

Using the Gem Microscope and Observing the Properties of Diamonds

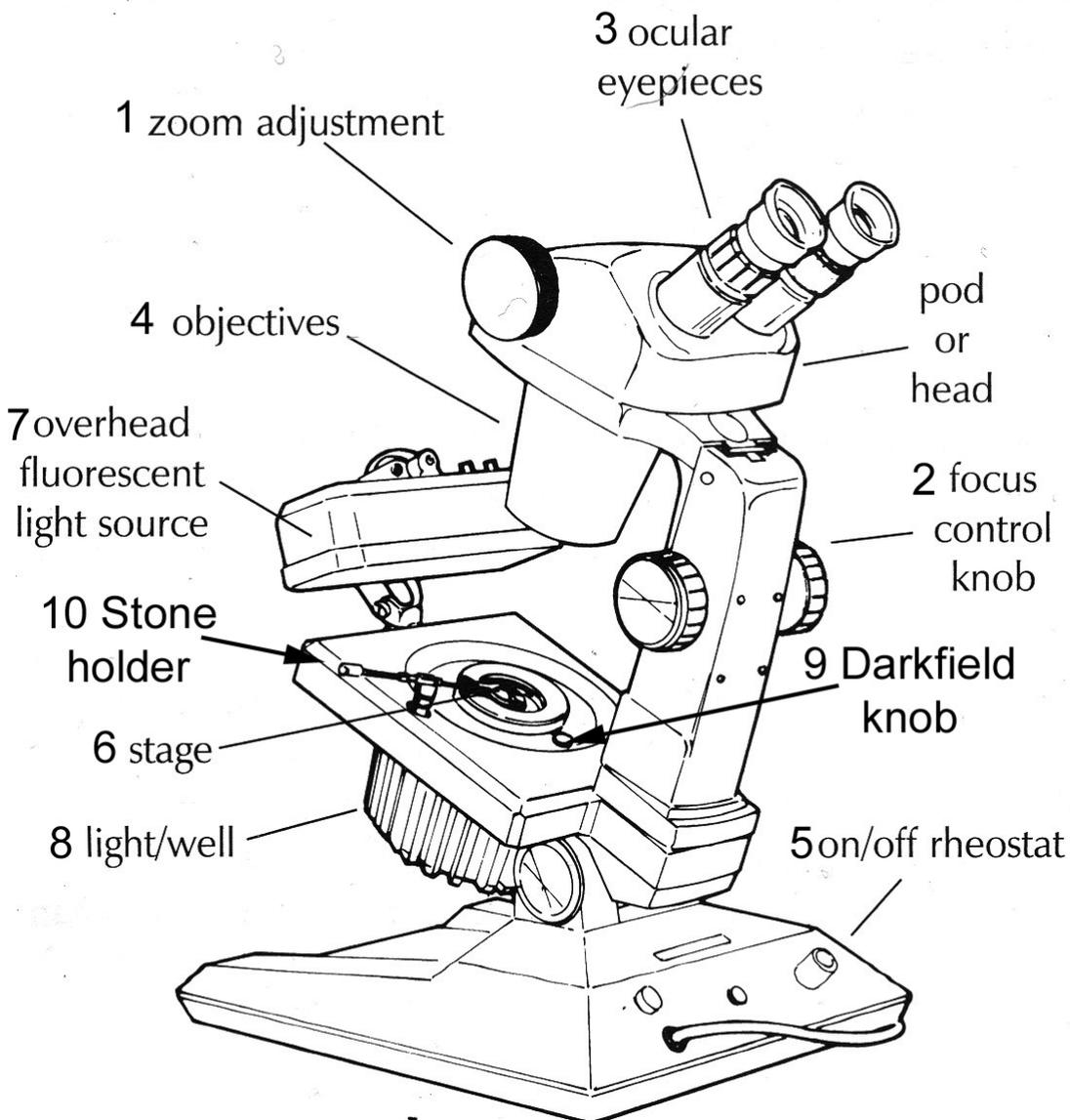
You will be using the **gem darkfield microscope** for the first time today.

The most important step at the beginning of lab is to become familiar with all of the microscope's parts and practice focusing the instrument on specimens.

Rule 1) Always start at the lowest magnification when focusing (See later instructions for magnification).

Rule 2) Always call the professor over if you have any doubt at all about what you are doing. Do not move a lever or change a knob's position until you know what it is operating.

A) Parts of the microscope



You should learn the parts of the microscope labeled **#1-10**. These can be on your next matching exam using a picture on a separate page.

