

Experiment 5: **Light Bulb Dissection**

Purpose:

To dissect a light bulb, examine the materials used in its fabrication, and understand the reason for the design and the use of the materials.

Materials Needed:

1. Light bulb - 100 watt or 3 way.
2. Hammer
3. Newspaper
4. Safety goggles
5. Gloves

Procedure:

In this experiment, students will dissect a light bulb to investigate how a light bulb is constructed. *This experiment will be more successful if the light bulbs first are turned on for about 10 minutes - the students could do this at home.* (As it is fabricated, the wire in a light bulb filament is drawn through a die and then bent into shape. At this point the wire is very brittle. When the wire is first turned on and heated up, it quickly anneals. In this state, the wire is still fairly strong, but it is much more ductile.)

The students should carefully break open a bulb by hitting it with a hammer, with the bulb encased in few sheets of newspaper. They should also wear safety glasses and thick gloves. Break off any sharp protruding pieces of glass with the hammer. ***This should be done under close supervision.*** Different types and wattages of bulbs as well as 3 way bulbs could also be dissected. Dissecting a 3 way bulb will be particularly informative if the students have already performed experiment 2.

Have them identify and describe the optical, thermal, electrical and material requirements for each of the components.

1. The filament
2. The bulb
3. The base
4. The lead wires that connect to the filament
5. The two welds where the lead wires are connected to the base
6. The exhaust tubing
7. The flare

Teacher's Guide to Experiment 5

1. Very high temperature capability, high resistivity.

Note, by looking carefully or through a magnifying glass or a microscope that the filament actually consists of a coiled coil of wire. It is easiest to see this near the end of the coil where it is connected to the lead wire. See Fig. 4 for a photograph of a section of coiled coil wire.

Now they can observe how a long length of filament can be contained in a such a small space. Have your students try to determine the length of the filament by estimating the diameter of each of the coils and estimating the number of turns. Recall that earlier we determined that the length of the filament was about 45 cm.

Note the similarity of the 3 way bulb filament design to the figure in the 3 way bulb section.

2. Transparent, cheap, formable at low temperatures.

3. Electrically conductive, cheap.

4. Electrically conductive, chemically and thermal expansion compatible with glass.

5. Electrically conductive.

6. Sealable at low temperatures.

7. Sealable at low temperatures.

Also note that the coating on the inside of the glass bulb is a dry white (silica or SiO_2) powder coating held on electrostatically to the glass, which can be wiped away to expose the clear glass.

See the attached appendix 2: The Extraordinary Light Bulb...Its parts and assembly, a GE publication, for information about the components of the light bulb and how they are assembled. Note that not all bulbs have the support wire. An interesting historical note: initially the pump out tube for the glass bulb was on top of the bulb, but this was considered unsightly. Notice that the pump out tube is not visible in the current design.

Also note that wires directly attached to the tungsten filament must have cross sectional area sufficiently large so that their resistance is much less than the filament. On the other hand, the cross sectional area must not be too large or the heat leak down these leads will be so great that the filament temperature will be much lower, leading to less light output and lower bulb efficiency.