Chip on board, (COB), LED microscope illuminator for older microscopes: The empirical amateur (EA) approach

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The amateur and professional microscopy literature abounds with articles on LED illumination conversions for microscopes. In the main these articles refer to the use of various types of LED bulbs, either singly or as an array – for example from LED torches.

One of the issues with using LED bulbs, which usually have a convex Perspex lens, is the difficulty of obtaining a sufficiently large circle of even light to illuminate the condenser. In terms of even light daylight on a cloudy day reflected by a mirror is hard to beat but unfortunately there are considerable practical difficulties with this traditional method which lead to the development of microscope illuminators in the first place. A flat top or straw hat LED can give a bigger circle of light and the author has used an 8mm straw hat LED with some success in replacing a tungsten bulb on a Wild M20. (Fig 1). This is very similar to the method reported by Carl Sartory. (Quekett Journal of Microscopy 2008, **40**, 701-711.) In addition to the difficulty in getting even light there is the practical matter of exactly where and how to place the LED in the light path of the microscope. Specifically, whether to place the LED at the site of the original light source and thereby use the existing collector lens system or to position it elsewhere. There are practical as well as theoretical considerations. In the case of the Wild M20 the design of the original bulb holder permits easy accessibility and the LED bulb can be placed more or less at the site of the original tungsten bulb.

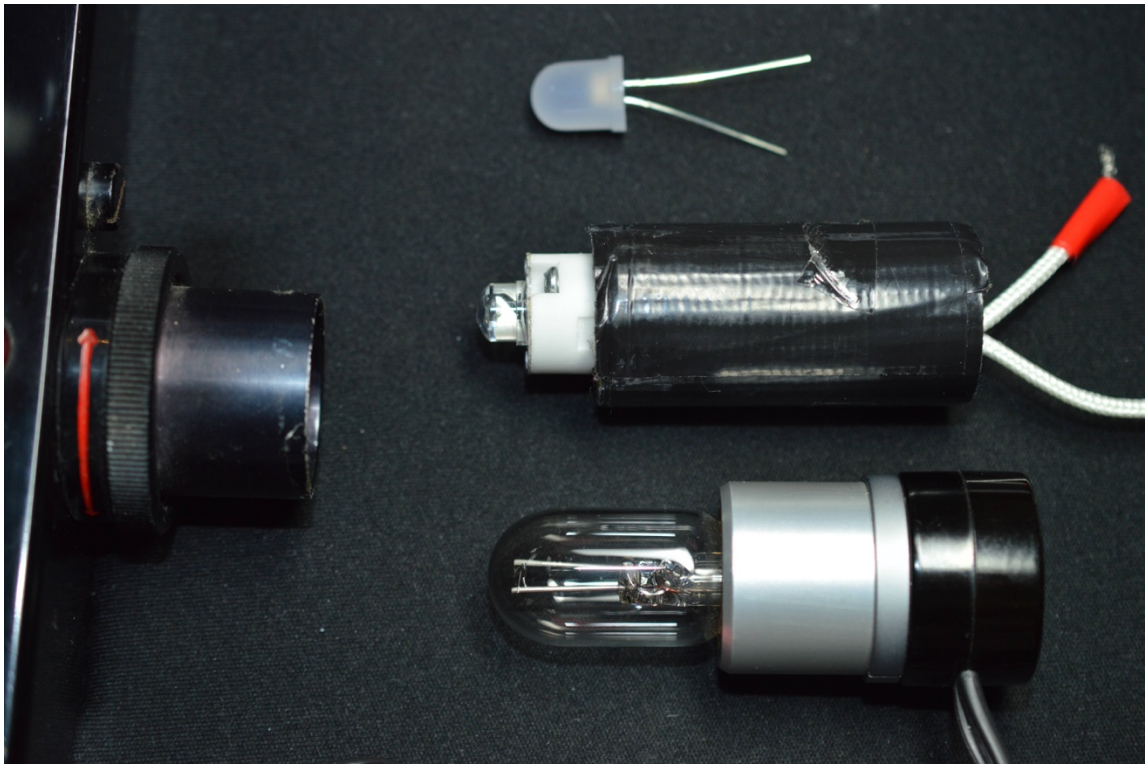


Fig 1. Wild M20 Replacement illuminator made out of broom handle cut to length with ceramic LED socket screwed in place, duct tape wrapped round to get snug fit. Straw hat LED mounted but can also use 10mm diffused LED