To start, always make sure the microscope zoom adjustment is set to the lowest setting. Some microscopes have the **zoom on the sides** of the microscope head (or pod) labeled **#1** above. Some microscope, **instead have it on the top of the pod**. The Bausch and Lomb Microscopes tend to have it on the top, and it should be turned all the way to the size that reads, 0.7. When set in this position, you see the **widest view at the lowest magnification**. By turning the zoom, you increase the magnification smoothly, but you may have to refocus. The focus control, **#2** is the knob that raises or lowers the microscope into focus on an object. When you start the microscope focus will be too low. Always focus upward first (raise the head). This is the case if the microscope was properly returned to its shelf. **You must lower the focus (to the point shown by your instructor) before putting the microscope away, or it may hit the shelf above. Lowering the microscope head when you are done is a safety precaution.**

#3, the eyepieces, or oculars, are what you look through. On many of our scopes, they are 15 times (15X) magnifying eyepieces. Thus if the objective zoom (**#4**) is set to 0.7, you will get a magnification of $15 \times 0.7 = 10.5$ magnification (objective times ocular values). This low value makes focusing easier, for several reasons A) you see the largest field, B) you are able to see the whole object and understand it, C) your depth of view (the amount of depth you can see things in focus) is greatest.

At 10.5X you see a lot and a lot is in focus, but if you turn the knob that adjust zoom, the object becomes larger, **but everything else, width and depth of field become smaller**. You usually have to adjust the focus downward when you zoom to make it sharp again (try a little in each direction).

#5 On/off switch. Do not leave the microscope on when you are not looking through it. The bulb gets hot and heats the whole microscope. Aside from that you save electricity and the bulb will last longer.

#6 The stage. The stage is a horizontal surface, like a show stage, the players are the gemstones. The stage is where other pieces are attached, for instance, the lights above and below the stage illuminate the gems, the actors in our play. **#7 is an overhead fluorescent light source (or overhead lamp)**, this is not for inclusions, but to illuminate the exterior of the stone so that you can see external scratches and grade the stone's color using daylight fluorescent bulbs.

#8 The Light/Well. This holds a **special parabolic mirror** that focuses light upwards in a cone. On the stage is an elongated knob that controls the cone.

#9 The Darkfield knob. This acts as a lever to move a dark stop into the lighting system of the microscope, only light from the sides, not the middle of the cone of light, created by the light/well parabolic mirror enters the gemstone when the darkfield stop is introduced.

This darkfield system was invented by Robert Shipley, Jr., son of the founder of the **Gemological Institute of America (GIA)**. In 1938, **GIA patented the Diamondscope** with darkfield illumination. Without this instrument, gemology would have suffered greatly. With a darkfield microscope system,

the interior of the stone can be seen in a way not possible with transmitted light directly from below. In fact, **mostly you will want to have the darkfield stop in place** when you use the gem microscope.

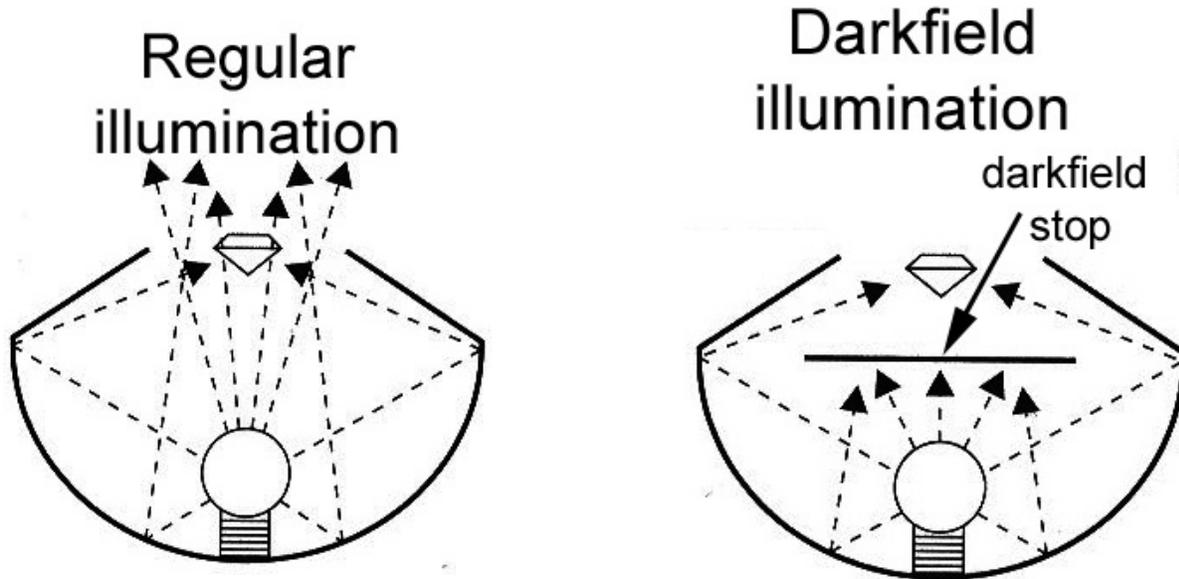


Figure 2. These two cutaway figures show how light from the bulb is reflected off the parabolic mirror in the microscope's light/well. It then illuminates the stone. In regular illumination, the stone gets light from directly below and the sides, but in the darkfield mode, with the darkfield stop in, only light from the sides can enter the gemstone. This makes the stone mostly dark, but any objects in the way bend (or refract) light into the microscope's objective lenses.

