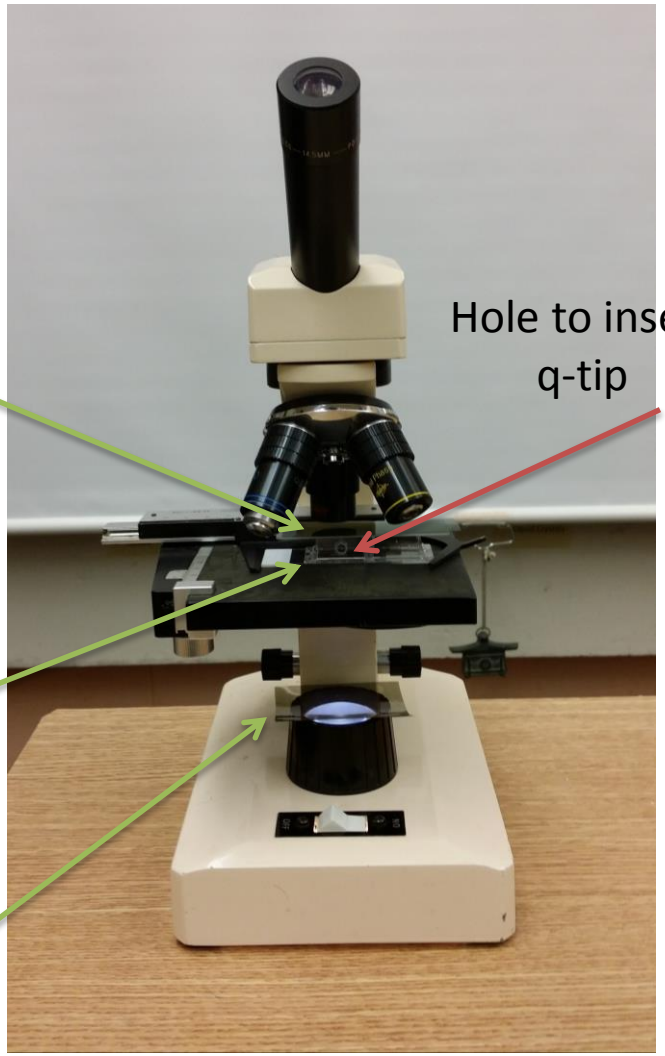
Experiment Setup



Glass slide with polarizer on top

Chamber slide containing EM grid with liquid crystal film

Polarizer



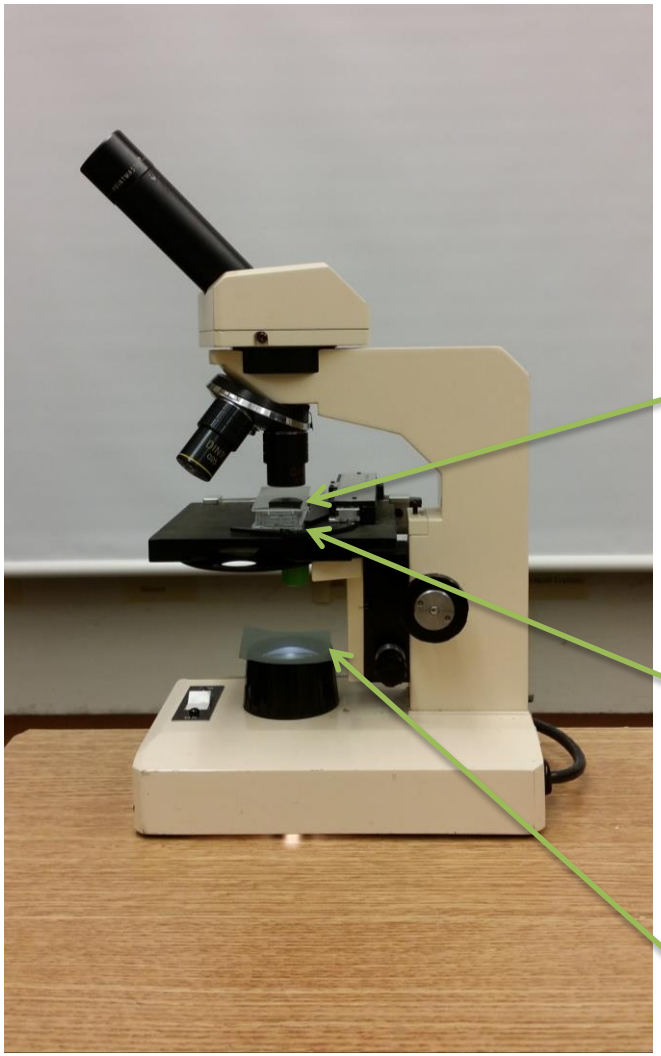
Hole to insert q-tip

In your lab notebooks…

- *Title:* Detection of volatile analytes using a liquid crystal based gas sensor
- *Purpose:* Why are you doing this experiment? What do you expect to learn?
- *Data/Observations:*