COB LEDs are an array of pin point light sources mounted on a circular, square or oblong board. They have a number of uses such as floodlights, car interior lights, torches etc. (Fig 2) They can be quite powerful depending on the number of little LEDs on the board but the lower power circular boards can be suitable for microscopy illumination. The diameter of the boards is appropriate for microscopy use and one big advantage is they are very thin and can be used where there is limited room. They are best powered, in the view of the EA, by a variable bench top DC power supply as the required voltage can easily exceed what is practical from a battery pack.

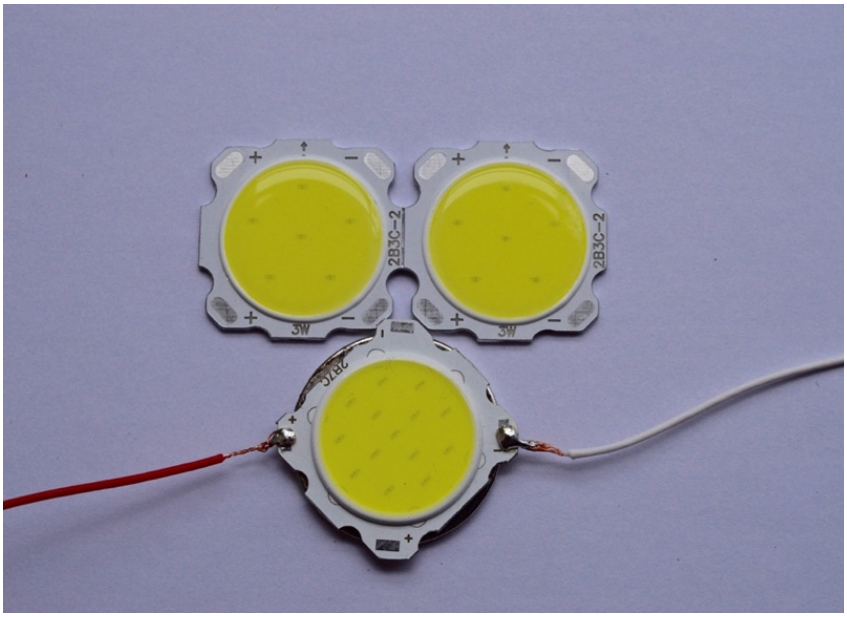


Figure 2. COB LEDs – 3 W and 7 W. Diameter of disc approximately 20mm

When these COB LEDs first came to the attention of the EA it seemed they might be a good option for replacement illumination for older microscopes at least – and perhaps more modern ones as well. Older microscopes with mirrors can be converted quite easily to this form of illumination with a minimum of DIY skills and materials. Some older microscopes such as the Beck 47 or Watson Service 2 microscopes are solid and very sturdy and perfectly usable if cleaned and restored. The original objectives although often quite usable do show their age and can be replaced with alternative 160mm tube length objectives or even 170 mm as these microscopes often have adjustable tube lengths. The EA often uses Lomo objectives which some of which are very good and at present at least represent quite good value for money. There is a certain satisfaction in getting these attractive, solid black enamel microscopes back working and the image quality can be good. The monocular tube is not a major disadvantage if one is using a microscope camera – it is just popped in and out and of course receives all the light when compared to a binocular head which may improve image formation.

As described in a previous article the Empirical Amateur is not weighed down with too much theory despite some success several decades ago with A level physics but that is not to say no thought is given to the problem. On reflection, (of thought not light), it seemed that a desirable illumination system would have the following characteristics:-

- Variable light intensity
- A circle of even light just big enough to illuminate the condenser and possibly the ability to further decrease the size of the circle. This circle of light either illuminates the condenser directly or via a lens collecting system.
- Adjustable centring or at least the illumination has to be accurately lined up to the condenser.
- Small size to facilitate fitting including directly under the condenser
- Different colours – usually provided by gel filters.

