# Next Generation Vitrimers

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# 2 types of plastics

**Thermoplastics**: highly re-processable, not very resilient

**Thermosets**: Tough, good chemical/thermal resistance, not re-processable (cross-linked)

# Vitrimers

## Exchangeable covalent bonds triggered by external stimuli

(Leibler, 2011)

Highly resilient

Reprocessible

# What we've been doing so far...

Investigating an acid-based system and characterizing its kinetics to show its Arrhenius dependence and effect of acid strength

# Where we want to go...

*Light* driven bond exchange using photoacids (these are reversible!)

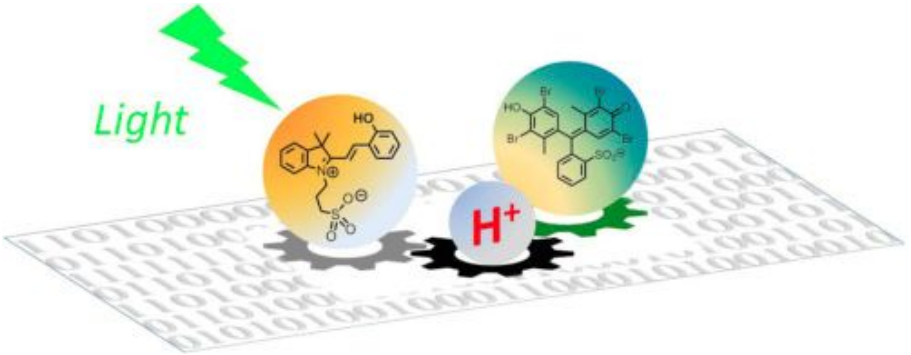



Image: Coudret, 2016

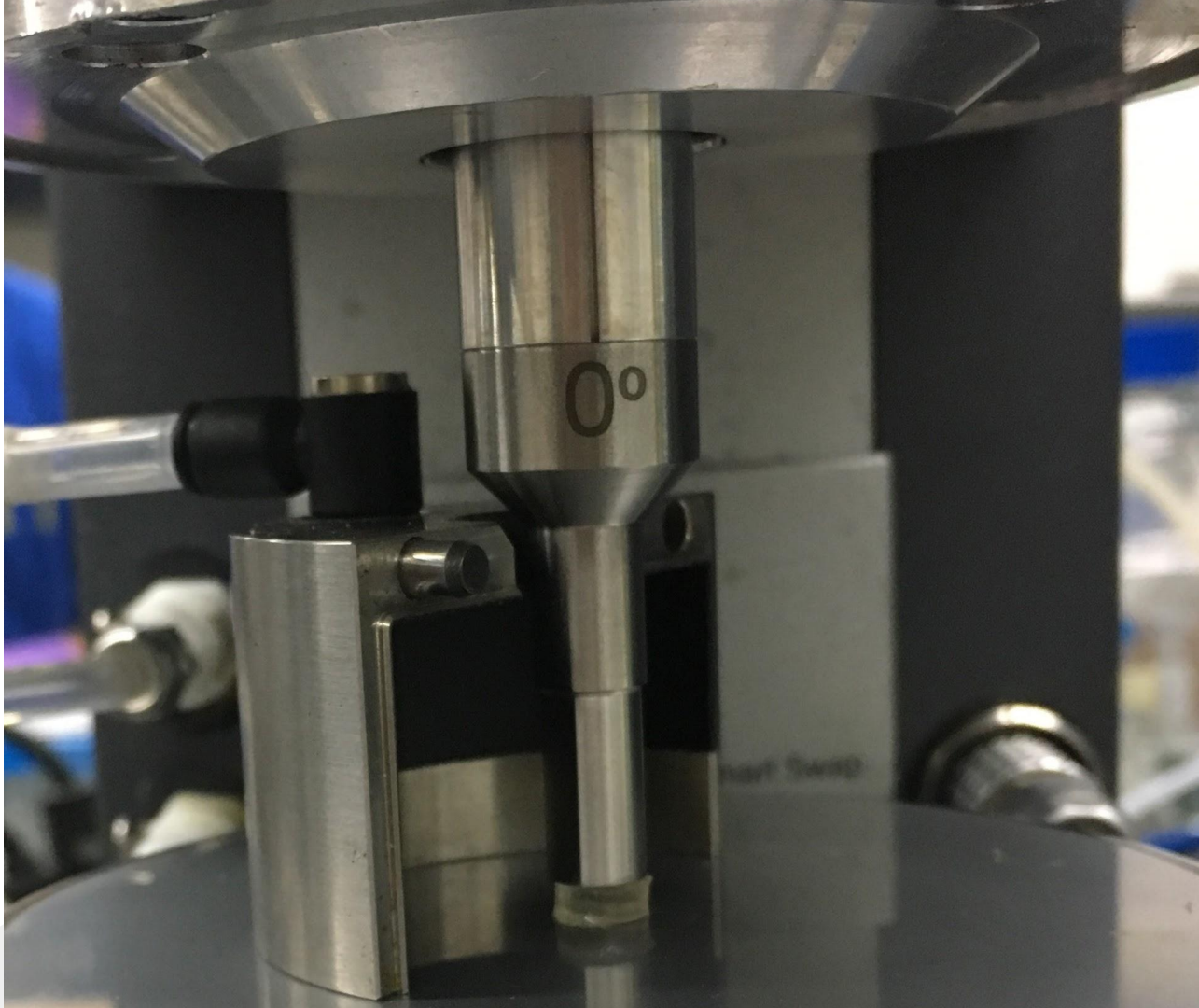
# Characterizing our vitrimer

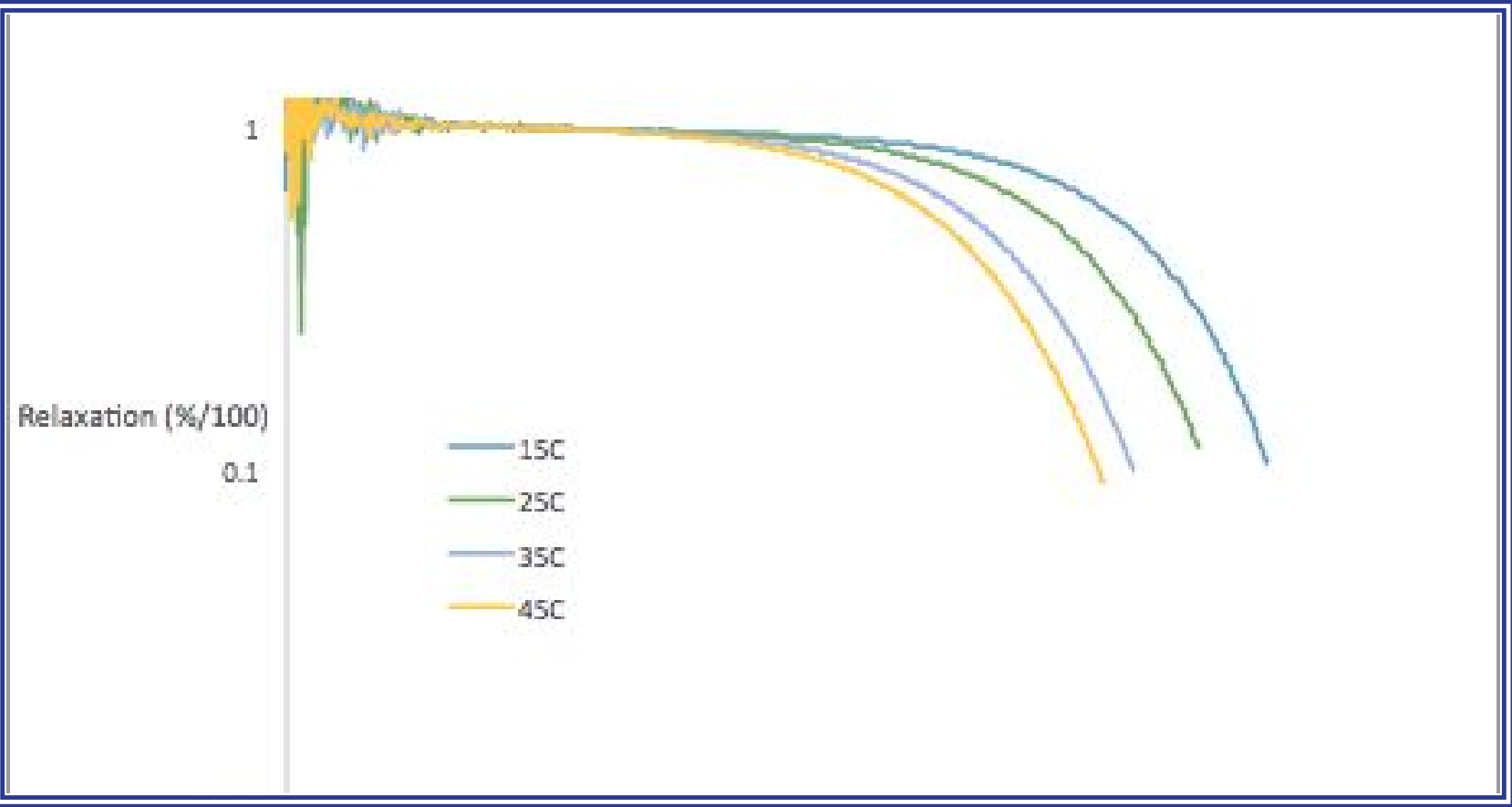
- The bond exchange of our vitrimers is acid catalyzed

