

## A DIY Filter Stacker and its use in Oblique Illumination.

Robert Hill, UK

### Introduction:

The past two years have been difficult for everyone and the Empirical Amateur's (EA) attention has been focussed away from the microscopy hobby towards more serious matters. Now things are easier it has been possible to bring to maturity but not completion, (are things ever completed in microscopy projects?), the **Filter Stacker Project**.

Most older microscopes, but not all, as used by the EA have condensers with filter trays under the condenser. In the main these trays accept a circular filter although the famous Leitz Heine Condenser has a fitting with lugs to accept a "tombstone" shaped filter. There are numerous articles in *Micscape* and elsewhere describing how to make home made filters to fit into these filter holders in order to produce dark field, Rheinberg and oblique illumination. Cutting these circular pieces of gel sheet and card can be fiddly and David Walker has referred to the "circle cutter challenge", yet despite this it is possible to cut filters to produce very satisfactory results. My particular personal challenge has been to produce good images of diatoms and I have devoted a lot of effort towards producing filters for oblique illumination.

A particularly good design was described by Wim Van Egmond in [Micscape](#) (November 2002) which was able to produce Nomarski-like effects. There are many other papers (accessed on line) that discuss the best shape of the oblique slit, for example "[Oblique illumination in microscopy: a quantitative evaluation](#)". By Carlos Sanchez, Gabriel Cristóbal, Gloria Bueno, Saúl Blanco, María Borrego-Ramos, Adriana Olenici, Anibal Pedraza, Jesus Ruiz-Santaquiteria. Instituto de Óptica (CSIC), Serrano 121, 28006 Madrid, Spain.

In my experience a crescent like slit seems to give the best effect but there are issues which include:-

How big to make the slit ? and usually different sizes are needed for different objectives.

Exactly where on the disc of black card to place the slit.

The technicalities of cutting a crisp edge to the slit

The non-adjustability or more accurately the difficulty of adjusting the position of the filter during observation.

The orientation of the slit – this is usually East West but that does not suit all diatoms and better definition of detail may be obtained North South or somewhere in between.

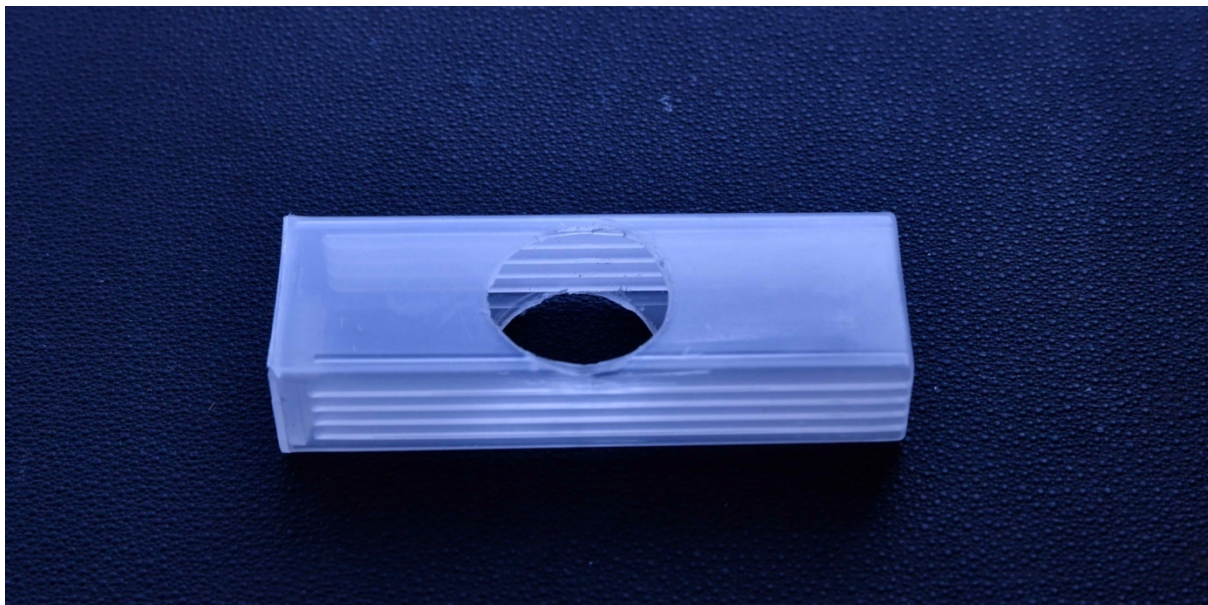
Adding coloured filters.