Sample ID:	**Solvent Mixture: (i-Pr, Glycerol, H_20)**	**LC Response:**	**Notes:**
A	10:10:80		
B	40:10:50		

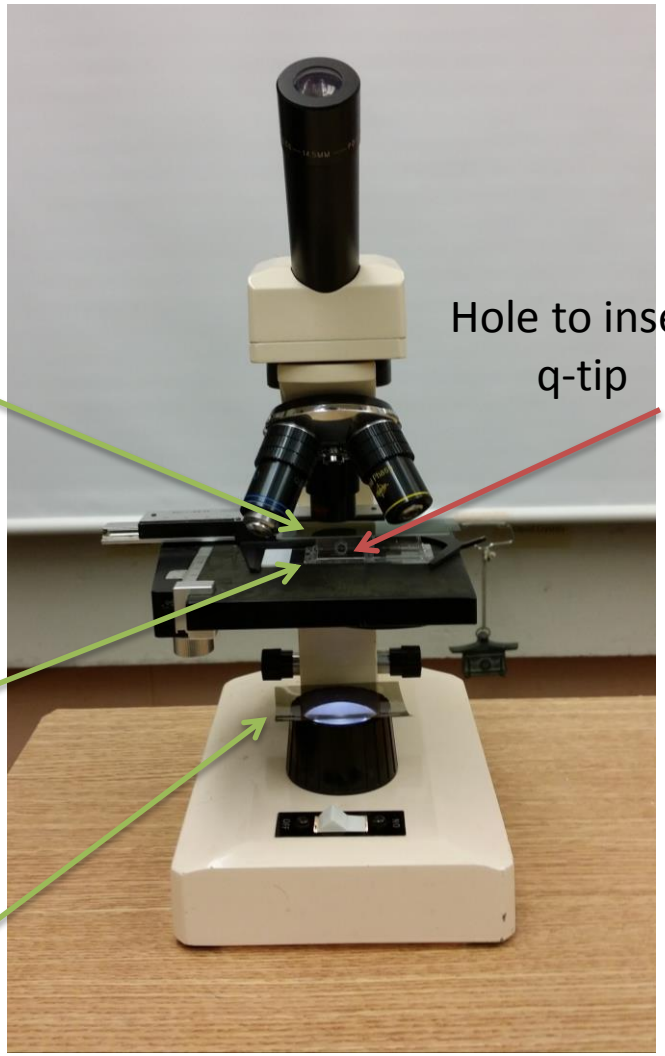
Experiment Setup



Glass slide with polarizer on top

Chamber slide containing EM grid with liquid crystal film

Polarizer



Hole to insert q-tip

What did you observe?

- What did a response from the sensor look like?
- Which component(s) trigger a response from the sensor?
- Do you think these components have a high or low vapor pressure?

