Radiant Light Film, Dichroic Materials and Thin Film Interference

Radiant light film is an eye-catching material – its interaction with light and its structure raises interesting questions. As the angle of incident light varies, there is a change in the transmitted color – from blue to magenta to gold depending on the viewing angle. This is a polymer film with no metal whatsoever – the colors in the film are not produced by pigments but by interference patterns of light passing through the film. The film is composed of hundreds of layers of polymer films with different refractive indexes. The interface between each of these layers refracts a small amount of light – when these many reflections exit the film constructive interference of the light waves results in different wavelengths or colors of light.

Another example of photonic crystal thin film optics is dichroic glass. Many thin layers of different metals are deposited on glass – the resulting crystal structure transmits and reflects different colors of light.

The rainbow of colors seen in a sheen of oil floating in a puddle of water is a product of the constructive interference of light resulting from a thin film of oil. The thickness of the film and the angle of light striking the film control the color of light produced.

Activity: Iridescence from a Polymer Film and Dichroic Glass

Materials

Radiant light film (available on inventables.com)
White and black paper
A light source (lamp or flashlight)
Dichroic glass

Procedure

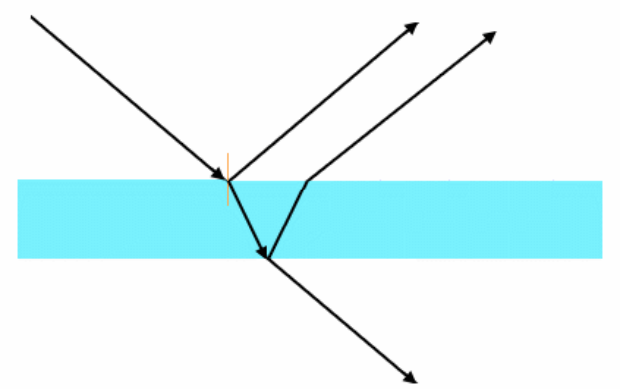
Radiant light film and dichroic glass

Place the radiant light film on a white sheet of paper - tilt it at different angles and observe the different colors. Now place against black background and tilt – is there a difference in its appearance?

Crumple the surface. Are there more colors?
Fold a piece over, creating two layers. If you sandwich the layers flat against each other and repeat the experiments does anything change?
Now hold the folded over piece so that there is some space between the layers (put a finger or two between the layers) and shine light in the middle. Can you produce green or other colors you couldn't produce when the material was just one layer?
Dichroic glass: tilt the glass at different angles and note the color changes!

Thin film constructive light interference
Place a sheet of black construction paper in a basin of water. Place a small drop of clear nail polish on the waters surface. Allow the nail polish to "dry" (solvents are evaporating) and carefully scoop off the thin film. Place on some newspaper and allow to dry.

Discussion
Why did the crumpled surface of radiant light film have multiple colors?
Why did the radiant film change appearance depending on the background?
What is the process responsible for the different colors we see from these three materials?



Standards
Investigation and experimentation
Physics grade 9-12 4f "properties of waves"

Resources

Buy a sample of radiant light film/acrylic:
https://www.inventables.com/technologies/radiant-acrylic--2
https://www.inventables.com/technologies/radiant-light-film?selected_variety_id=272

"Make permanent rainbows" thin films activity: a great resource with "Thin film color calculator" http://sci-toys.com/scitoys/scitoys/light/permanent_rainbows/permanent_rainbows.html