In Wim's article he makes the point that he is using dark field illumination in combination with oblique illumination to get the DIC effect and this is one thing that the filter stacker is able to do but in an easy to adjust manner. As readers may know tiny alterations to the position of the filter can make all the difference. There are numerous other ways to utilise the filter stacker which is why I say this project is not completed.

At this point I wish to emphasise the value of a phase telescope – it is essential to be able to relate the image obtained to the configuration of the filter and this is easily done if the phase telescope is inserted in one slot in the binocular head leaving an eyepiece in the other. When satisfied with filter position and the effect obtained then the telescope is removed and the eyepiece replaced for viewing.

### **Filter stacker design.**

The filter stacker is made from a slide mailing box. These plastic rectangular boxes accommodate 5 standard glass slides. In brief a hole is drilled from one side to the other using a flat or spade drill. The maximum diameter of the hole achievable is about 22mm in diameter. It may be better to use a drill a little smaller than this. The aim is to cut a central hole without damaging the plastic ledges inside that support the slides. (Figure 1). All plastic “swarf” has to be removed with a scalpel. The ends are cut off so the box is open at both ends. As may now be obvious this permits up to 5 filter strips, the width of a slide, to be positioned inside the box – stacked on each other – more later.

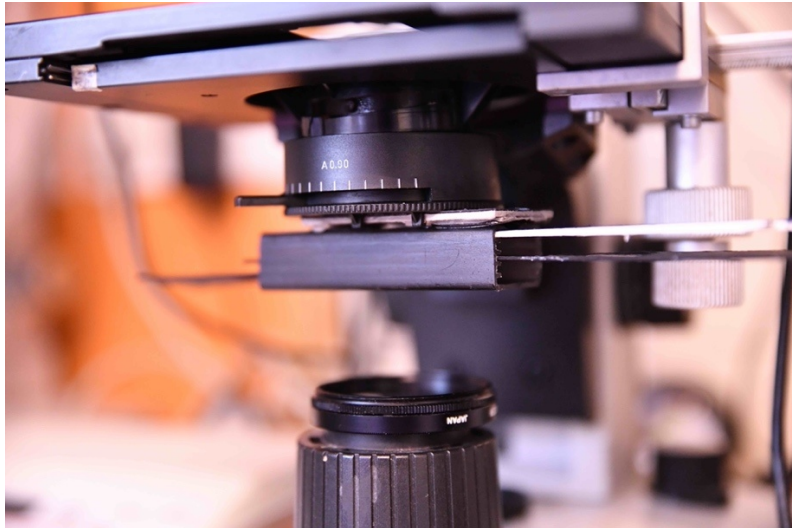


*Figure 1. Slide Mailer Box with hole cut in centre before ends are cut*

Having made the stacker the next thing is to attach it to the base of the condenser in place of the circular filter holder. This is a matter of ingenuity and may require intermediate mounting discs. My “every day” microscope is a Leitz Laborlux 11 which has a fixed pre centred condenser under the stage - there is no filter tray, however there are lugs underneath which presumably are to accept a tombstone type filter. For this microscope the method is to cut a rectangular piece of stout card that will fit the lugs, cut an aperture in the card for the light, insert the card and secure it with glue and then mount the stacker to the card. I must counsel against using super glue adjacent to optical components – as it sets it gives off a vapour that will settle on lenses fogging them. This is a simple example – on other occasions plastic rings/cardboard tubes and so on are needed to attach the stacker to the

condenser. For example with a Berek Condenser a piece of cardboard tube of the correct diameter glued to the stacker will allow an interference fit over the end of the condenser. In passing its worth observing that this sort of fit will permit rotation of the entire filter stacker changing the East West orientation of the filter to North South and in between depending on room below the stage.





