INTERNATIONAL JOURNAL OF CONSERVATION SCIENCE

ISSN: 2067-533X Volume 1, Issue 3, July-September 2010: 161-166 www.ijcs.uaic.ro

UV FLUORESCENCE PHOTOGRAPHY OF WORKS OF ART: REPLACING THE TRADITIONAL UV CUT FILTERS WITH INTERFERENCE FILTERS

Luís BRAVO PEREIRA*

Art Conservation and Restoration Centre, School of Arts, Universidade Católica Portuguesa, Portugal.

Abstract

For many years filters like the Kodak Wratten E series, or the equivalent Schneider B+W 415, were used as standard UV cut filters, necessary to obtain good quality on UV[i] Fluorescence photography. The only problem with the use of these filters is that, when they receive the UV radiation that they should remove, they present themselves an internal fluorescence as side effect, that usually reduce contrast and quality on the final image. This article presents the results of our experiences on using some innovative filters, that appeared available on the market in recent years, projected to adsorb UV radiation even more efficiently than with the mentioned above pigment based standard filters: the interference filters for UV rejection (and, usually, for IR[ii] rejection too) manufactured using interference layers, that present better results than the pigment based filters. The only problem with interference filters type is that they are sensitive to the rays direction and, because of that, they are not adequate to wide-angle lenses. The internal fluorescence for three filters: the B+W 415 UV cut (equivalent to the Kodak Wratten 2E, pigment based), the B+W 486 UV IR cut (an interference type filter, used frequently on digital cameras to remove IR or UV) and the Baader UVIR rejection filter (two versions of this interference filter were used) had been tested and compared. The final quality of the UV fluorescence images seems to be of a superior quality when compared to the images obtained with classic filters.

Keywords: *UV radiation, UV Fluorescence, interference filters.*

Introduction

When photographing works of Art, one of the most used and simple way to implement non-invasive techniques is UV fluorescence. Recording UV fluorescence images with photographic methods (with digital sensor or with film) requires the use of an adequate UV source, like the Wood's lamps [1]. Those lamps produce essentially UV radiation but also some blue visible light, even if they are usually known as "black lights", because ideally they should be emitting only UV radiation. In some cases and if necessary, a barrier filter should be inserted in front of the radiation source (usually Wratten 18A or Scotch UG1 filters) [2]. When the UV radiation hits the surface of the work of Art in study, it will induce in some of the materials a fluorescence of visible light. This fluorescence, being a visible phenomenon, can be recorded photographically, but some care should be taken with the photographic technique in use:

* Corresponding author: lbravo@porto.ucp.pt

- the “white balance” should be adequate to show, on the final image, a similar look to what human eye sees when observing directly the fluorescence in cause (usually daylight colour temperature is adequate);
- some authors recommend the use of a yellow filter, such as the Wratten 12 [2], to eliminate the blue 'leakage' common with many Wood's lamps and ultraviolet transmission filters [2];
- sometimes a pale cyan filter (10-20CC) is also recommended [2] by some authors as part of the barrier combination to absorb the slight red leakage of the Wratten 18A[iii], when this filter is used;
- it is essential to avoid UV radiation from being recorded; this radiation is necessary to induce the fluorescence phenomenon but should not be recorded on the final image, because the reflected UV image shows a different type of information [3, 4] than what can be obtained with UV induced fluorescence[iv].

To avoid the strong UV radiation reaching the camera sensor or film, it is recommended to use a more efficient than the common “UV” or “Skylight” filter in front of the lens, and traditionally the recommended filters are the Kodak Wratten series E filters or some type of equivalent filter. In this case, the equivalent to a Wratten 2E made by Schneider with the brand B+W, the B+W 415 glass filter has been used. Those filters are efficient on removing UV radiation but all of them present a major inconvenient: their internal fluorescence too [2], emitting a yellow light when receiving UV radiation directly, and this can reduce the image quality. Some authors [2] recommend to use the filter on the rear of the lens instead, because this way the glass and anti-reflection layers of the lens elements will reduce the UV radiation, but this is way of holding the filters it is not possible to implement with the majority of filters and lenses in use by Art photographers.

