Yet another note on laboratory lighting

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There have been a number of notes in Ancient TL on the subject of the lighting that should be used in the laboratory when preparing samples for luminescence dating. The most recent is that of Spooner (2000), wherein can be found an excellent detailed account of the science, and which should be consulted for earlier references. Spooner recommended the use of a low-pressure sodium lamp emitting predominantly at 2.1 eV (589 nm), with a yellow plastic filter to remove higher-energy photons, at an illumination level of 0.1 μW.cm^{-2}. Here we review the little-known earlier results of Ditlefsen (1991), and describe our own lighting which makes use of compact fluorescent bulbs and orange light-emitting diodes, which are cheaper and more convenient.

Ditlefsen (1991) reported excitation spectra, and the rates of decay of the luminescence intensity after the excitation was switched on, at excitation photon energies of 1.8-2.5 eV (670-480 nm). These data were then combined with the eye response to deduce the photon energy that would have the least effect on the sample for a given level of laboratory illumination as seen by the eye. This was done for one quartz separate and some sediment feldspars.

The result for the quartz was the redder the better; in other words as the energies of the excitation photons decreased, the probability of excitation of electrons from traps decreased faster than the eye response.

The result for feldspars was quite different. There is a clear broad optimum at a photon energy of 2.0-2.3 eV (620-540 nm), in the yellow part of the spectrum. This is shown in Fig. 1. At higher photon energies the excitation probability increases more rapidly than the eye sensitivity. At lower photon energies the excitation probability decreases less rapidly than the eye sensitivity. This result is of relevance to laboratory lighting if it is the same traps that are being emptied at the different photon energies. We have now shown that this is the case over the range 1.2 - 2.1 eV, which encompasses the resonant excitation peak at 1.4 eV used for dating, using the method described in Huntley and Ditlefsen (1994).

Our lab lighting has been designed to match the optimum at 2.1 eV. For several years we have been using compact fluorescent light bulbs that are available

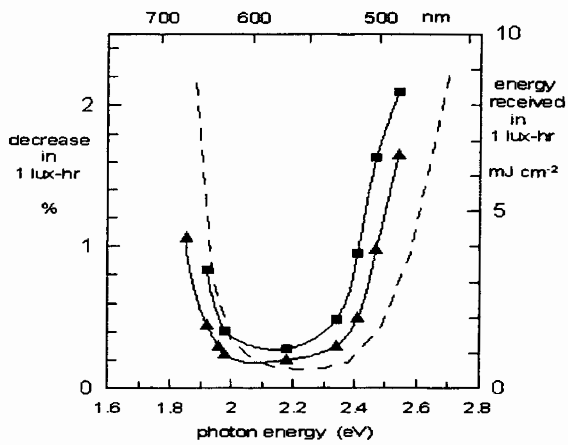

Figure 1.
The decrease in 400 nm luminescence emission during a 1 lux-hr exposure to photons of the energy shown. Solid triangles are for 100-200 μm K-feldspars separated from Riso sample R908002 (Tirstrup); solid squares are for 4-11 μm grains from loess from Karamaidan, Tadzhikistan. Solid lines are spline fits to the data. The dashed line shows the incident energy during a 1 lux-hr exposure. The data are from Ditlefsen (1991, Ch 4). (1 lux = 1 lumen cm^{-2}).

in hardware stores. The particular kind we use is an 18 W Philips, and has a complete plastic cover which is roughly a 6 cm diameter by 10 cm long cylinder. These are relatively inexpensive, and are convenient because they screw into ordinary ceiling or desk-lamp light sockets. They emit an insignificant amount of infrared light, as is necessary when preparing feldspars. They do, however, require a filter to eliminate the high energy photons. For this we use an orange filter designed to wrap around the long fluorescent light tubes, the same type as traditionally used in thermoluminescence work. A piece of this is 13.3 x 119 cm. From one of these we cut a piece about 4 x 119 cm, wrap it around the middle of the compact fluorescent bulb, and use black electrician's tape to hold it in place and cover the rest of the bulb. The only light then emitted is from a 0.8 cm wide strip around the middle of the bulb.

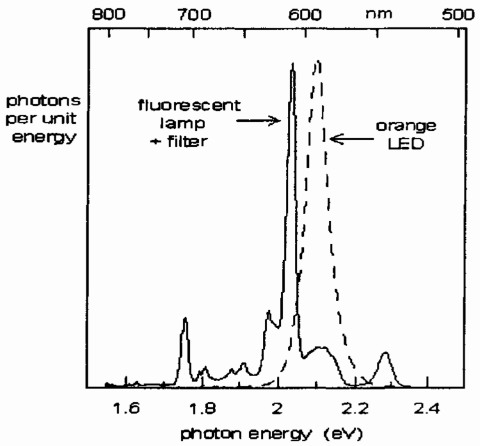

Figure 2.
Emission spectra for a Philips 18 W compact fluorescent lamp fitted with a filter as described in the text, and a Photon Micro-Light® orange LED as sold.

The spectrum of the light emitted by a bulb outfitted with such a filter is shown in Fig.2.

We have tested its use on feldspars separated from a Tertiary sample (CBSS), and found the luminescence emitted under 1.4 eV excitation to be decreased by 0.07 % per hour of exposure of the grains when the light was in a ceiling light socket. In fact most of the light was arriving at the sample after reflection from the walls of the room. The light intensity was 0.2 μW cm^{-2}. This light intensity is adequate for most work, but an increase of an order of magnitude could be tolerated for short periods.

For some years also we have used ordinary pocket flashlights in which we have replaced the bulbs by an orange light-emitting diode and a suitable resistor. These are very convenient for hand use. One has to be careful since some such LED's emit some light at higher photon energies and it can be necessary to add an orange filter. There has recently appeared on the market some very convenient flashlights using orange LED's (and other colours). These are made by Photon[a], cost about Can$12, are designed to be attached to a key ring or zipper pull, and are available at outdoor stores. A spectrum of one is shown in Fig.2. We have tested exposure of feldspars separated from a tertiary sandstone (sample CBSS) to light from one and found the effect to be ca 0.5 ± 0.1 % per minute of direct illumination at a distance of 20 cm, the intensity being 100 μW.cm^{-2}. This is much brighter than one needs in practice; it does, however, permit one to view a sample in a bright light for a few seconds. This LED is also very convenient for looking in dark cupboards, drawers etc, and I expect to use it in the field when sampling in the dark

The data of Ditlefsen, Spooner and those presented here all show that an exposure of 1 lux-hour, which at 2.1 eV corresponds to 0.1 μW cm^{-2} for about 2 hours, causes a reduction in the 1.4 eV-stimulated luminescence under 1 %.

[a] Photon Micro-Light®, L.R.I., P.O.Box 58, Blachley, Oregon, 97412-9718, U.S.A.

References

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Reviewer
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