*Figure 2 and 3. Set up of Laborlux 11 Microscope showing Nikon D3200 Camera attachment. A small LED screen can be connected to the camera and images seen in live view function. Figure 3 shows close up of filter stacker in situ with filters inserted from both ends.*

This is the simplest filter stacker design. It is possible to incorporate a light source under the stacker using a COB LED mounted in a shortened plastic film cannister – the basic design of these was described in my [article](#) in *Micscape* in September 2018. This is probably the subject of a further article.

### **The filters.**

The only limit is your imagination. All filters are rectangular strips of gel or card cut to a width slightly greater than a microscope slide – slightly greater to ensure a snug fit in the stacker but not so snug that you cannot push it in or out. As gel is flimsy it may be better to mount it in a frame of card.

Filters of diffusing material or Polaroid film can also be made.

At this point the second essential piece of equipment is needed and that is a sharpened cork borer. These come in different sizes but you must sharpen them with a file – they have to be razor sharp. Take a strip of black card, carefully mark the centre line and cut a series of holes of increasing size with the cork borer. This is a template to tell you what size hole you need in the filter to match each objective, (looking down the phase telescope). Write the size next to the hole.

For oblique illumination there are several possibilities:-

A simple piece of rectangular card just inserted into the stacker and observed under the phase telescope to see how far it has to be pushed in to get the effect you want.

A simple piece of card with a slit cut in it – in any orientation you wish – the North South/East West matter mentioned above if you cannot rotate the stacker.

In practice what I use is a crescent slit made by cutting out a circle of card at the end of the strip (Fig 4). Use the template to decide how big the diameter has to be.

### **The “DIC effect.”**

This uses 2 or 3 stacked filters depending on the effect required. 3 filters give you a combination of Rheinberg, dark field and oblique. If you don't want the Rheinberg its 2 filters

- A. A coloured filter to give Rheinberg effect (Fig 4 )
- B. A coloured filter to give background colour (Fig 4 )
- C. The oblique slide filter (Fig 4 )

The advantage of the stacker is that each filter can be positioned (under the phase telescope) independently of the others and tiny adjustments are easy (if you have a steady hand). If you make filters in a strip as shown then its easy to move from blue Rheinberg to red or change the background colour. I find the filters much easier to make than the circle cutter challenge.

