EXPERIMENT 3

Photography and Sunscreens

INTRODUCTION

The chemical processes for photographic image processing have been known since the mid-19th century, with various modifications in recent years to improve methods for amateurs. In the cyanotype process, paper is sensitized with ferric ammonium citrate and potassium ferricyanide. Exposure to ultraviolet light causes some reduction of the ferric (Fe^{3+}) salts to ferrous (Fe^{2+}), and the blue image is produced by the formation of a ferric ferrocyanide (also known as Prussian Blue). Further oxidation with a stronger oxidant, such as hydrogen peroxide, produces a deeper blue (almost black) image. Washing in alkaline solution, such as ammonium hydroxide, results in some loss of the color (the pigment dissolves in the solution and so washes out of the paper permanently).

You can experiment with washing the exposed paper in ammonium hydroxide and hydrogen peroxide solutions to alter the color and pigment density in your photograph. It is possible to work with this photographic material in subdued light, so avoid direct sunlight and fluorescent lights in the lab. Fluorescent lights have sufficient emission in the near ultraviolet region of the spectrum to catalyze the chemical changes that take place in formation of the image on paper. Keep in mind that ultraviolet light catalyzes this reaction, whereas visible light does not. What is the difference between ultraviolet and visible light that may account for this difference in catalysis?

There will be negatives available in the lab to use for printing an image on the paper, but you may bring your own creations to make images. These include black and white negatives, drawings with black marker on acetate sheets, or placing solid objects (keys, rings, etc) that will produce negative images on the paper. You may also cut out images in paper and place this cutout on top of the chemically treated paper for printing the image. What color will the cut out portion be in the final photo? What color will the remaining paper portion (blocking the light) be in the final photo? Be inventive!

You will also test commercial sunscreens for their ability to block uv light by spreading

some sunscreen on a piece of clear acetate, placing this over the treated paper and exposing it to uv light. You should find that the sunscreen will block out the uv rays and result in less exposure of the chemicals on the treated paper, giving a lighter image where the sunscreen has been applied, relative to the areas where there is only lotion and no sunscreen.

Note: Turn off the fluorescent lights in the lab and keep the chemicals and paper away from the light coming through the windows. Subdued light coming through the windows should not interfere with the process.

MATERIALS NEEDED

Artists paper (high quality with smooth finish), ferric ammonium citrate solution (20 g/100 mL), potassium ferricyanide solution (8 g/100 mL), hydrogen peroxide solution (3%), ammonium hydroxide solution (0.5 M), trays for H_2O_2 and NH_4OH solutions, 150 mL beaker, paint brush, blow drier, negatives or objects to produce an image on the photographic paper, clear acetate sheets, samples of skin lotion with and without sunscreen, and ultraviolet light box for exposure. Note: Direct sunlight can be used to expose the photographic paper and produce an image.

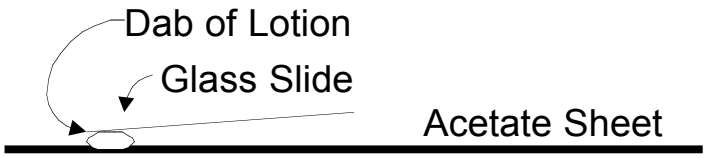
PROCEDURE

Mix equal amounts of ferric ammonium citrate solution (10 mL) and potassium ferricyanide solution (10 mL) in a 150 mL beaker. Paint or spread this solution as evenly as possible on 2 pieces of the drawing paper (this is just a high quality art paper). The solution must be spread evenly to get a good quality print. Please wash out the paint brush when you have finished. Dry the paper with the blow dryers. **Make sure the treated paper is completely dry before placing the negative on it or you will permanently destroy the negative with the chemicals in the solution**.

Place a negative with glossy side up on top of one piece of the **completely dry** treated paper and place it under glass in the light box for uv light exposure. While the negative and paper are being exposed to UV light for 6 to 8 minutes, you can treat a sheet of clear acetate with different types of lotion containing sunscreen with different sun protection factors (SPF) or

lotion without sunscreen. Apply the different products as a thin film in a straight line on the acetate sheet and indicate which product has been applied in each area. A glass slide or flat piece of plastic may be used to spread the lotion (see below). Alternatively, you may want to write the name of the product on the acetate using the product itself. Place the acetate sheet with lotion samples on the second piece of **completely dry** treated paper. Avoid getting lotion on the photographic paper or it will leave permanent stains. Allow 6 to 8 minutes light exposure in the box.

CAUTION: Do not get lotion on paper or the glass used to cover the negatives. Do not look at the uv lights. Why?



Remove the paper from the light box. **Handle the negative with care and return it to its protective envelope.** Wash the paper in a tub with running tap water for about 5 minutes. This should give a good permanent image.

If you want a darker image (dark blue - Prussian Blue) rinse the photo in a dilute hydrogen peroxide solution (3% hydrogen peroxide from a pharmacy is suitable) just briefly (10 seconds), then rinse again in the running tap water.

If you want a lighter image (much of the color will be washed out), place the photo in dilute ammonium hydroxide solution for a few seconds, then rinse well with running tap water. You can place the paper in the hydrogen peroxide solution very briefly (a few seconds) after the ammonium hydroxide rinse, and rinse well with running tap water. This will produce an image that is nearly black and white in tones.

Questions to answer in your notebook:

1. Using information from experiments 1 and 2, and discussions in the text regarding uv light, summarize what is happening to produce the photographic image you made on the paper, in terms of the catalyst that caused the chemical reaction to take place and the chemicals used for the reaction.

2. Why is it possible to work with this photographic process in subdued room light, whereas

most photographic processes must be done in a dark room, with no light or a special colored light. (You may want to refer back to experiments 1 and 2 to answer this question)? You may want to find more information on photographic processes in general, or the cyanotype process in particular.

3. Did you find that this photographic paper makes a good medium for testing sunscreens? Would you expect commercial photographic paper, which must be used in a darkroom, to work as well for testing sunscreens? Explain.

4.* Chapter 2 of the textbook describes the formation and destruction of ozone catalyzed by ultraviolet light. These uv light catalyzed processes in the upper atmosphere protect us from the damage that can be done by high energy uv radiation, yet they do not block out the visible radiation coming to us from the sun. Similarly, the photographic process in this experiment requires uv radiation, but is not affected by visible light. Briefly describe why it is important that the ozone layer protect us from harmful uv radiation, indicating why uv radiation causes damage to humans and other living things, and why visible or infrared light does not have the same damaging effect. You should also try to integrate the results of the sunscreen tests in this experiment into your answer for this question.