Polarising Microscopy

Using crossed polarising material to reveal beauty otherwise invisible

Introduction.

Central to the matter of interpreting the image that one sees when examining a specimen with a microscope is the interaction of the illuminating electromagnetic radiation, usually, but not always, "visible" light. Two of many phenomena determining the colours observed are:

1. Some materials contain molecules that have particular structural elements that can absorb some of the energy provided by illuminating light. The specimen will then appear to have a different colour from that of the original light. For example, only the components of "white" light which will give a blue effect will pass through a blue filter; all the rest will be absorbed.

2. A model that helps us to interpret what we actually see happening at a macro level, is a stable atom with its electrons moving around the nucleus, each at its appropriate radius. If atoms are exposed to electro-magnetic radiation (including, of course, white "visible" light), some electrons may move to a higher energy level. When they slip back to their original state, radiation of a different frequency / wavelength is emitted and colour effects are observed.

Polarised light microscopy used to be used by geologists to identify minerals and rock materials. Thin sections (30 µm) were cut using a diamond saw. These were then abraded to obtain smooth surfaces and viewed through crossed polarising materials. Now, however, much more "high-tech." methods are used. These are easier and give results quickly but expensive equipment is required.

Two pieces of polarising material are needed. The lower is the 'polariser', (always below the specimen) and the upper (above the specimen), the 'analyser'.
A simple polariser may be made by cutting a disc of polarising material to fit the filter tray. Many microscopes have no obvious place above the specimen where the analyser could be put so a good alternative is to make an eyepiece sleeve for it. Cut a ½" disc from the base of an old 35 mm film canister and glue your analyser there. Such a sleeve over the eyepiece works well.

Rotate the analyser until the view is as dark as possible. This is 'extinction' when a minimum of light can pass. If, using a low powered microscope, a suitable specimen is viewed through crossed polarising material, it will appear brightly lit and probably coloured. Rotate the specimen and other colours will often appear and disappear.

Next introduce and then rotate a 'retarder' (a window of cellophane and/or some other similar translucent material); this will often change the colours of both the specimen and the background. Try again with several layers of retarder using the same or other similar material for further visual effects.

Swift was the specialist maker of geological polarising microscopes. Besides two polarising filters, other features of these microscopes are: lenses of unstressed glass and a circular graduated stage. Some are fitted with a Bertrand lens. If one looks down the tube of a microscope with the eyepiece removed, one sees what is imaged in the back focal plane of the objective lens. If a so-called Bertrand lens is inserted at an appropriate place in the tube (between the objective lens and the eyepiece) one sees the same pattern but without the need to remove an eyepiece to do so; the pattern is also easier to see. The so-called interference figures seen in the objective's back focal plane are significant when using geological microscopes so instruments designed for this work would have a Bertrand lens that can be slid in and out of the operating position.

Equipment & materials.

A stereomicroscope, a compound microscope, blank slides, coverslips (preferably, 22x22mm square or 18x18mm square), warming plate, spirit burner (with methylated spirits for fuel), dissection instruments, a "squeezy" wash-bottle bottle (to dispense water in small amounts) and a small diameter glass "dropper rod".

Evaporation of solvent (let us stick with water) from a solution will make the solution more concentrated and, in many cases, crystals will eventually form; these will contain "water of crystallisation" but, as surplus water will have evaporated, the crystals will be dry. Ways to obtain the crystals we want are:

a. put a drop of cold solution on a side and leave it on a hotplate (not hot enough to melt the crystals) for a while.
b. start with a hot solution and leave this to cool gradually; in time, crystals will form and all surplus water will disappear through evaporation.
c. melt solid crystalline material and leave it to cool and re-crystallise.

Using the polariser/analyser. [Developed from a procedure introduced to me by Dennis Fullwood.]

1. Using thick paper, make some squares 24 x 24 mm; cut a central hole c.14 mm ($^{9}/_{16}$") in dia.
2. Clean a slide & cover-slip as usual.
3. Attach a paper square to the centre of a slide using PVA glue.
4. Hold firmly in position with 2 clothes pegs.
5. Leave on hot plate (@ c. 60°C) for 15 minutes.
6. Induce crystals using one of the three methods above.
7. Attach a 22mm square cover-slip over specimen with PVA glue.
8. Attach another square of paper with a central hole with PVA glue.
9. Label slide.
10. Using crossed polars, view. Rotate the analyser. Observe the effects.
11. Using a variety of different retarders, repeat.
12. Try a different method to obtain crystals and repeat the whole process.

*These were used: Ammonium chloride, Copper sulphate, Magnesium hexa-hydrate, Oxalic acid, Potassium iodide, Sodium tetra borate, Tartaric acid, Taurine powder, Urea, Vitamin C.

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