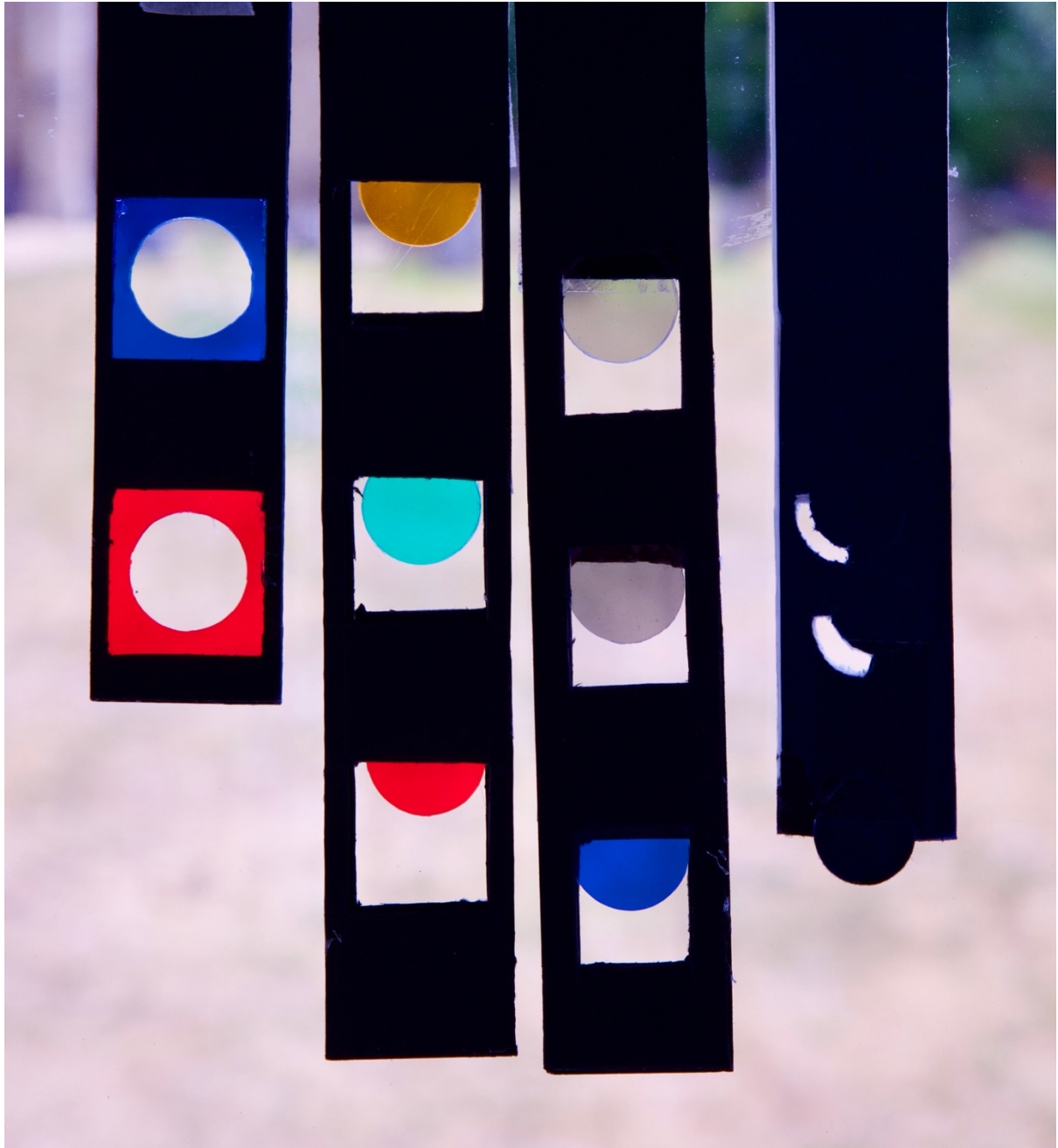


Figure 4. Selection of filter strips. From the left:-

- A. Filter for Rheinberg – this has to positioned just on fringe of aperture seen down phase telescope. Inserted from left for ease.
- B. Two examples of filter strips for background colour. Inserted from right.
- C. The oblique slider. The leading edge is a circle of correct size. There are also two oblique slots to permit oblique from different azimuth. Inserted from right.

The filters are inserted one by one under phase telescope control. Remember with this set up the crescent consisting of the background colour will lie on the left if oblique slide inserted from right to progressively cover it, and therefore the background colour filter is largely overlapped by the oblique slide and it is only the leading edge of the circle to the left that is exposed. This is why in the filter there are only half circles visible. All sizes for an

individual objective have to be templated although in this system x25 and x40 do require roughly the same size. Fine adjustment of the sliders is possible with “fingertip control” i.e. slide them in or out a bit as needed to get desired effect. Experiment !

The above description is a summary rather than a full description of exactly how I made the stacker and all permutations so far but should introduce the reader to the concept and an outline of the technique.

Now some pictures:

Technical points.

All photographs use crossed polarised filters

The lens is Leitz Fluotar x25 NA 0.6.

