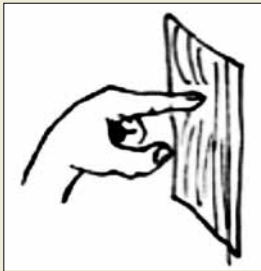


# Super Materials: Carbon fibers

Components made of carbon fibers are present in our everyday life these days, but most students don't know what they really are. In this activity we demonstrate what a carbon fiber part is made of, and how it can be used to build strong but very light materials. Showing carbon fibers (without the resin) is a first step. Since fibers cannot be shaped without a matrix to hold the shape, epoxy resin and molds are then introduced. To avoid the toxicity of the epoxy resin in class, substitute waxed cotton cords and PVA glue for the fibers and resin. Have the students make two sets of samples on sheets of newspaper, one with the cords lying parallel on the sheet and another with the cords woven. Students should then spread glue (use a lot to cover the entire surface) on the cords.



Use a hair dryer to harden the glue and perform two "mechanical tests." In the first, ask two students to test the 'composite' with only parallel cords. As them to hold one opposite sides of a sheet and pull in the direction of the cotton cords (parallel to the cord). It will hardly break because of the strength of the cords. Ask them to pull perpendicular to the cord, and it will easily break apart. After, ask other two students to test the sheet with cords woven using the same procedure. They will behave similar in any direction. Last, ask them to pull a newspaper sheet by itself and see that it tears apart easily.

In the other "mechanical test", ask one student to hold the sheets with his/her hands, and another student to push in the middle with a finger until it breaks. Do this with both parallel and woven cords. Also ask them to do with with the newspaper sheet.

Ask which one is stronger. The woven one should withstand more force, and that's how carbon fibers (and other materials such as Kevlar and glass) are typically applied – as reinforcements of epoxy resins and other polymeric matrices

While still playing with carbon fiber concepts, you can show how important materials are for safety. Bring two small watermelons, a tall plastic box (it may be the same one used for the mug drop experiment), and a bike helmet made of carbon fiber (these are not so expensive anymore, and costs around \$20). Show the woven fibers visible in the helmet. Use a ladder next to the box and throw a watermelon with a helmet inside the box. The helmet protects the fruit, which does not break. Then, from the same height throw a watermelon by itself and watch it break. Of course the students can eat it later. It is a good idea to have a plastic covering the bottom of the box to make cleaning easy.

**What do they learn?** Carbon fibers, waxed cotton string, PVA glue, newspaper, carbon fiber-reinforced bike helmet, two small watermelons, plastic storage container approximately 23 × 16 × 12 inches, thin plastic cover (such as those we use for painting) that covers the whole container base, ladder, hair dryer.

**What do they learn?** Carbon-fiber materials are not only fibers but need a vehicle to shape them. The final property of this so-called composite is a mixture of the matrix and the fibers, and also of the design of the fibers. These principals can be applied to design all sorts of materials technologies, including ones that promote safety.