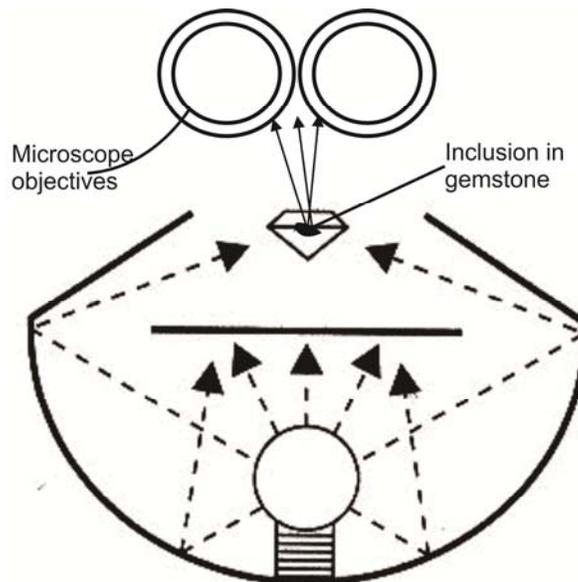


Figure 3, above, shows an inclusion that causes light to be "bent" from gemstone's interior toward the objectives. The inclusion is now bright, but the background is mostly dark. This makes it easier to see the stone's interior and the gemstone inclusions that can be very important for identification, etc.

#10 The gemstone holder. A spring loaded tweezers is used to hold the gemstone over the microscope's light/well (# 8) (Figure 4.). The gemstone holder fits into small ring of metal on the stage. It is usually used to hold the stone around its girdle (Figure 5). The stone is placed upside down on the table facet and then the tweezers can be placed around the girdle. The tweezers are then put into the holder on the microscope's stage.



Figure 4. Gemstone tweezers or stoneholder. This device is delicate and no force should be used. If you are having trouble of any kind, contact your professor. Even very small stones can be grabbed and viewed with these tweezers under the microscope.

#11 The iris diaphragm. It is not shown, but is on the stage of the microscope is the most delicate part of the microscope. It is completely adjustable. The iris can either be **left fully open**, as is done most of the time in **darkfield mode** or by means of a lever on the microscope stage it can be moved to any desired amount of closure. Note, however, that the iris diaphragm little protection and is prone to breakage, something you do not want to happen.

Respect the iris diaphragm, a few words of caution are needed. The iris diaphragm is delicate. You should therefore never close it down too tightly, or close it around any object, or force an object through the opening. Always use the iris diaphragm control handle extending from the side of the diaphragm ring housing to open and close the diaphragm. **Never open it by forcing your finger or any other object through the opening.** Any handling of this nature can easily damage or spring the diaphragm blades and render it useless. With a little care the iris diaphragm should last a life time on the microscope. To the immediate right and left the iris diaphragm are the mounting nubs for the stoneholder (provided on the microscope base). With the stoneholder, an object, such as a gemstone or transparent mineral can be held so that it is directly over the center opening of the microscope's light source and in the path of the brightest portion of the transmitted light beam.

1A. Using microscopes on the side table for general knowledge.

Step 1. Focusing the microscopes. **We will do this as a group at the side tables.**

Let's start by focusing a couple of microscopes around the room. We have demonstrations of the letter "e" and pieces of colored thread to start.

A) Describe how the microscope focuses. Using the Stereomicroscopes. Focus and raise the magnification with the **Zoom adjustment control**. Does it jump or move in smooth steps as you increase the zoom magnification.

B) Find the compound microscope on the side of the room with a letter "e". Does the letter "e" look strange? Describe it. Move the slide. Does the letter move to right when you move the slide to the right?

Use your own words to describe it.

C) Look at the threads. Which color is on the bottom? We can try this with either type of microscope. Which is easier to use in general? Which would you use to work on jewelry with?

1B. Using our gem-base microscopes.

Now Set up the microscope at your Lab bench (**We get out the Gem microscopes now**).

Your instructor will show you how to carry them, but they are heavy and you may need help!