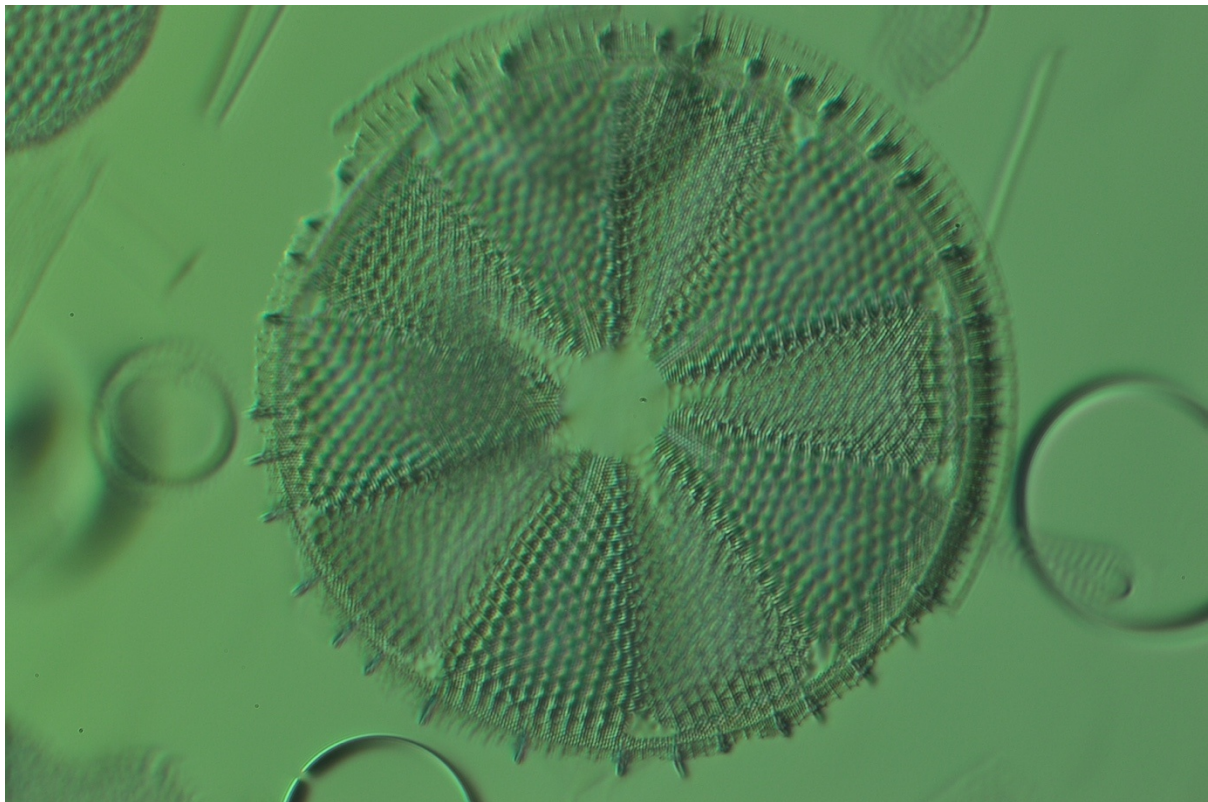
The camera is a Nikon D3200 mounted to the trinocular head utilising an old Leitz film shutter in method referred to in Quekett “Advanced digital photomicrography” (accessed on line).

Exposure is manual and empirical to get the best picture.

