NanoDays
The Biggest Event for the Smallest Science!

Exploring Properties—UV Bracelets

Try this!

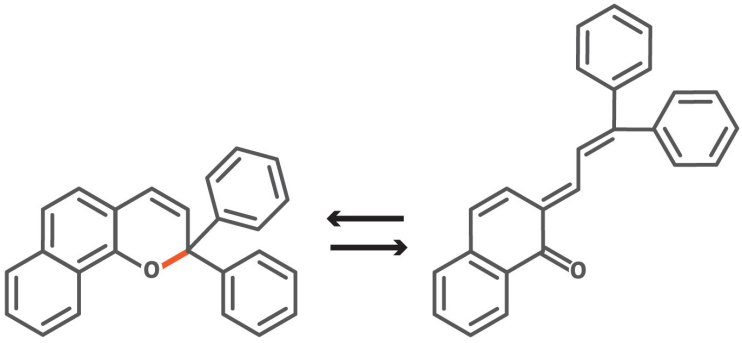
1. Thread three UV beads onto a pipe cleaner.
2. Thread additional ordinary beads onto the pipe cleaner.
3. Wrap the pipe cleaner around your wrist and twist the ends to tie it.
4. Shine the UV flashlight on the beads. What happens?

What's going on?

The ultraviolet (UV) beads change color, but the regular beads stay the same. The UV beads contain a special material called a *photochromic* dye. ("Photo" means "light" and "chromic" means "color.") The molecules of this special dye change color when exposed to ultraviolet light. The beads will change color when exposed to any UV light source, such as the sun or a special UV flashlight.

The UV light causes a bond in the molecule of the dye to break, allowing the molecule to twist into a new shape. The newly-shaped molecule absorbs light differently, giving it a different color.

This process is reversible. Once the source of UV light is removed, the broken bond will reform and the bead will return to its original color. So when you turn off the flashlight (or come out of the sun), the UV beads turn white again. You can test this by turning off the flashlight (or coming out of the sun).



Ultraviolet light causes a molecule to change shape

How is this nano?

The way a material behaves on the macroscale is affected by its structure on the nanoscale. Changes to a material's molecular structure are too small to see directly, but we can sometimes observe corresponding changes in a material's properties. The UV beads in this activity change color as a result of nanoscale shifts in the shape of the dye molecules.

Some eyeglass lenses darken in sunlight

Nanotechnology takes advantage of special properties at the nanoscale to create new materials and devices. The most common uses of photochromic dyes are in eyeglass lenses. Some people have glasses that are clear indoors but darken into sunglasses when exposed to UV light outdoors. There are also new windows that use a similar technology to keep buildings cool and save energy.

Learning objectives

1. The way a material behaves on the macroscale is affected by its structure on the nanoscale.
2. The UV beads in this activity change color as a result of nanoscale shifts in the shape of their molecules.

Materials

- Pipe cleaners
- UV beads
- Ordinary pony beads
- UV flashlight

UV beads are available from www.teachersource.com (#UV-AST).

UV flashlights are available from www.homedepot.com (#809-2717-D).

Notes to the presenter

SAFETY: The ends of the pipe cleaners can be sharp. Use caution while handling them.

SAFETY: The UV flashlight emits very low levels of UV radiation. It is safe to use, but you should discourage visitors from looking directly at the UV bulbs when the light is on. Supervise visitors at all times during this activity.

This activity should be done in a location out of direct sunlight so the UV beads will be white or very pale when visitors start the activity (not brightly-colored). If you prefer not to use the UV flashlight, you may be able to do the activity near a window, using sunlight to expose the beads to UV light. After the UV beads change color, they will slowly return to white once the ultraviolet light source is removed.

Children, individuals with limited dexterity, and low-vision visitors may need assistance threading the beads onto the pipe cleaners.

Additional information on the photochromic dye: The UV beads contain *naphthopyran* dye molecules. The energy from the UV flashlight breaks a bond in these molecules, changing their shape. The bond that breaks is indicated in orange in the illustration on the front side of the guide. This same process occurs for all colors of beads (though the exact composition of the dye molecule is different for each color).

Related educational resources

The NISE Network online catalog (www.nisenet.org/catalog) contains additional resources to introduce visitors to nanostructures and nanomaterials:

- Public programs include *Aerogel, Biomimicry: Synthetic Gecko Tape Through Nanomolding, Nanoparticle Stained Glass, Nanosilver—Breakthrough or Biohazard?* and *World of Carbon Nanotubes*.
- NanoDays activities include *Exploring Materials—Ferrofluid, Exploring Materials—Thin Films,* and *Exploring Structures—Buckyballs.*
- Exhibits include *Bump and Roll, Changing Colors,* and *Unexpected Properties.*

Credits and rights

This activity was adapted from "Reversible Sunglasses" developed by The Franklin Institute, in partnership with Penn State MRSEC and the Cornell Center for Materials Research, through funding by the National Science Foundation and Penn State University. The original activity is available at www.mrsec.psu.edu/education/museum_shows/small_wonders/

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