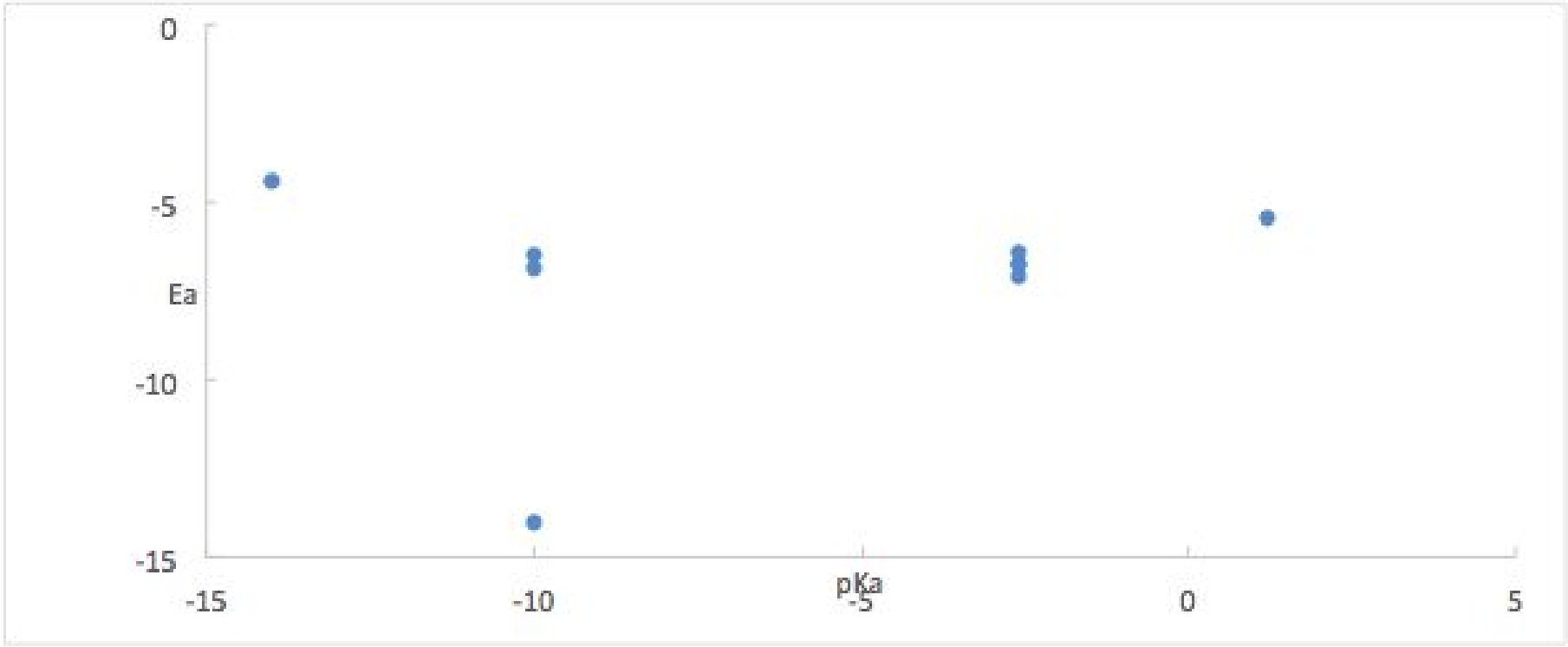
- We want to characterize the kinetics of our different acid catalysts
  - Is there a relationship between the strength of the acid and the activation energy of the relaxation?
  - Are the kinetics independent of acid concentration?