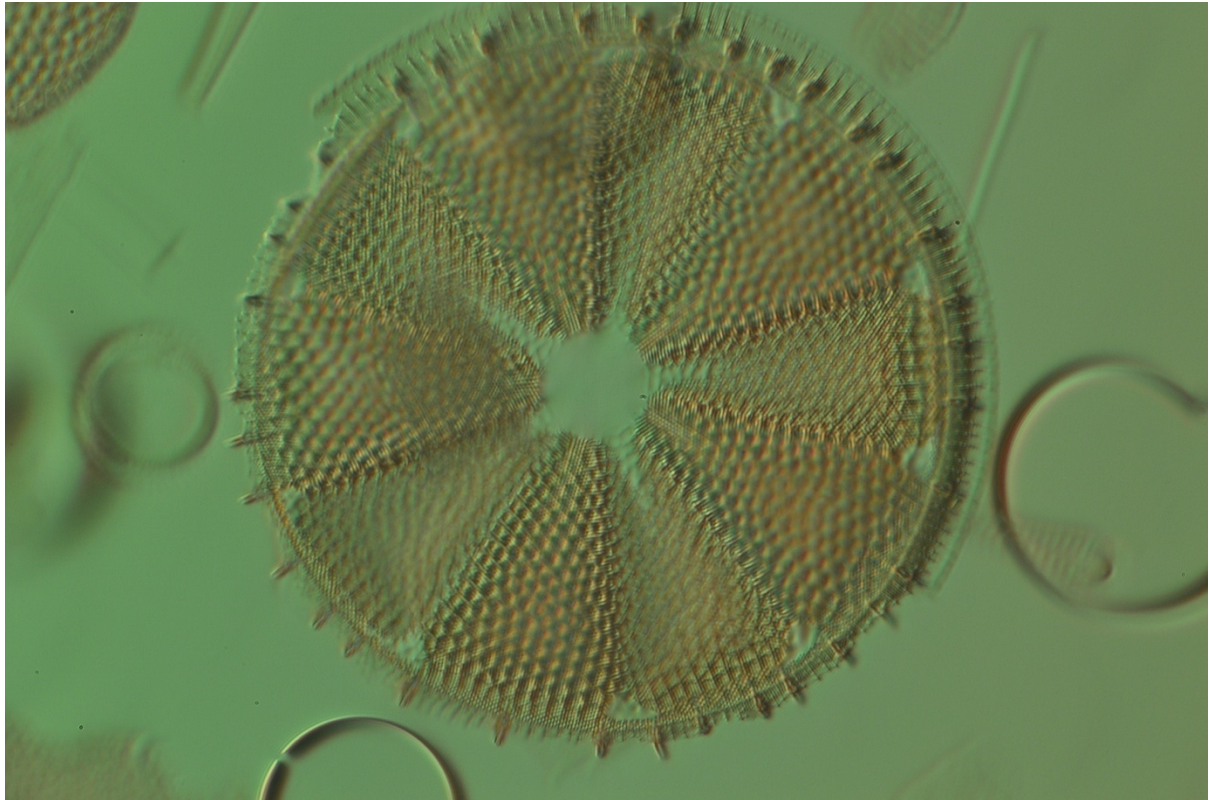
Noise reduction is off

Diatom slides are strew slides by Diatom Shop Fossil Dunkirk Maryland.

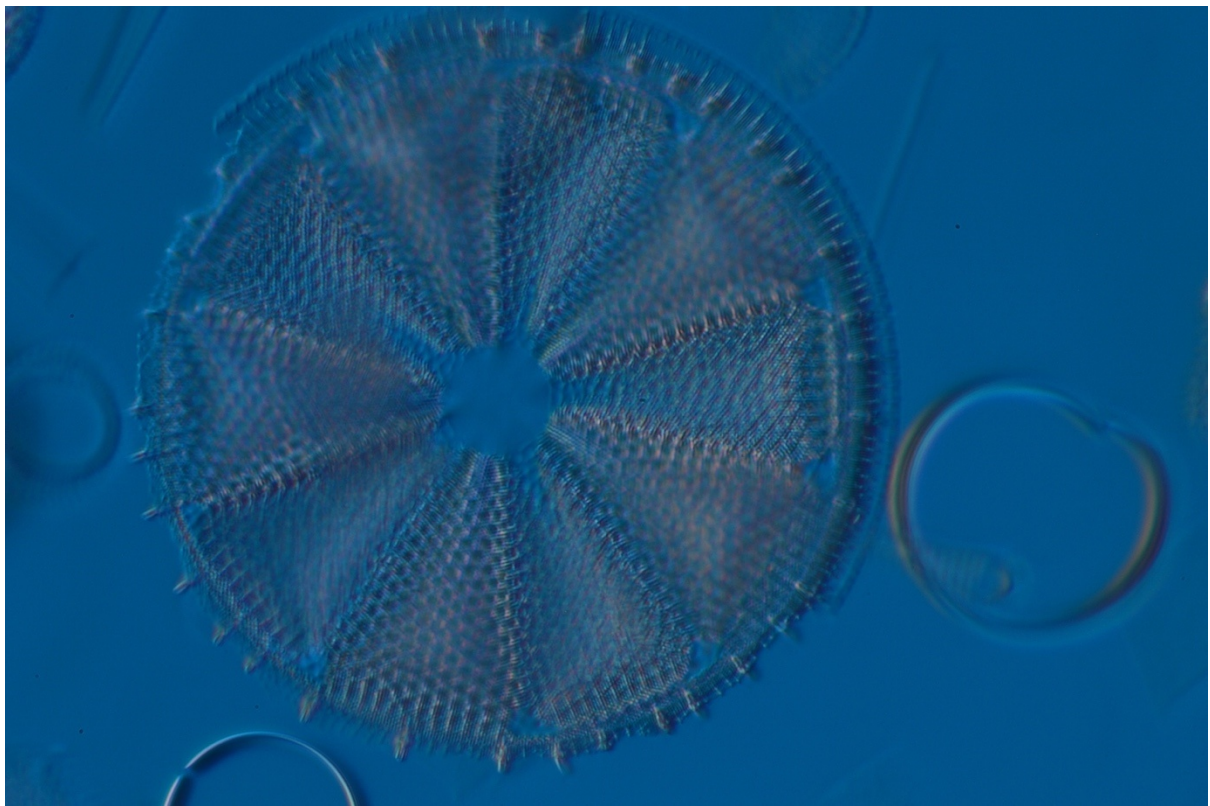
Illumination is by 20W halogen bulb (standard for this microscope).



