

We are chemical engineers at North Carolina State University, working on non-Newtonian fluids, soft matter, and biomaterials. We test out your favorite ideas with real experiments and report back in Part 2 of this virtual lab event. AUA!

Hsiao<sub>Lab</sub><sup>1</sup> and *ScienceAMAs*<sup>1</sup>

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April 17, 2023

### Abstract

Hello Reddit! We invited your burning questions about non-Newtonian fluids in Part 1 of our lab's AMA series last year, promising to test the most interesting ideas with real experiments. The time has come for us to release our results to these popular questions! 1) Can oobleck (shear thickening fluid) be used for the best kind of speed bumps? (Credit: /u/slp50) ANSWER: Yes! Turns out /u/slp50 had the best idea all along. Experiment: We drove a remote controlled car over two different types of oobleck speed bumps at different speeds. The resultant video itself not the most interesting, but we analyzed the vertical acceleration of the car in slow-mo, and the analysis shows some really exciting results! When we compared our data with people driving their cars over all kinds of road speed bumps in 1973 (source: G. R. Watts, Transport and Road Research Lab Report, 1973), we find that non-Newtonian speed bumps are actually MORE COMFORTABLE AT LOW SPEEDS! And on the flip side, they are really uncomfortable if the car exceeds a certain critical speed! So, this idea is a winner. 2) What happens if you shoot ultra-strong sound waves into oobleck? (Credit: /u/ittimjones) ANSWER: The water inside the oobleck ends up quickly separates from the solid particles, and the entire non-Newtonian fluid expands. See our experimental video here. 3) What happens if you inject oobleck onto oobleck, or drop other non-Newtonian fluids onto themselves? (Credit: /u/bangbangIshotmyself) ANSWER: This one was really hard to do experimentally, so we changed it just a bit: we injected colored water into a normal liquid, a transparent gel that flows kind of like ketchup (yield stress fluid), and oobleck (shear thickening fluid). The gels lock the injected fluid in place, while oobleck "spits out", or phase separates, the injected fluid. Check out our experiment here. 4) What if we drop a ball in these fluids? (Credit: /u/Croanius) ANSWER: We tried two types of non-Newtonian fluids: a liquid gel made of clay, and our cornstarch oobleck. Balls get stuck in the gel, and balls bounce on oobleck. Did you know that the army uses gels to test the effect of ballistics on humans, because no matter how much we work out, our bodies are basically jello? You can check out our results of dropping a ball into non-Newtonian fluids here. 5) Is full fat mozzarella cheese really necessary for the best kind of pizza (where the cheese is stretchy)? (Credit: /u/voilsb) ANSWER: For pizza connoisseurs: Yes, you must use full-fat mozzarella cheese if you want to reproduce that stretchy cheese phenomenon found in Pizza Hut commercials. We tested full-fat and skim-milk mozzarella, and the full-fat moz stretches extremely well above 80°C (175°F). See our experiment here. 6) Are cats non-Newtonian fluids? (Credit: Dr. Goulu) ANSWER: YES! But it depends on the situation and mood of the cat. Hear it from the IgNobel Physics prize winner! Tell us what you think about these experiments, non-Newtonian fluids, or just science life in general. Our lab members will be here to answer your questions all day.

[REDDIT](#)

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HSIAO\_LAB [R/SCIENCE](#)

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## CORRESPONDENCE:

## DATE RECEIVED:

February 26, 2018

## DOI:

10.15200/winn.151957.70286

## ARCHIVED:

February 25, 2018

## CITATION:

Hsiao\_Lab , r/Science , We are chemical engineers at North Carolina State University, working on non-Newtonian fluids, soft matter, and biomaterials. We test out your favorite ideas with real experiments and report back in Part 2 of this virtual lab event.

AUA!, *The Winnower*

5:e151957.70286 , 2018 , DOI:

[10.15200/winn.151957.70286](https://doi.org/10.15200/winn.151957.70286)

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Will it ever be possible to use chameleon pigmentation mechanism to display text or even images like we do with e-ink screens?