The variable light intensity is easily achieved by using the bench top DC power supply and with respect to centring the illumination to the condenser and just filling the condenser it seemed an idea to directly attach the illumination to the condenser or at least to the filter holder under the condenser making a combined illuminator/condenser system. For this to be practical the illuminator has to be thin and light – just like a COB LED. Varying the size of the size of the light circle i.e. a field diaphragm is a little more complicated.

The EA method requires the following:-

COB LED perhaps 5 or 7 W. These do not come with leads attached so a little soldering is required. (Fig 2) Available on e bay.
A diffuser. Experiments showed a diffuser was necessary to get an even light or almost even light. The diffuser has to be placed a minimum distance from the COB LED to be effective – determined empirically
A black plastic photographic film container with lid
Black card
Super glue and araldite
Aluminium foil and double sided adhesive tape
PVC black insulating tape.

Depending on the size of the condenser filter carrier it may not be possible to use the card method of attachment (described below), in which case the illuminator can be attached magnetically for which some tiny magnets will be needed and a ring of self adhesive ferrous sheet cut to size and stuck to the underside of the filter carrier.

The method is as follows:

Solder thin wires to the COB LED.
Decide how much room is available below the condenser for the illumination unit. Usually there is room for the whole film container but if not carefully cut the film container to size.

Cut a hole in the base of the film container which needs to be smaller than the whole of the COB LED but sufficient to admit the circular yellow bit with the LEDs. This can get a bit hot

when running so it may best to mount it outside the film container so the aluminium base is exposed to the air. However, the COB LEDs can be mounted inside the film container in which case drill two holes for the leads to exit and it may be wise to have a hole in the bottom so the base of the LED is exposed. You may wish to line the inside of the film container with aluminium foil using the double sided tape – why ? Well it seemed a good empirical thing to do to reflect all the light up towards the diffuser but I don't know if its actually required. PS. Make sure you don't short out the LED ! (Figs 4)

Take the lid and cut a whole in this as well to take the diffuser. It is possible to cut circles of diffuser using a circular cutter out of sheets of diffuser material also available on e bay. The technique requires a sheet of plywood to have holes cut in it of appropriate size then clamp this to the diffuser sheet and use as a jig – stops the circle cutter slipping on the plastic sheet and scoring it. (Fig 3) Mount the diffuser.

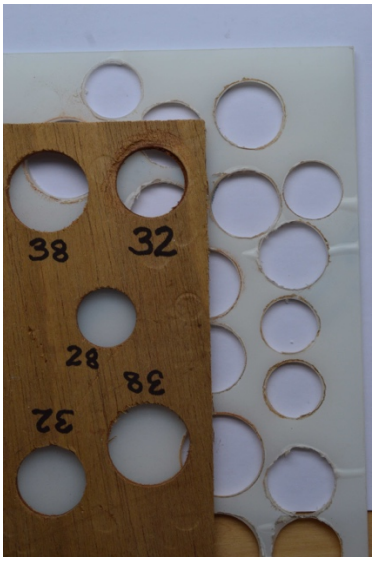
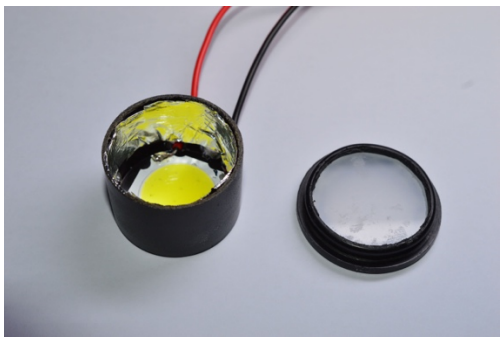


Figure 3. Cutting diffuser disc



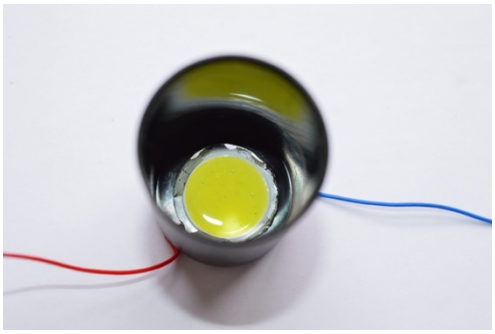


Figure 4a and b. LEDs mounted in film canisters with and without aluminium foil and diffuser disc mounted in canister lid before being re attached.

