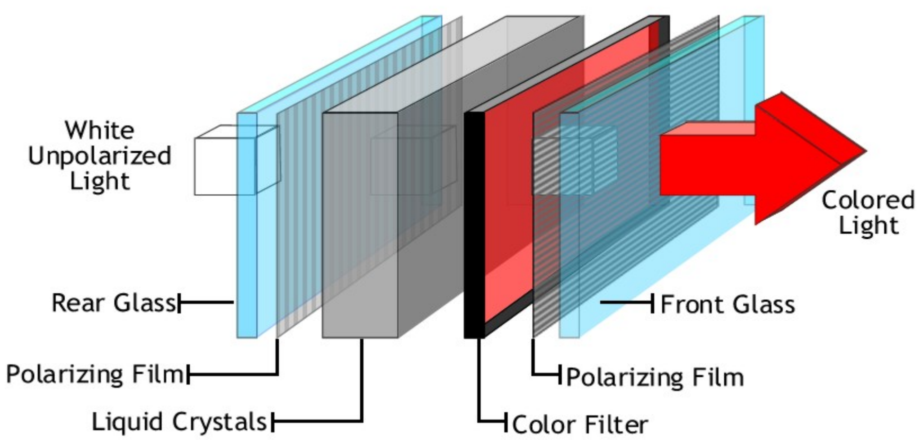
Preparation of a Liquid Crystal Pixel

This procedure for a liquid crystal pixel is modified by George Lisensky and the Materials Research Science and Engineering Center (MRSEC) at the University of Wisconsin-Madison from Farrell Rogers from E. R. Waclawik, M. J. Ford, P. S. Hale, J. G. Shapter, and N. H. Voelcker, "Liquid Crystal Displays: Fabrication and Measurment of a Twisted Nematic Liquid-Crystal Cell," *J. Chem. Educ.*, **81**, 854 (2004) and C. Liberko and J. Shearer, "Preparation of a Surface-Oriented Liquid Crystal," *J. Chem. Educ.*, **77**, 1204 (2000). Additional information and procedures added by David A. Katz, Department of Chemistry, Pima Community College

Click on this link to go to the entire Video Lab Manual of experiments for Nanoscale Science and Technology at MRSEC. http://mrsec.wisc.edu/Edetc/nanolab/index.html

In this experiment a liquid crystal is oriented between two polarizing filters. The transparency changes when a voltage is applied. This is similar to the process that occurs in an LCD display or TV. Light, front behind the display pixel is passed through a polarizing filter. A layer of liquid crystal material, which is colorless under normal conditions, is subjected to a small voltage which causes the liquid crystal material to twist, resulting in a change of the orientation of the polarized light passing through the layer. When that light passes through a second polarizing filter on the front of the pixel, only a portion of the light spectrum is observed, producing a specific color.



Materials Needed

Polyvinyl alcohol, MW 100,000. (This will be available as either a powder or as a 4% aqueous solution.)
4’-pentyl-4-biphenyl-carbonitrile (Aldrich 32,851-0)
Petri dish, glass
Hotplate
Glass stirring rod
Conductive Glass, 2 pieces, 1" x 1" x 2.3mm TEC 15 glass (Available from Hartford Glass Co, 735 E Water Street, Hartford City, IN 47348 Phone: 765-348-1282)
Cotton cloth

Tissue (Kim Wipe or equivalent)
Plastic wrap
Scissors
Binder clips
Capillary tubes
Polarizing filters, 2, 1” x 1”
Aligator clips
9V battery snap with leads
9V Battery

Safety Precautions

Wear approved eye protection at all times in the laboratory.

Liquid crystal materials may cause irritations to skin or eyes. In the event of contact, rinse well with fresh water..

Disposal

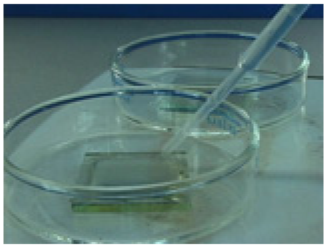
Dispose of all materials in the proper waste containers.

Procedure

If a polyvinyl alcohol solution is supplied, skip this step.

Prepare a 10 mL of a polyvinyl alcohol solution:

Weigh 0.4 g of the polyvinyl alcohol and place it in a 50 mL beaker or a petri dish.
Add 10 mL distilled water. Stir.
Heat thebeaker, or petri dish, and its contents on a hot plate until a clear solution is obtained. DO NOT BOIL the solution.
Allow the solution to cool before use.



Place the conductive glass, conductive side UP, in a petri dish on a hot plate.

Add polyvinyl alcohol solution, dropwise, onto the surface of the glass square, so it is covered with the solution.

Turn on the hotplate to evaporate the polyvinyl alcohol solution, leaving a polyvinyl alcohol film on the conducting side of the piece of FTO glass.

Prepare two pieces.

Gently rub the PVA layer on each piece of glass with a cotton cloth. **Rub in one direction only.**

Note the direction of how you wiped the glass on each piece.

One edge of the glass must be free of PVA. Wipe about 2 to 3 mm of the PVA film off the edge by wiping with a damp tissue.

