Introducing the effects of processing on material behavior

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MRSEC REU presentation (6/24/21)

- Presented fundamental materials science processing topics to REUs for the summer session.
- This work encompassed crystallinity, defects, interfaces, complex concentrated materials, and various processing techniques.

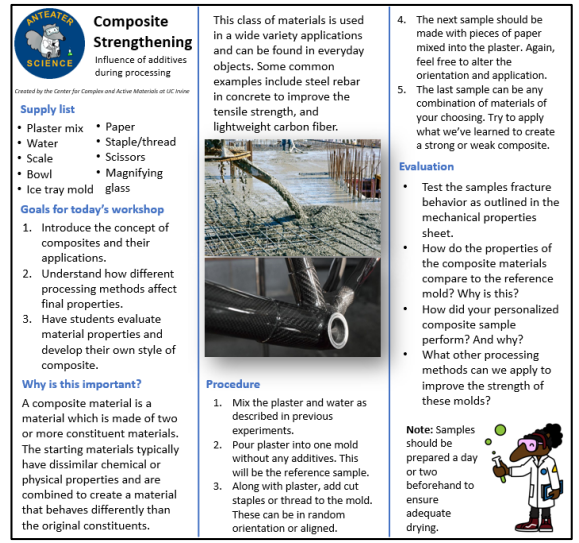
Short materials experiments

- Created a video detailing a short experiment on the fundamentals of work hardening with copper tubes (Fig.1).
- A separate experiment involving only soap, water, and a bottle teaches students about surface tension and the fundamentals of grain growth (Fig. 2).

MRSEC summer weeklong project

- In collaboration with other groups, we detailed a weeklong project on the processing of plaster molds. Students discover different ways of improving or decreasing mechanical properties, which are measured via a drop test. The day 4 example shown in Fig. 3 discusses possible composite strengthening techniques for the molds.

Fig 1. Video tutorial on cold working of a thin copper tube



Composite Strengthening
Influence of additives during processing

Supply list
- Plaster mix
- Water
- Scale
- Bowl
- Ice tray mold
- Paper
- Staple/thread
- Scissors
- Magnifying glass

Goals for today's workshop
1. Introduce the concept of composites and their applications.
2. Understand how different processing methods affect final properties.
3. Have students evaluate material properties and develop their own style of composite.

Why is this important?
A composite material is a material which is made of two or more constituent materials. The starting materials typically have dissimilar chemical or physical properties and are combined to create a material that behaves differently than the original constituents.

This class of materials is used in a wide variety applications and can be found in everyday objects. Some common examples include steel rebar in concrete to improve the tensile strength, and lightweight carbon fiber.

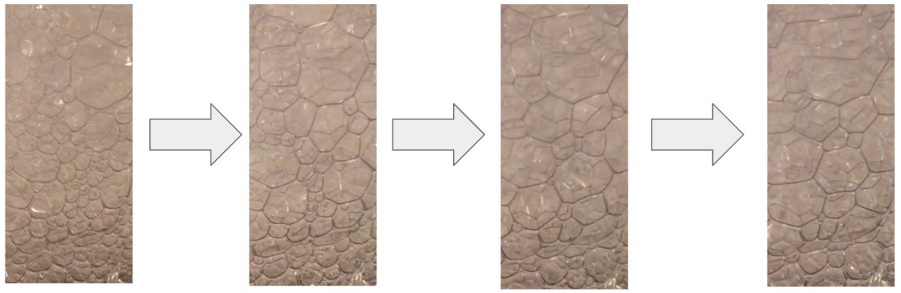
Procedure
1. Mix the plaster and water as described in previous experiments.
2. Pour plaster into one mold without any additives. This will be the reference sample.
3. Along with plaster, add cut staples or thread to the mold. These can be in random orientation or aligned.
4. The next sample should be made with pieces of paper mixed into the plaster. Again, feel free to alter the orientation and application.
5. The last sample can be any combination of materials of your choosing. Try to apply what we've learned to create a strong or weak composite.

Evaluation
- Test the samples fracture behavior as outlined in the mechanical properties sheet.
- How do the properties of the composite materials compare to the reference mold? Why is this?
- How did your personalized composite sample perform? And why?
- What other processing methods can we apply to improve the strength of these molds?

Note: Samples should be prepared a day or two beforehand to ensure adequate drying.

Fig 3 above. Day 4 of weeklong processing outreach project highlighting composite strengthening

Fig 2 below. Interface behavior experiment using soap bubbles to highlight surface tension and grain growth



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