- Our end goal is to create a light-activated acid catalyzed system (via a photo-acid)

# Testing




1
Relaxation (%/100)
0.1
15C
25C
35C
45C


0
-5
Ea
-10
-15
-15
-10
pKa
-5
0
5

# Next Questions

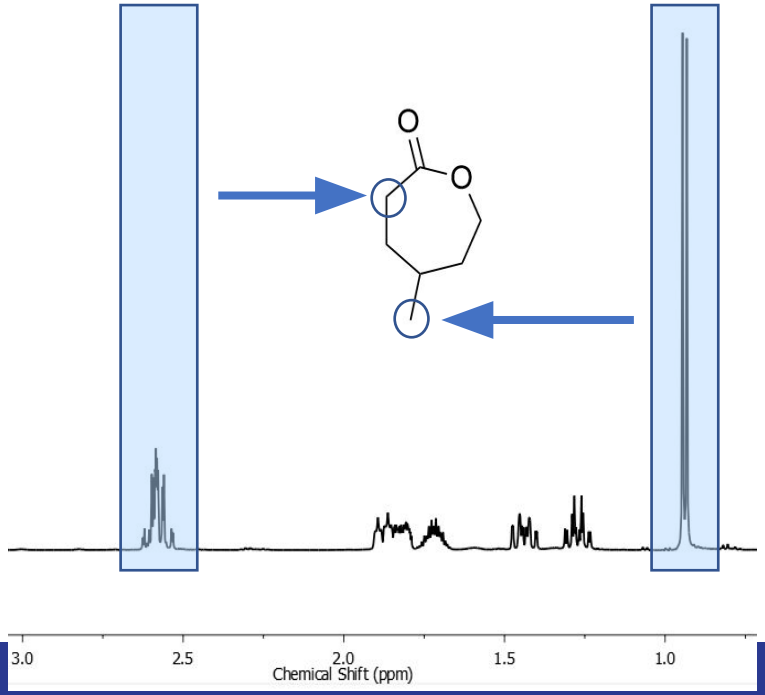
What is the percent conversion of our polymer?

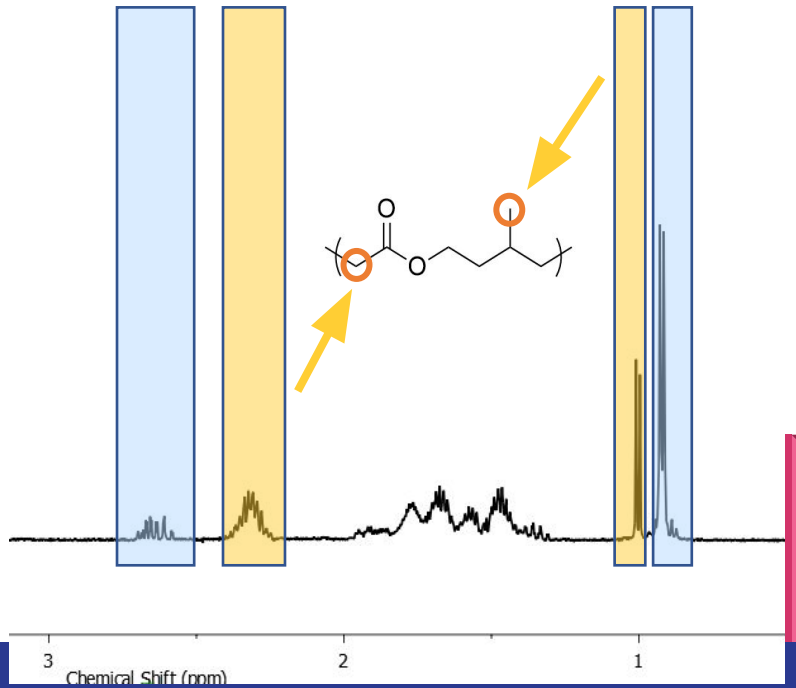
Are there multiple relaxation processes convoluting our data?