Next there is the mounting of the illuminator to the filter carrier – if the diameter of the film container is smaller than the filter carrier you have to cut a ring out of black card of appropriate size, glue this to the film container lid and then it will suspend the illuminator from the filter holder. (Fig 6) The whole illuminator is so light this is not a problem. On the other hand if the filter holder is the same size or smaller than the film container use the magnet method. Cut a ring from the self adhesive ferrous sheet and glue to the underside of the filter holder, superglue tiny magnets (E Bay) to the rim of the film container lid and use this to attach instead.(Fig 5)

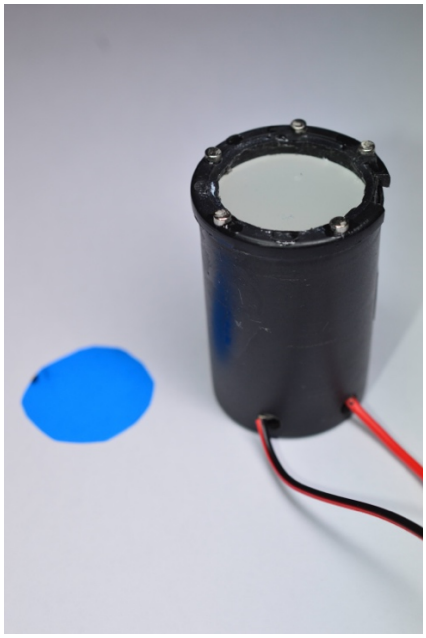


Fig 5. Magnetic mount

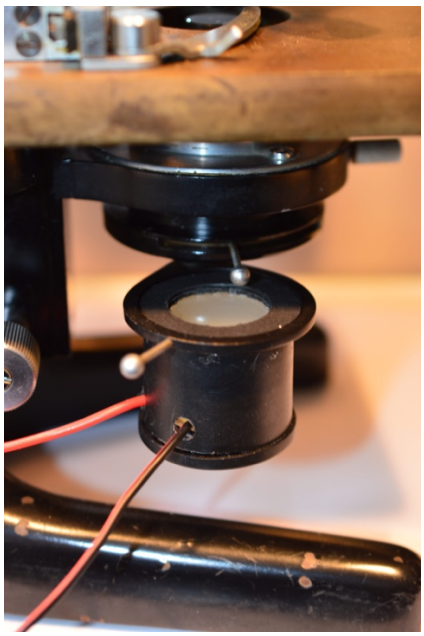


Figure 6. Card ring mount on Watson Service 2.

Fig.7. Mark II illuminator with diaphragm and magnet on base.

It is also possible in a Mark II version to mount the illuminator magnetically underneath the microscope and not to the filter carrier. The magnetic mount facilitates accurate centring (using a phase telescope). If this is desired a larger circular magnet is needed cemented to the base of the illuminator and a small sheet of steel on which the microscope sits provided the older microscope has a W or V base with room for the illuminator between the legs (Figs 7 & 8). This version does have a field diaphragm to vary the diameter of the circle of light striking the condenser.