- How could we make this sensor better or more sensitive?

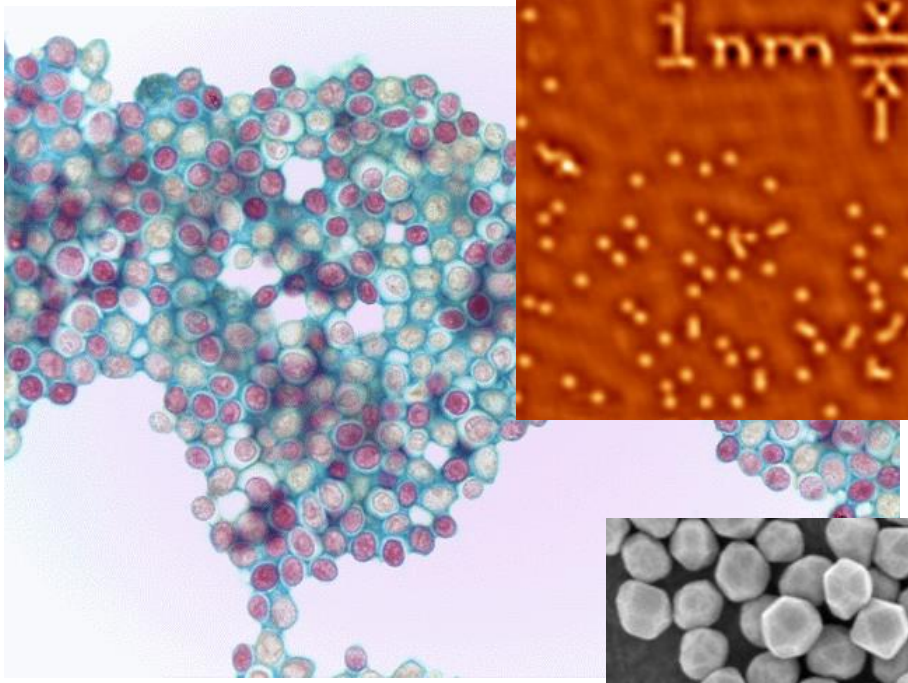
VOC's in household products

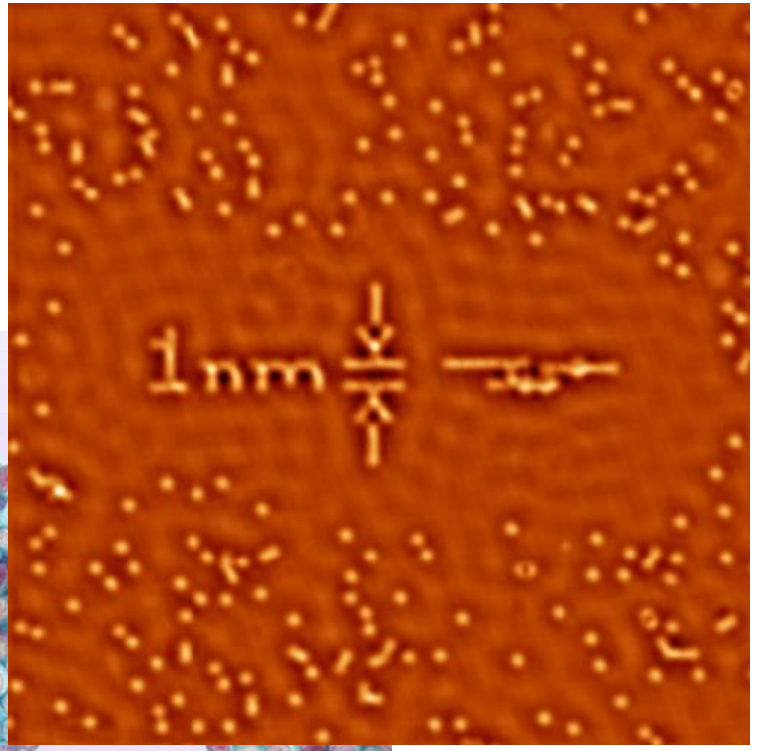
Product	Solvent	LC response
Sharpie		
Mouthwash		

