

Chemistry

with Professor Daniel Higgins

Talking points

Knowledge & Comprehension

1. What are organic micropollutants, and why can they be harmful?
2. What are microplastics, and how can they increase the harmfulness of other micropollutants?
3. What is the difference between hydrophobic and hydrophilic molecules and surfaces?

Analysis

4. What impact does weathering have on how a microplastic will interact with micropollutants?
5. Dan's students use both super-resolved single-molecule tracking (SMT) and confocal fluorescence correlation spectroscopy (FCS) to study how micropollutants interact with microplastics. What does each technique tell them, and why is it useful to use both?

Evaluation

6. Why is it useful to study microplastics and micropollutants in a laboratory when real-world conditions are far more complicated?
7. Dan and his students study how individual pollutant molecules interact with plastics, rather than directly trying to reduce or replace plastics. Do you think this type of research can address the larger problem of plastic pollution? Why or why not?
8. What interests you most about a career in chemistry? What skills do you already have that would help you, and how could you develop other useful skills?

Activity

In this activity, you will create your own fresh and weathered microplastics and then use a simple light microscope to observe how fluorescent dye interacts with them.

You will need:

- Different types of waste plastic (e.g., drink bottle, food container, carrier bag)
- Something abrasive (e.g., coarse sandpaper)
- A solution of Nile Red dye (or curcumin) in ethanol
- A light microscope

First, discuss the following:

- What do you predict will happen? How do you think fresh and weathered microplastics will interact with the dye? How do you think different types of plastic will interact with the dye? Why?
- How will you ensure your experiment is fair? What conditions will you keep constant throughout the experiment, and what variables will you change?

Experiment instructions:

1. In small groups, prepare samples of microplastics from waste plastic, for example by abrading a drink bottle with coarse sandpaper or cutting up a plastic bag into pieces <5 mm. Label each sample of microplastics so you know what plastic it originated from.
2. Weather your microplastic samples, for example by exposing them to sunlight for several days.
3. Once you have prepared samples of weathered microplastics, repeat step 1 **using the same plastic sources** to create fresh samples of microplastics.
4. Place each sample in a solution of Nile Red dye in ethanol for a few minutes then rinse them with water to remove excess dye.
5. Examine each sample under the microscope. Make a note of the colour of dye on the microplastic particles in each sample. Record any differences between the fresh and weathered samples and between samples from different original plastics.

After, discuss the following:

- What differences did you observe between fresh and weathered samples of microplastics, and between different types of microplastics? Did the results match your predictions, or did anything surprise you?
- What are the similarities and differences between your experiment and the research conducted by Dan and his students?
- Why do you think understanding how dye interacts with plastic surfaces will be useful in the real world?

More resources

- Learn more about the work of Dan and his colleagues in the Department of Chemistry at Kansas State University: k-state.edu/chem/about
- Watch videos on a whole range of chemistry topics: ted.com/topics/chemistry