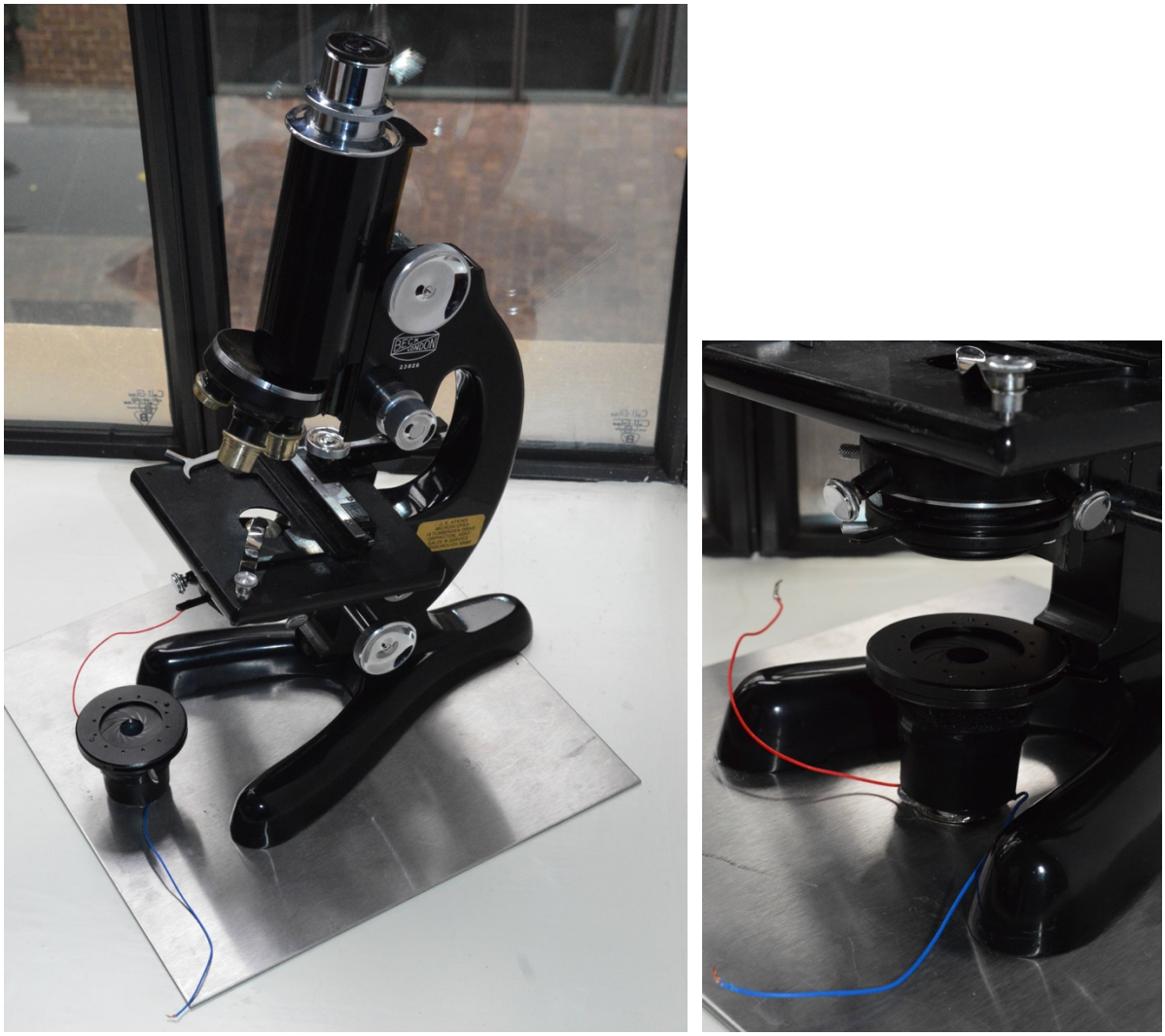


Figure 8. Beck 47 on steel sheet with magnetic Mark II illuminator being centred

Fig 9 shows a diatom strew slide prepared by the author from a brackish lagoon in the United Arab Emirates taken on the Watson Service microscope with illuminator shown in Fig 6. The COB LED (7W) is very bright and allows closing down of the condenser diaphragm without too much loss of light which contributes to the contrast. This may be especially useful with very high power objectives. The light is even to the eye but the more critical camera does show some unevenness which doesn't seem to matter too much to the final image. The image is stacked but no other adjustments have been made.