[BananaRescueTeam](#)

Hi! Thank you for this insightful question. Yes, but I'll reframe your question in a slightly different way. Chameleons and cephalopods (octopi and squids) are known to rapidly change their color based on some kind of environmental stimuli. There are many research groups working on mimicking this type of responsiveness in synthetic polymers and particles, because you might imagine making a kind of sensor where the material detects a change in the environment, and provides some kind of change to alert the user. This is even more powerful than using the pigments to display text or images in electronics. -LCH

I don't see links for the "See our experiment here" comments.

[fishead62](#)

Fixed. Thank you!

Is there any research into chlorophyll-based solar energy cells?

[monkeydave](#)

Hello, we currently don't have any research in solar cells. You can check out the research from our friend Adam Wallace on Cellular Artificial Leaves from the Velev and Flickinger groups:

<https://www.cbe.ncsu.edu/velevgroup/members/wallace/>

DCV

I've never heard of the term soft matter. Can you talk about it? What are some examples, uses, etc?

[LiveMic](#)

Soft Matter daily life examples: Shampoo, hair gels, mozeralla cheese, butter jam, paint and lots and lots more :)

ARJ

What is your suggested path through college to become a chemical engineer, also, what is your day to day work schedule like? Do you enjoy the field? Any other suggestions for someone interested in chemistry?

[justalittlePUNISH](#)

My suggested path would be to obtain a bachelor's degree in chemical engineering if you want to be a chemical engineer. Of course I love being in this field. You get to solve problems that are super impactful on people's lives (design products, work on energy crisis or environmental issues, make sure processes are running properly). Chemical engineering has some chemistry aspects, for example you get to work with reactors. However, ChemE has always been rooted in physics and mathematics - many nobel prize winning physicists and mathematicians developed the basis for the field as it is

known today. -LCH

What is your suggested path through college to become a chemical engineer, also, what is your day to day work schedule like? Do you enjoy the field? Any other suggestions for someone interested in chemistry?

[justalittlePUNISH](#)

It's great to hear that you are considering a career in chemical engineering! Assuming that you're currently a high school student, I would say the best thing that you can do is to take as rigorous a curriculum as you can in regards to science and mathematics. It doesn't have to and shouldn't consume your entire life but you will want it to be challenging. That will help you with getting into programs but more than anything it is for your own benefit. I would also recommend seeing if you can find a chemical engineer to job shadow. That will give you an idea of what sort of day-to-day work you can expect. Once you're in college much of your path will be set out for you. Engineering generally has a very standardized curriculum given that it is a professional degree program. You'll be able to take a few electives tailored to your interests, though. Being in an academic setting, we don't exactly do the traditional work (process engineering) that most chemical engineers in industry do. Being in academia, our work schedule is very flexible though we still have to accomplish a large amount of work. It's hard to say what a typical schedule for a chemical engineering graduate student is like as everyone is a bit more free to find what works for them in regards to balancing research and teaching responsibilities. Was this helpful?

CMS

Primarily interested in ballistic applications but closer to the average person, how far along are viable products for use in high impact sports and incorporation into vehicle safety features?

[BloodMoneyMcGrim](#)

We might not be that far away. For example it might be possible to tailor soft materials to absorb all force on impact(eg; American Football). The material needs to be lightweight and have high force dissipation property. The challenge would be scaling the production of these materials from lab scale to large scale. On the other hand vehicles are already designed well to absorb most of the impact. But soft matter could help push the boundaries of safety and protection to new levels. Research in these directions are progressing quickly. ARJ

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[BloodMoneyMcGrim](#)

They are at the stage where the technology is housed in start-up companies. So, viable products are already in existence. For example, some fabrics used by law enforcement and even astronauts are embedded with non-Newtonian fluids to make them more ballistic resistant. However, due to economic considerations, they are not quite ready for prime time as a consumer product, and require a lot more research and development behind the scenes to truly make it into the market. -LCH