Neckerchief Composite Materials – STEM Activity

Learning Objective:

Overview of Composite Materials and Composite Materials merit badge. Careers in Composite Materials

Activity Overview:

Scouts will make a Neckerchief slide by molding using a two part epoxy resin material.

Assumptions: Groups of 10, 4 groups per hour, 4 hours per day, 4 days of operation, total 640 participants.

Equipment Requirements:

Safety:

(10) Safety Glasses

(20) Gloves per Group of 10 (not latex for chemical)

(1) Large Fan

Education:

Posters

Flash Cards

Handouts

Activity:

2 Gallon Oomoo 25 Moulding Casting Rubber compound or equivalent. 75 minute cure time ~$155/ Gallon

5 Gallons Smooth Cast 325 Liquid Plastic 2 Part epoxy resin ~$85 per gallon

700 (10 oz) Plastic Mixing cups

1000 popsicle sticks

1400 (4 or 6oz) clear plastic cups

88 feet of 12 Gauge wire cut in 1.5 in strips for back of slide

10 Sheets of 18” by 24” corrugated plastic sheets for master molds

5 utility knives for trimming

100 extra utility blades

60 Feet of 3/4” plastic PVC Pipe cut to 1inch sections for backing

100 pencils for or dowels for setting

700 Hair bands

100 sheets 100 grit sandpaper cut in 8 pieces

Supporting:

(4) 8 foot tables

Large Trash can

1 20 by 20 cover or 2

Preparation:

Station 1 needs to have adequate gloves and glasses. Should have twenty small cups with premeasured mold chemical, popsicle sticks and mold containers at the ready. Mold Release and sufficient master materials.

Station 2 needs to have Twenty small cups with premeasured chemicals for the resin, popsicle sticks, wire backs and pipe jigs.

Flow:

1) Scouts gather in a group 10 to 12 (work in buddy pairs). Start by moving to the Molding area.
    a. Give Safety briefing and hand out gloves and glasses.
    b. Explain that we are going to be making a neckerchief slide that they can take with them and learning about Composite Materials today. Ask them if they know what that is and see what answers you get. We will be teaching more later.
    c. Explain that the Molds take a long time to cure so we will be making molds for tomorrow and that they will use molds made previously.
    d. Explain about the two chemicals used to make the rubber mold and how they will react to form a master mold.
        a. The most common silicone compounds used for mold making are RTV or "Room Temperature Vulcanizing" silicones which are mixed in two parts (a base and a catalyst) to induce curing.
        b. There are two main classes of RTV silicones: 1. Tin catalyzed or "condensation cure" silicones and 2. Platinum catalyzed or "addition cure" silicones. Each has its benefits and drawbacks. Silicones in the first group are the less expensive and easier to use. They are typically of low viscosity (easily poured) and are not inhibited by many materials. In contrast, platinum cure silicones (often called elastomers) are inhibited by many naturally occuring compounds, especially sulfur, tin, and amines.
        e. Coat part with mold release material.
        f. Have teams of four scouts mix and pour a mold.

2) Scouts move to station two after it clears from the previous group clears.
    a. Give safety talk
    b. Explain the two part Epoxy Resin
        i. *Sometimes referred to as liquid plastic, two-part casting resin begins in a liquid state and, after mixing, hardens to a solid finish. Unlike resins that require a catalyst to harden, two-part casting resin involves mixing equal amounts of resin and an accompanying hardener. After being poured into a specialized mold, the resin undergoes a chemical reaction that causes it to cure to a hardened state. This curing process creates a finished, hardened object that is an exact replica of the mold in which it was cast.*
        ii. ***Explain thermosetting polymer***

Prepolymer in a soft solid or viscous state that changes irreversibly into an infusible, insoluble polymer network by curing.
Note 1: Curing can be induced by the action of heat or suitable radiation, or both. Note 2: A cured thermosetting polymer is called a thermoset. 2004, 76, 898 IUPAC Compendium of Chemical Terminology 2007

Explain the Curing Process

The curing process transforms the resin into a plastic or rubber by a cross-linking process. Energy and/or catalysts are added that cause the molecular chains to react at chemically active sites (unsaturated or epoxy sites, for example), linking into a rigid, 3-D structure. The cross-linking process forms a molecule with a larger molecular weight, resulting in a material with a higher melting point. During the reaction, the molecular weight has increased to a point so that the melting point is higher than the surrounding ambient temperature, the material forms into a solid material.

Explain the difference between Thermoset and Thermoplasitc

Thermoset materials are generally stronger than thermoplastic materials due to this three dimensional network of bonds (cross-linking), and are also better suited to high-temperature applications up to the decomposition temperature. However, they are more brittle. Many thermosetting polymers are difficult to recycle.

Uncontrolled reheating of the material results in reaching the decomposition temperature before the melting point is obtained. Therefore, a thermoset material cannot be melted and re-shaped after it is cured. This implies that thermosets cannot be recycled, except as filler material

c. Have each pair of scouts select a mold for each of them (note we should probably have about 25 good molds at any given time).
d. Have scouts combine pre-measured chemicals.
e. Pour mold, insert wire and support with pipe jig.

3) Move scouts to a second station to talk about composite materials while the molds cure (10 to 15 minutes).
    a. See Education documentation.
4) De-mold and trim
    a. Have a staff member move the finished molds to a de-mold station.
    b. Have the scouts carefully de-mold their slide.

c. Allow them to trim the slide
d. If we have a roll on paint, allow them to roll the paint over their neckerchief to achieve a white color on the letters.
e. Have them clean up.
f. Return molds to station 2
g. Hand out Composite MB info
h. Thank them and move on.