



*Drexel-SDP GK-12 ACTIVITY*

## Activity Template

**Subject Area(s)** Physical Science, Science and Technology

**Associated Unit** Nanotechnology

**Associated Lesson**

**Activity Title** Privacy Glass

**Grade Level** 11 (10-12)

**Activity Dependency**

**Time Required** 1 Hour

**Group Size** 1

### Summary

In this activity students fabricate polymer dispersed liquid crystal (PDLC) samples, sometimes known as privacy glass. The students first study the physical properties of liquid crystals and polymers. After learning the background, students apply their knowledge by fabricating PDLCs. Once the samples are made, the students characterize the samples by observing their optical and electro-optic properties.

### Engineering Connection

Electro-optic materials are a large area of investigation in electrical engineering and materials engineering. Specifically, liquid crystals are used in display technologies and their properties must be well understood to apply them in engineering applications. Polymers are also frequently combined with liquid crystals in engineering applications as an optical and structural material.

### Keywords

electro-optics, liquid crystal, light, polymer, privacy glass

### Educational Standards

- Science: 3.2B, 3.2C, 3.4, 3.7
- Math: 2.3

## Learning Objectives

After this lesson, students should be able to:

- Use a multimeter to measure resistance of a material
- Fabricate a PDLC device
- Describe the inner workings of a PDLC
- Use a power supply to find the switching voltage of a PDLC

## Materials List

Each group needs:

- 1 drop of polymer liquid crystal mixture
- 2 ITO coated glass squares
- 2 binder clips
- Gloves

To share with the entire class:

- Black light
- Variable AC power supply

## Introduction / Motivation

Liquid crystals are an important state of matter, especially because of its electro-optic properties. The liquid crystal state is a state of matter between liquids and solids. Liquid crystals flow like liquids but also have some structural organization like solids. This structural organization leads to unique optical properties that have allowed liquid crystals to be used in everything from thermometers to high definition televisions. Today we are going to make one of the lesser known optical devices that utilize liquid crystals. This device is known as polymer dispersed liquid crystal, or PDLC. PDLCs are devices which are able to change from a foggy, opaque state, to a transparent state when voltage is applied.

## Vocabulary / Definitions

Word	Definition
Electro-optics	Field of technology dealing with materials whose optical properties change under an electric field.
Liquid Crystal	State of matter which flows like a liquid but has some structured orientation like solids.
Polymer	A large molecule composed of many smaller molecules (monomers).
Refractive Index	A material property which describes the speed that light propagates through the material.

## Procedure

### Before the Activity

- Make the monomers and liquid crystal mixture. The mixture should be made 70% liquid crystal and 30% monomers. ~5-10 $\mu$ m spacers should be added.
- Cut the glass into 1" squares.
- Set up the black light

### With the Students

1. Use the PowerPoint presentation to introduce the new concepts. Try to connect the new ideas to concepts the students are already familiar with. For example, the students have seen scattering from small particles in clouds and foggy glass.
2. Give the students the instructions for making the PDLC samples. First, they must use the multimeter to find which side of the glass is coated with ITO. Then they will put a small drop of the liquid crystal polymer mixture on the ITO side of one glass slide. [Make sure the students offset the glass slides so that there is room for alligator clips to be attached in later steps.] The students must then place the second glass slide on top of the first with its ITO side down. Next, the students will put two binder clips on opposite edges of the glass to ensure an even thickness. Finally, the sample should be placed under the black light for ten minutes to cure the polymer.
3. Once the students have made their PDLC samples, they should test the switching properties of them. Ask them to find at what voltage the sample becomes transparent. Ask if the transition is gradual or sudden at the switching voltage?

### **Attachments**

PDLC\_Presentation.pdf

### **Safety Issues**

- Gloves and goggles should be worn; the monomer mixture can be irritating to the skin and eyes.

### **Assessment**

#### **Pre-Activity Assessment**

*Discussion:* The introduction and discussion will allow you to see how much the students previously know about liquid crystals, polymers, and scattering.

#### **Activity Embedded Assessment**

*PDLC Sample and Switching Voltage:* The students' PDLC sample and the record of their switching voltage can be used to see if the students followed directions properly.

#### **Post-Activity Assessment**

*Lab Report:* A full lab report will fully show the students' understanding after the activity.

### **Owner**

Drexel University GK-12 Program

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