We can set up microscopes and then we will get specimens of less expensive gems to practice focusing.
We may focus first on some Amethysts with inclusions first.

D) Put the specimen into the gemstone holder in the way you instructor explains. Grab it around the girdle with the stoneholders when it is facing down (table down). Insert the holder into the nub on the stage. Focus on the specimen with **the darkfield stop in place (see Figs. 2 and 4)**

E) Take the darkfield stop out. Is it easier to see the gem or harder?

F) With the **darkfield Stop out**, narrow or **close the iris diaphragm** using the small lever on the stage. Careful! If it sticks, do not force it call the professor over! Is closing it down making it easier to see?

G) You should study the stone with different light and draw a little picture of or describe how different darkfield is from brightfield illumination.

2) Looking at Diamonds

For this we will work in groups and you should prepare some comments.

There will be four groups. A) external features. You will look at surface features on the diamond crystals. B) Internal features you will look at cut stones with polished surfaces and point out several flaws. C) Fluorescent features. You will look at diamonds with the fluorescent cabinet and UV-lamp. Mostly we will look at small diamonds from China. These will be in a box and you must be careful of them. D) Color grader and also if possible spectroscope analysis of a diamond. You will set up the color grader and a fiber optics lamp and try and see if we can see a gem spectrum from a yellow "Cape diamond."

A) External features. Your professor will try and provide a few opaque and translucent to transparent diamonds. Also see if you can find typical diamond shapes, Octahedron, etc.

Describe some features of and look up if you are unsure:

1) a "Congo" cube.

2) a "**burnt**" diamond. What does this mean? See if you can find this on line.

3) a **trigon** on a diamond. We may have trouble finding this easily.

B) Internal features.

We will set up at least 3 microscopes with different features. You will use some cut diamonds and some uncut ones.

1) find a fracture (should be rainbow like feature)

2) a black spot often referred to as “carbon” or “graphite.” Look on line to see if this is considered true today?

3) an inclusion of another mineral in a diamond. If we see different colors or shapes these may be included minerals. Which was there first? The diamond or the included crystal? Try to draw the inclusions so others can see them.

C) Fluorescent features. Use the black plastic box and the UV lamp. Do not use the lamp outside the box. We must take precautions as some of the diamonds are small. Do all the diamonds fluoresce? What colors do we see in the ones from China, etc.

Do they fluoresce in Long or short or both longwave and shortwave?

Describe the colors. If any.

Do any of them phosphoresce? Continue to glow after the light is shut. Doubtful.

Look up on the Internet or your book. What might be a negative aspect of diamond fluorescence? Explain to the class.

D. Color grader and Try a spectroscope with a fiber lamp.

The color grader is supposed to compare stones. We may look a some diamond simulants too. The grader gives you uniform light. What light should be used for grading in nature? Look this up on line and explain to the class.

Also we will try and set up a yellowish diamond and see if we can get any spectrum from it. This may not work, but we are looking for a "Cape spectrum." Look that up in the book and explain it.

Draw the Cape spectrum to explain the line.

Diamond Simulants

Your instructor may show you diamond simulants

Take a few notes

1) Cubic Zirconia (zirconium = metal, not gem!)

2) YAG (Yttrium Aluminum Garnet) A rare earth material. YAG is rare today.

3) Rutile (titanium dioxide). Also known as Titania, made by Verneuil method. We have a boule.

4) Strontium Titanate (SrTiO_3) Also made by Verneuil method.

Review Questions

- 1) To see the widest view at the lowest magnification, set the zoom to _____
A) the highest setting B) the lowest setting
- 2) When you increase the zoom (magnification), what becomes larger? _____ What becomes smaller? _____ (choose from below; all answer belong somewhere)
A) The object you are looking at. B) The depth of view (depth of field) C) The area you see. D) The distance to the object of the objective.
- 3) What is controlling #4 (actually changing) on Figure 1? _____
A) #5 B) #1 C) #2
- 4) Does changing the focus really change the magnification? Yes/no.
- 5) Eyepieces are also called _____
A) objects B) lens C) oculars D) éclairs E) the well
- 6) The overhead lamp is mainly for seeing _____
A) deep into the stone B) the surface and color grading C) the stones oculars' D) éclairs
- 7) What company made the first darkfield microscope for gems?
A) GE B) De Beers C) GIA D) Éclairs E) the British Gemmological Society
- 8) What is a negative of a diamond fluorescing?
- 9) Did you see inclusion? They reduce clarity, but are geologically interesting. Is there anything you can find about their use in geological studies?
- 10) What is laser drilling?
- 11) What is clarity enhancement? Who is Mr. Yehuda?
- 12) Name 4 diamond simulants, how they are made, are there some negatives to the different simulants?