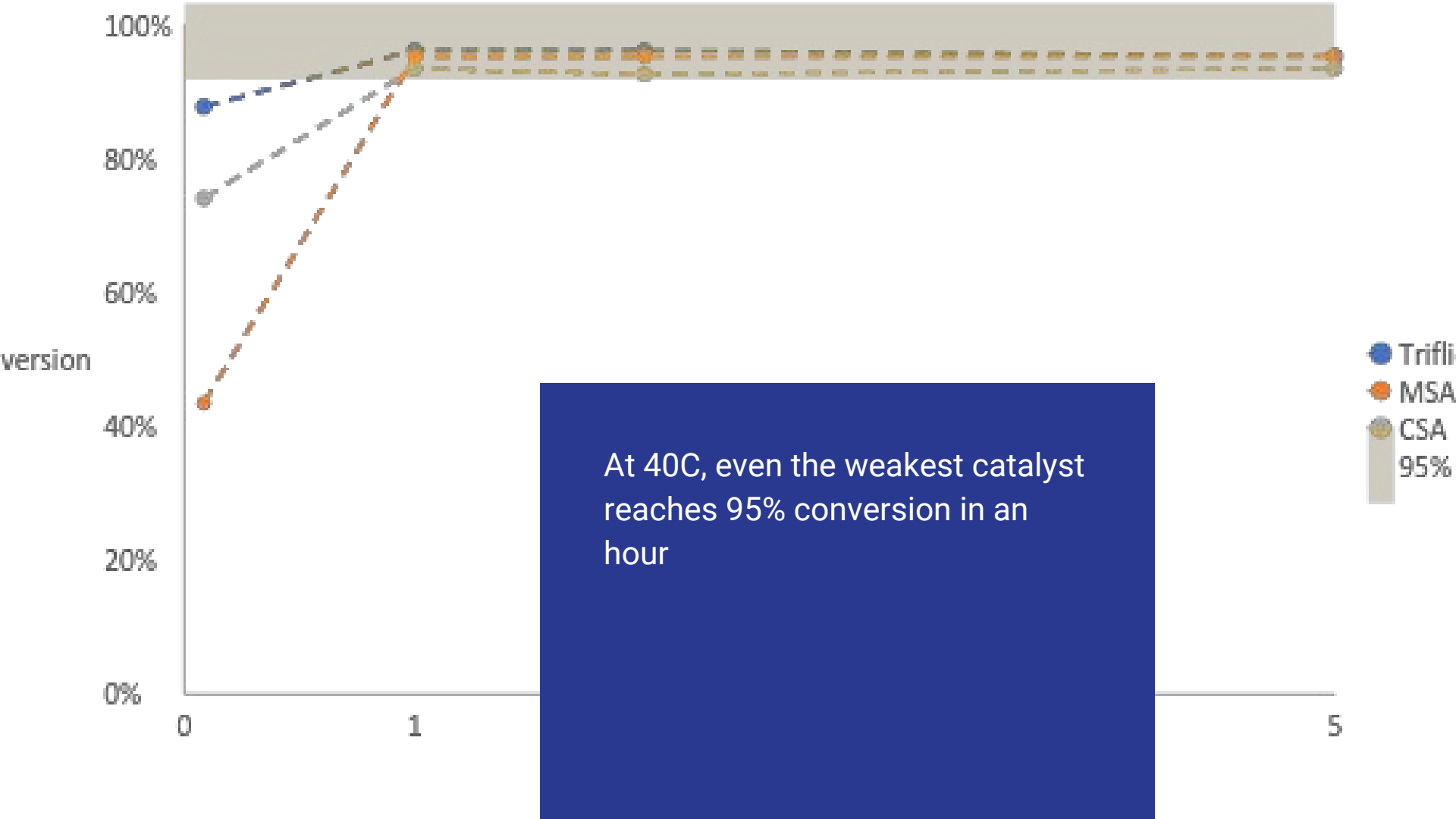
How can we integrate a photoacid into our vitrimer to create a light-dependent relaxation?