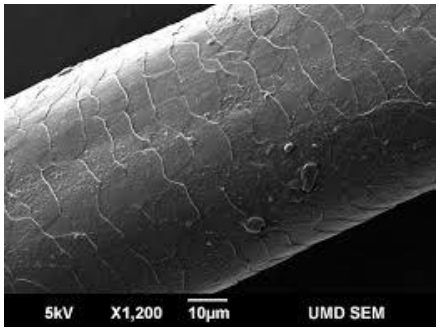
The Nanoworld

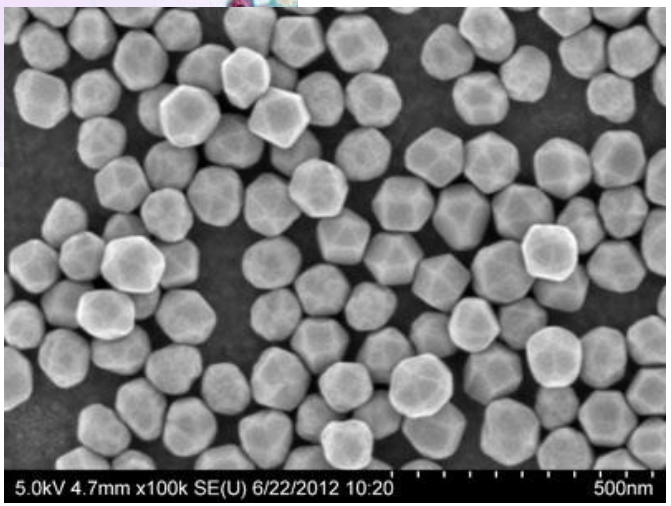
[Size and Scale Demo]