*Oblique, green background, darkfield (i.e. no coloured Rheinberg filter)*

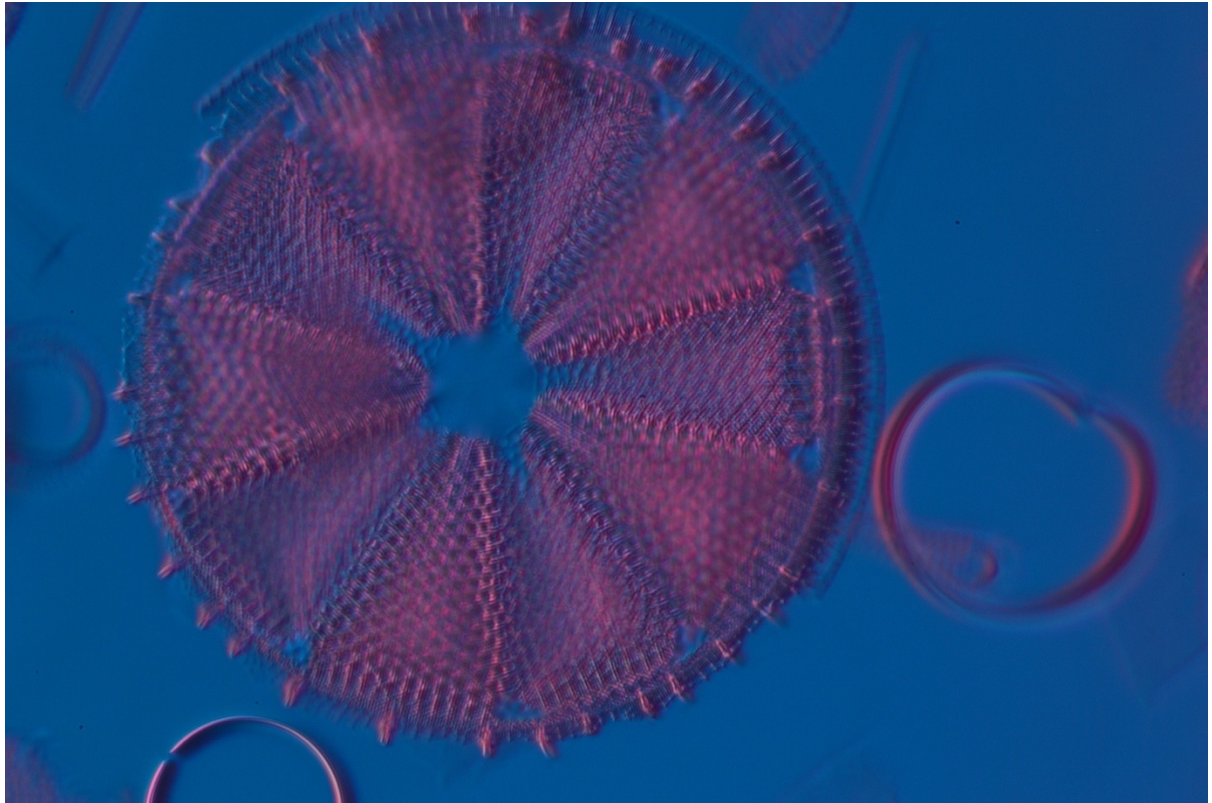


*As above but now red Rheinberg filter added.*

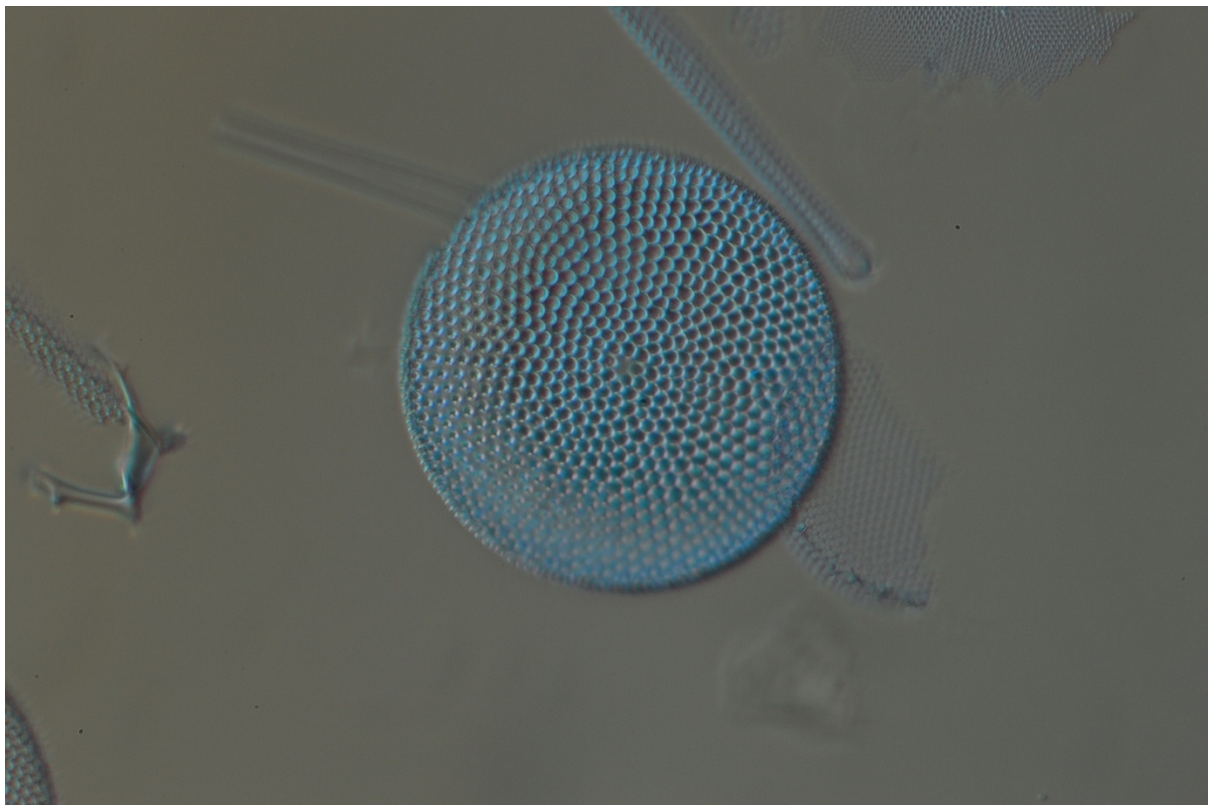


*Oblique, blue background with darkfield (i.e. no coloured Rheinberg filter)*





*As above but now red Rheinberg filter added.*



*Oblique, grey background, blue Rheinberg filter (one of my favourites)*



*As above – this is the only image that has had any form of digital sharpening and improving.  
All the other were straight out of the camera with NO adjustments.*

Comments to the author are welcomed, email – robahill AT hotmail DOT co DOT uk.

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