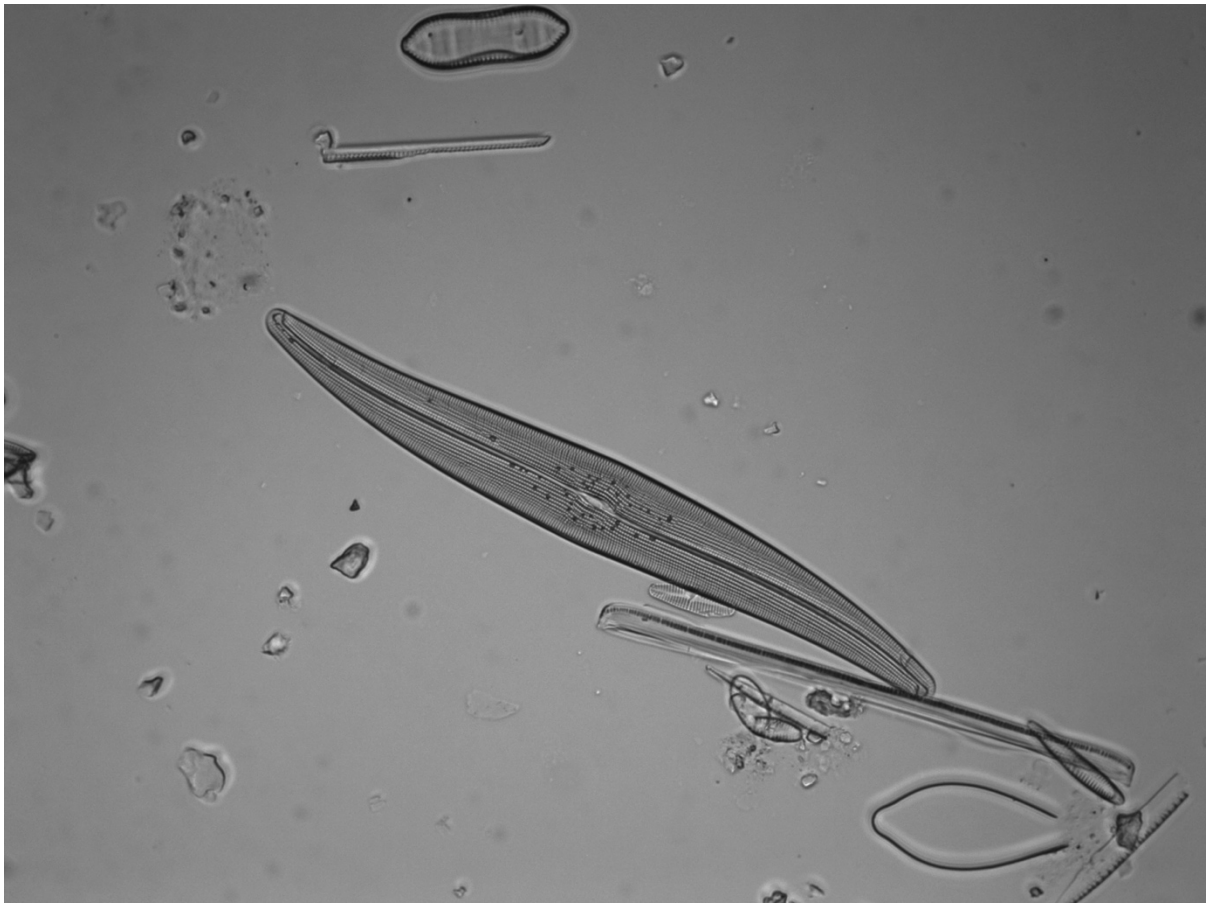


Figure 9. Monochrome image from Watson Service 2 Microscope using Lomo x 40 objective.

COB LEDs are cheap and worth considering when devising replacement illumination systems. They are light and take up very little space. Older microscopes with robust swing in filter carriers mounted to the condenser are particularly suitable for this method and can be rejuvenated producing good quality images to rival more modern microscopes. With further empiricism it may be possible to use these LEDS in more modern microscopes with broken built in illumination systems.

A word of warning: All LEDS and perhaps especially the brighter COB LEDS can cause injury to eyesight. It is best not to stare too long down the eyepiece and the EA turns the power down when focussing and then exchanges the eyepiece for a microscope camera before increasing the brightness.

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