- Dime walk



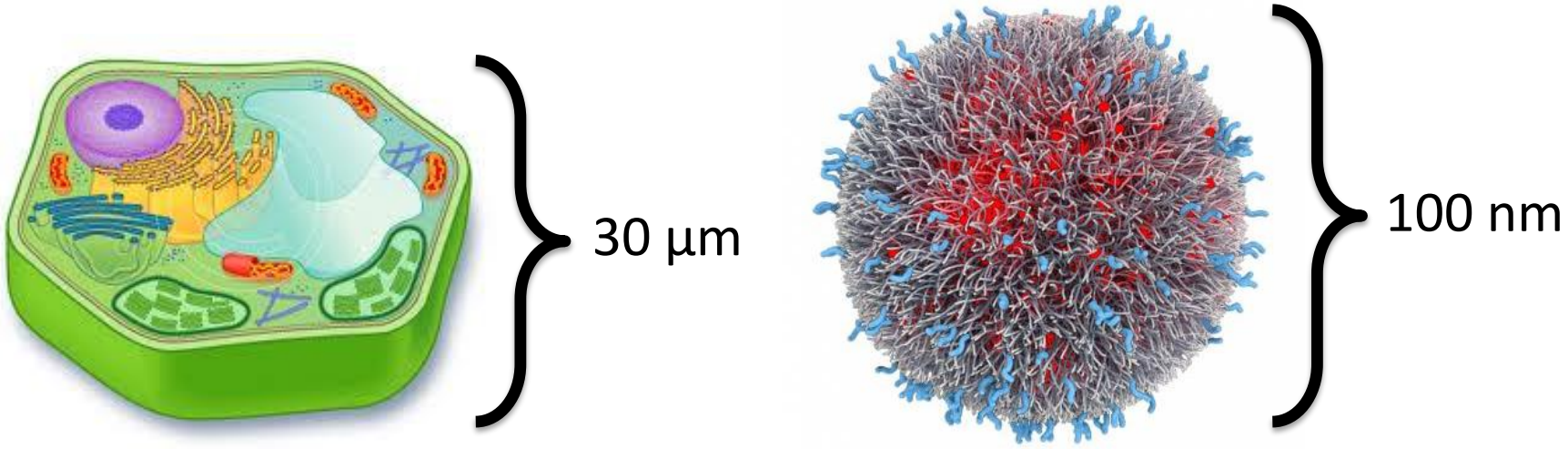






The Nanoworld

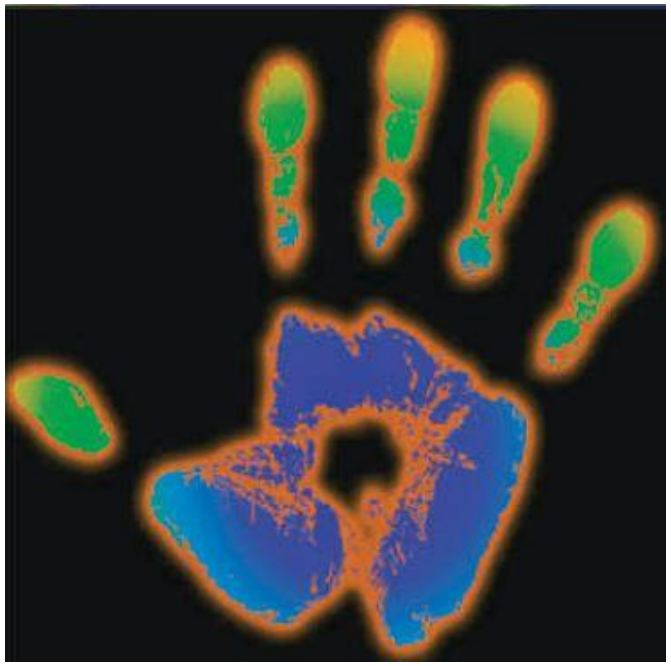
- The *surface* becomes a very important part of the nanoworld.

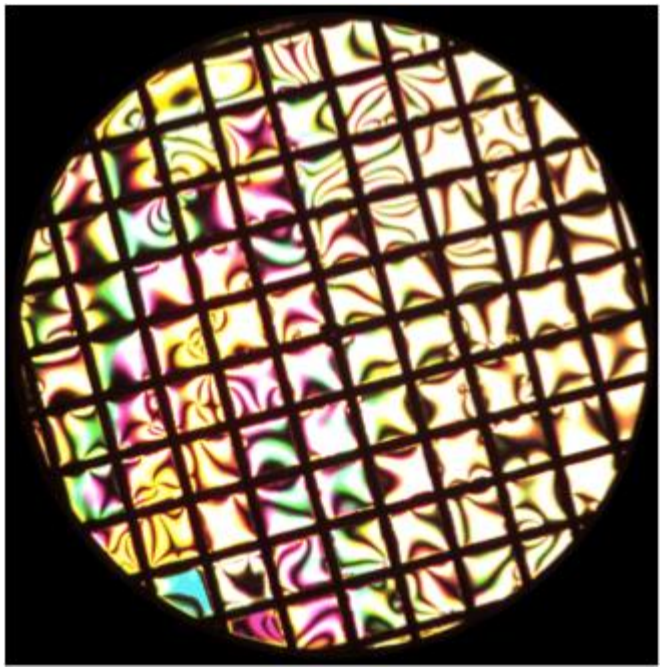


- Smaller particles have more surface area to interact with their environment.

