

Experiment Title: “Thin Films”

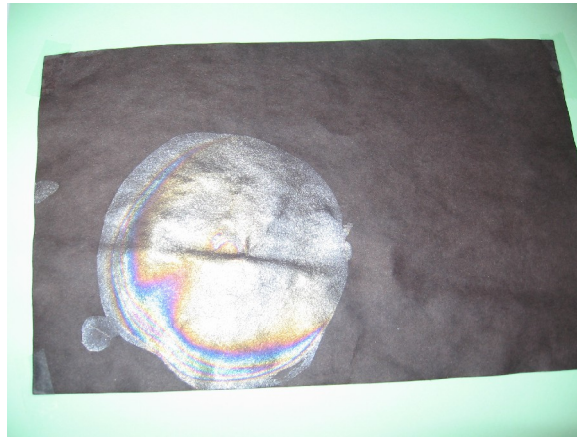
Purpose: To investigate thin films.

Background/Literature:

Can we make a nanoscale thin film? Can we estimate how many atoms thick it is? We learned that as a rough estimate, 1 cubic centimeter of any solid material is about 10^{24} atoms. There are at most 10 atoms in a line 1 nanometer long. A human hair is about 75,000 nanometers in diameter.

Procedure:

Fill a tray with water. Cut some sheets of black construction paper. Drip a small drop of clear fingernail polish on the surface of the water. Estimate the size of the drop. Watch the polish spread instantly to a thin covering on the surface of the water. Slide a sheet of black construction paper underneath. Slowly lift the construction paper to catch the film. Let it dry. Measure the size of the film area.



Results:

Estimated size of nail polish drop: 8 cubic millimeters.

Estimated number of atoms:

$$\text{Number of Atoms} = 8 \text{ mm}^3 \times 10^{21} \text{ atoms/mm}^3 = 8 \times 10^{21} \text{ atoms.}$$

Slick area is a circle about 100 mm in diameter.

$$\text{Area of film} = \pi \times (50 \text{ mm})^2 = 7854 \text{ mm}^2$$

$$\text{Thickness of film} = 8 \text{ mm}^3 / 7854 \text{ mm}^2 = 0.001 \text{ mm} = 1 \text{ micrometer} = 1000 \text{ nanometers}$$

Number of atoms thick is about 10,000 atoms

Conclusions:

We were able to make a thin film using finger nail polish. This thin film is not a nanoscale coating since it is more than 100 nanometers thick. Rainbow colors are in the thin film. These indicate differences in the film thickness because of constructive and destructive interference of visible light. These differences are nanoscale since the wavelength of visible light is several hundred nanometers.