

MODERN OPTICS

PROJECT HOLOGRAPHY

Introduction

Galileo (1564-1642) attempted to measure the speed of light but concluded that its speed was infinite. Sir Isaac Newton (1642-1727) succeeded in splitting white light into the various colors of the spectrum with a prism. Dr. Thomas Young (1773-1829) established that light travels in a wave motion not unlike waves in the sea. In 1882 the speed of light was established to be 299,778 km/sec. Neils Bohr discovered in 1913 that electrons could be raised to a higher energy level by exposure to energy sources, which helped bring about the reality of laser.

In 1947 the Hungarian-born scientist Dennis Gabor first published the theory of holography. He made the first hologram in 1948 using a mercury lamp. The blurry, dim images roused little interest in the invention. In 1960 the first laser was built and interest in holography was rekindled by the advent of the laser. In 1971, twenty-three years after his discovery of the principle of holography, Gabor received the Nobel Prize in physics.

Equipment List:

1. Helium Neon Laser (rated about 25 mW power)
2. beam stops
3. mirrors
4. diverging lenses
5. photographic plate (treated with emulsion sensitive to red color)
6. plate holder
7. object (bright, reflective objects or translucent work best)
8. vibration free optical bench
9. darkroom equipped with green safety light, clock, etc.
10. developing chemicals
(the chemicals are stored in labeled jars):
 - solution A, solution B, bleach, photoflo
 - distilled water

Safety Precautions:

- 1) **NEVER LOOK DIRECTLY INTO THE LASER LIGHT.** It can be harmful to the retina. Also never insert mirrors or any reflectors into the beam after the laser is turned on. Stray reflections can enter someone's eyes. Safety glasses are available on the table.
- 2) Make sure **all** the lights (except the green safety light) are turned off before photographic plate is taken out of its box. It will take a few minutes before your eyes get used to the dark and you can actually start seeing things under the green light. Be sure to close the lid of the box tightly and put it away before proceeding.
- 3) Be careful to avoid vibrations while exposing. In other words, try not to bump anything!
- 4) Be aware of potential hazards of chemicals used for developing. Use rubber gloves or tongs and do not directly touch the chemicals.
- 5) During developing, make sure you do not splash water on to other chemicals.

Set-Up And Exposure

- 1) The laser is mounted on adjustable lab jacks. The mirror is set so that it reflects the laser beam onto the diverging lens. The diverged beam falls on the object* and then onto where the plate will be mounted. (The beam should strike the plate at an angle.) A used plate can be placed to ensure the exact position of the plate. Use a beam stop to block the laser light, once all the components are aligned.
- 2) The unexposed plate should never be taken out of the package or exposed to normal light.
- 3) Do a “dry run” with only the green safelight on, so you know exactly what to do.
- 4) Place the photographic plate on the holder with the emulsion side facing the object. (The emulsion side is sticky when a wet finger is placed on one corner; or if you put your lips to it!)
- 5) Wait for vibrations to die down for a few minutes.
- 6) Remove the beam stop (shutter) and count to 4 (or 5) seconds** and replace the stop. Now the plate has been exposed for 4 (or 5) seconds.
- 7) Remove the exposed plate and follow developing procedures.

* *Positioning the object needs planning and careful thinking.*

** *Exposure time has to be adjusted depending on laser power, quality of object, and the kind of hologram you are making.*

Developing Procedure

- 1) Mix equal parts of solution A and B in a glass tray just before developing. (This mixture will have a lifetime of 8 hours.)
- 2) Develop in the above solution for 2 minutes. Keep the emulsion side of the plate up, so it doesn't scrape on the bottom of the container.
- 3) Remove the plate and wash in running water 3 minutes.
- 4) Bleach until hologram is transparent (less than a minute).
- 5) Soak in photoflo solution for 3 minutes.
- 6) Hang up vertically to dry (stand it up against something) for about 20 minutes.
- 7) Place a little sticker at the bottom right hand corner of the holoplate with your initials on it.
- 8) Cover all the trays containing chemicals with foil or parafilm. Clean up after yourself.

Goal for this Project

The optics should be nearly set up for you. Try to make at least one good hologram during the time you have. If your first hologram is not successful, try again, adjusting exposure time, developing time, or whatever you think might be useful.

Report

Sketch the optics arrangement, label components, (lenses, laser, plate, object, etc.) and write down your exposure time and a brief summary on the quality of your hologram (and any other observations).

Your report is due at our next class—Tuesday April 5.