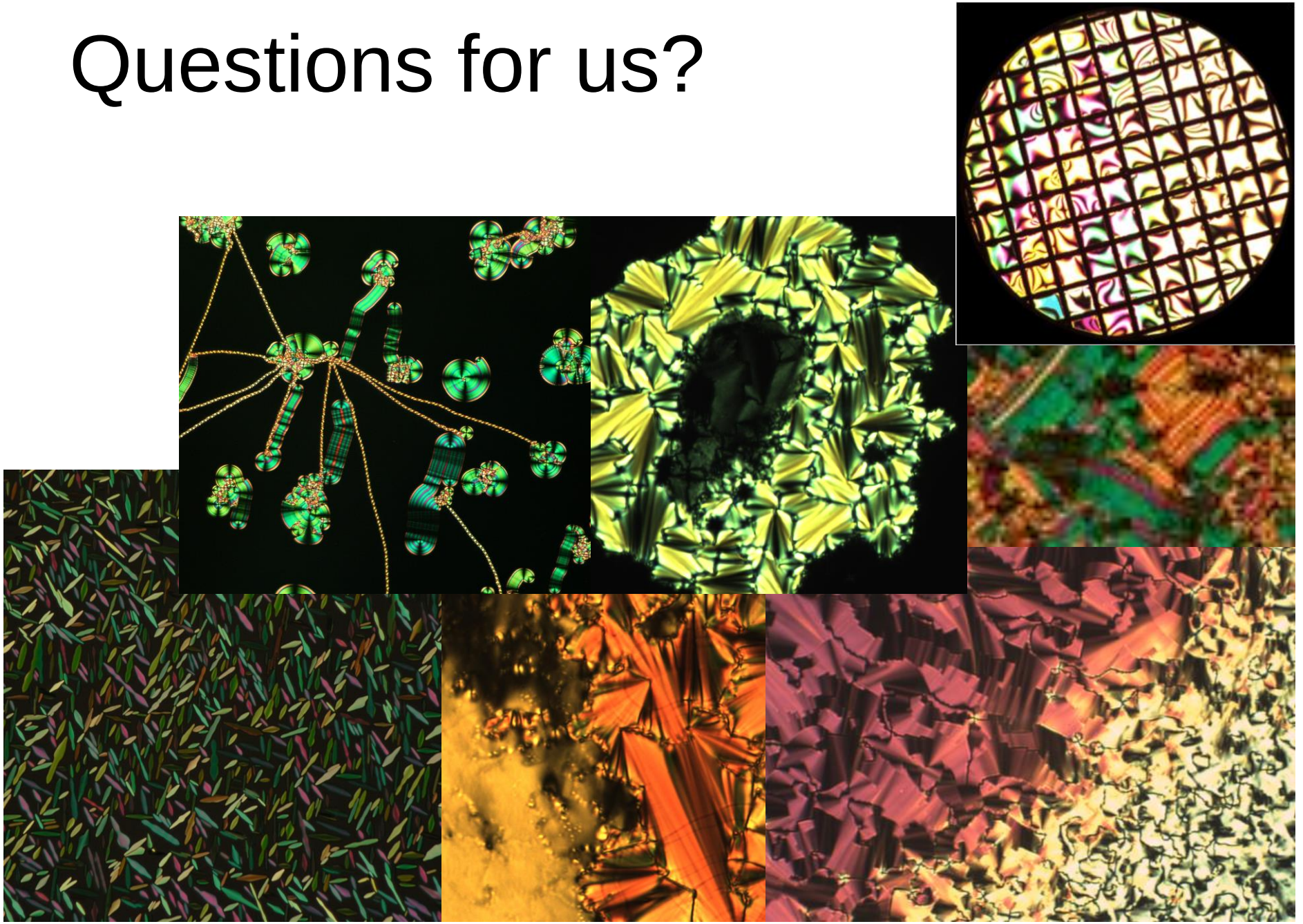
The Nanoworld

- Small objects (that we can’t see) can be used as detectors.





Questions for us?



Safety information

- Always use products with VOCs in well-ventilated areas.
- Do not hold the VOCs to your nose for long periods of time.
- Do not swallow or consume products with VOCs.
- If you get light-headed, move away from products with VOCs until you feel better.