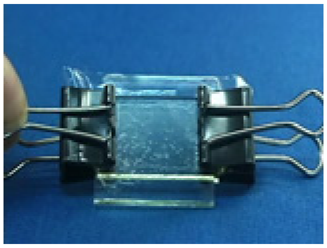
The stroke orientation for the second piece should be perpendicular to that of the first piece. So rotate the second piece of glass 90° before wiping the PVA off the edge.

The two pieces of glass should be coated with PVA except at one edge.

Cut two strips of plastic wrap, approximately 1 ½" by ½".

The plastic wrap will be used as a spacer. Cover approximately ¼" (5-6 mm) of each PVA coated side of one glass plate with the plastic wrap.

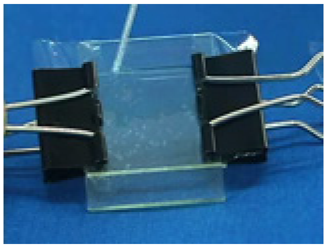
Place the second piece of glass, offset on top of the first, with PVA on the inside, The uncoated edges extending beyond the sandwich to allow an electrical connection to each glass piece.



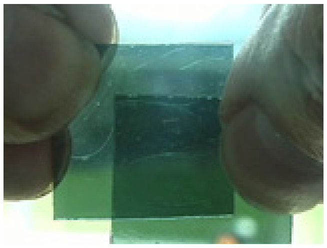
Clamp the glass squares together using binder clips.

Use capillary action to transfer the 4'-pentyl-4-biphenyl-carbonitrile liquid crystal into a capillary tube.

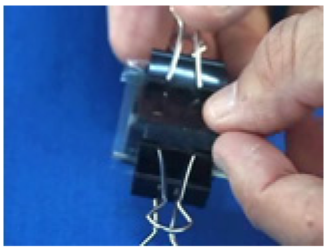
(The 4'-pentyl-4-biphenyl-carbonitrile liquid crystal material may be in a small bottle or a labeled glass vial.)



Transfer liquid crystal from the capillary tube to the space between the glass plates. (You may have to do this several times to get the liquid crystal material to fill the space between the two glass plates.)



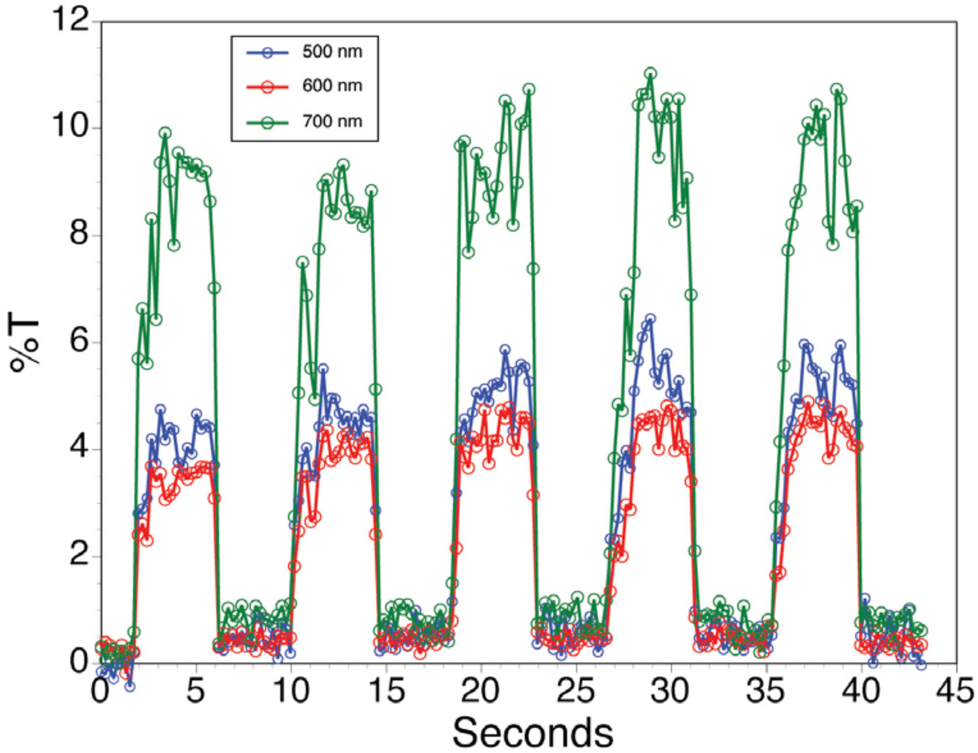
Obtain two polarizing filters. Crossed polarizers do not transmit light.



Add crossed polarizers, one on each side, slipping them under the binder clips.

Cycle the pixel on and off by connecting and disconnecting a 9V battery.

To do this, snap one end of the battery clip onto the 9-volt battery. Rotate the second snap to touch, then move away from the second battery pole.



Graph of %transmittance as a function of time when the voltage is cycled on and off. The colors represent the wavelengths of the transmitted light. These are the three colors of the pixels in an LCD color display.

Questions

1. Describe the behavior of the liquid crystal pixel when the voltage is switched on and off.

2. What colors do you observe? Do other groups have the same color effect?