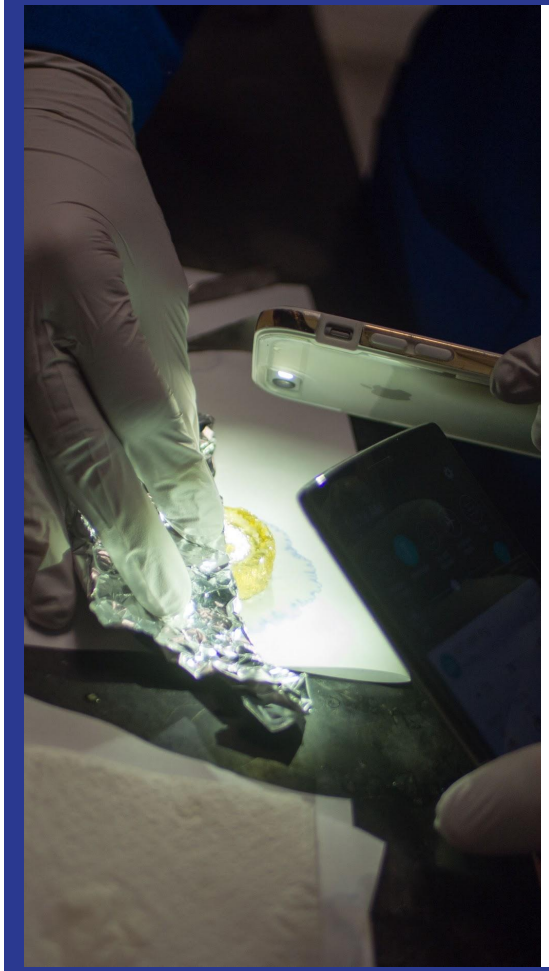
# % conversion

Took aliquots of our polymer every hour to determine the percent conversion




100%
80%
60%
40%
20%
0%
0
1
5
version
Trifli
MSA
CSA
95%
At 40C, even the weakest catalyst reaches 95% conversion in an hour



# Challenges of the photo-acid

Not soluble in our vitrimer

Can swell it into the gel using solvent, but it is not desirable for industrial uses (solvents evaporate)

# Applications

Light-sensitive materials are more energetically efficient than heat-sensitive materials

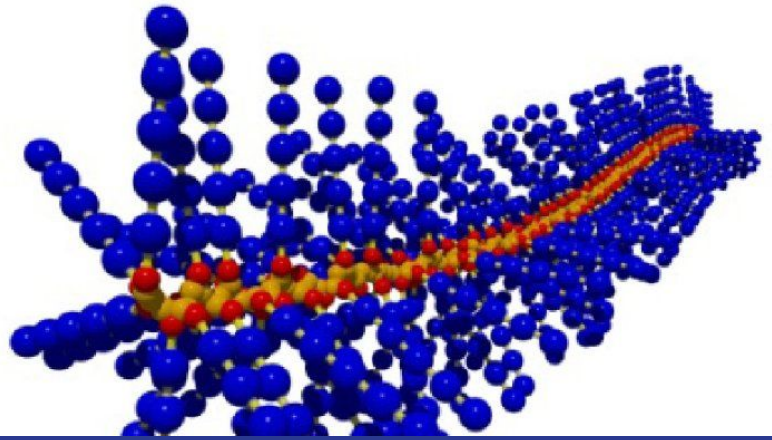
Allows for finer spatio-temporal controls

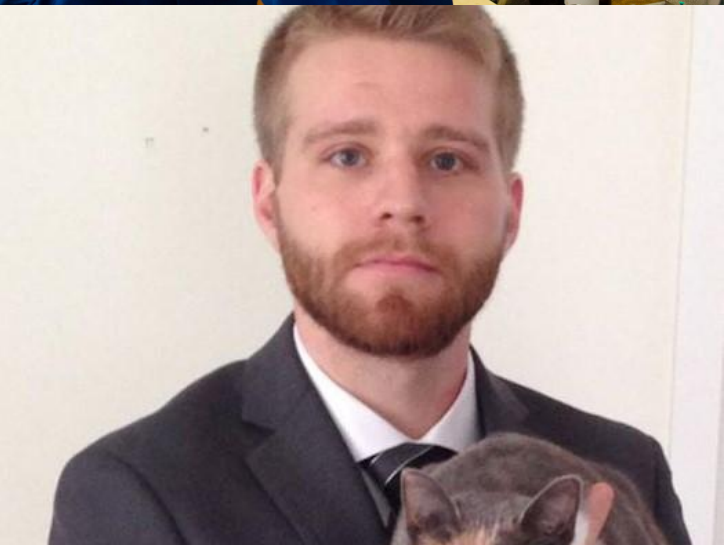
Can be used in conjunction with materials that are heat-sensitive

Light, so hot right now

# Lessons Learned

- Polymer chemistry!
- Chemistry is a black box
- Much of scientific research is problem-solving/ trouble-shooting





# Thank you


MRL, Research Experience for Teachers Program

Frank Kinnaman, RET Coordinator

The members of my RET group

Jeff Self, Mentor/PhD candidate

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Javier Read deAlaniz, PI

The members of the Bates and Read Group