So, even if the Wratten 2 series filters (or other brand equivalents) were, for a long time, the standard recommended filters to reject strong UV radiation in fluorescence photography, they are not the best available today: nowadays there is a new kind of filters, that can remove efficiently the UV radiation without presenting the internal fluorescence inconvenience, and that is possible because instead of absorbing the unwanted radiation with pigments, they use interference layers to eliminate this same radiation.

However, the interference filters can present some inconveniences too:

- they should be hold perpendicularly to the lens axis to have maximum efficiency [[5]];
- because of this “angle efficiency” characteristic, they are not suited for lenses with a wide angle of view [[5]], otherwise the corners of the image will not be filtered efficiently;
- they are usually more expensive than the traditional filters.

In the present article a comparison between different UV barrier filters has been performed, testing internal fluorescence susceptibility and there efficiency and quality on the resulting UV fluorescence image. The goal was not to compare exhaustively all available models on the market or quantify there efficiency with precise measurements, but simply to communicate to the scientific community the experience and (always subjective) validation by appreciation of the obtained images resulting from the use of two models of filters as replacements of the traditional Kodak Wratten 2 or there equivalents [6].

Materials and Methods

The three compared filters are:

- "B+W 415 Ultraviolet cut", a Wratten 2E equivalent made by Schneider;
- "B+W 486 UVIR cut", a recently introduced interference filter from the same provider [[7]], that removes UV and IR radiation, one of the most recommended today for use with modified cameras, like the Fuji IS Pro;
- "Baader UVIR Rejection filter" or "UVIR cut", an interference filter [[8]] that removes UV and IR radiation with a complex interference system of 39 (old type) or 44 (current type) dielectric coating layers; this filter, produced by Baader, a company of products for Astronomers, is developed to be used on telescopes, and therefore is available only at the maximum diameter of 48mm; the upgrade from 39 to the current 44 dielectric coating layers was to improve the anti-IR capability, a better characteristic on the current version when compared to the previous version but with no impact for rejecting UV when the filter is used for fluorescence photography.

The used illuminants are the following:

- Two General Electrics Wood's lamps (GE F20112 BLB, 20W, 60 cm long fluorescent tube Black light), 1 meter equidistant from the photographed target, one each side of the target and with an angle of circa 45 degrees relatively to the target.

The used targets:

- the filters described above (Fig. 1), used to demonstrate the presence/absence of internal UV induced fluorescence;
- a "mock-up" of a painting, that is to say, not a real "work of Art", but a simulation of a painting made of a blank canvas with acrylic paint and some synthetic varnish over the pictorial layer; this "painting" was made without any artistic purpose or value, but only to use it for demonstration purposes (Fig. 2). For ethical reasons we have decided not to use real Works of Art for demonstration or test purposes in the current article.

The lens used to capture all the images in this article:

- Nikon Micro-Nikkor 55mm f/2.8 AI-S lens.

The cameras used in the tests are:

- A Nikon D300, used only to capture the image of the filters fluorescence (Fig. 1); adjusted at f/8, iso400, 6 sec. exposure; "Daylight" white balance;
- A Nikon D70 DSLR[v] camera, to photograph the works of Art (Fig. 2); this model is currently used in our Restoration Center (since 2004, when it was first introduced on the market), adjusted at f/4, iso400, 3 sec. exposure; "Daylight" white balance.

Both cameras were configured shooting RAW[vi] files, Adobe RGB colour space, cameras configured to "Daylight" white balance, using the custom white balanced on the Adobe Photoshop ACR[vii] with a white non-fluorescent card as neutral reference (Fig. 1) and leaving with the preset daylight white balance (Fig. 2). Successively the files were resized, converted to sRGB colour space, cropped and saved as JPEG[viii] to include the images in this article. In the legends of the images (Fig. 1 and Fig. 2) the remaining relevant data is described in detail.

The remaining steps for the methodology used to capture the images of fluorescence were the commonly recommended for works of Art [1, 2, 4, 6]: images captured on a photographic studio in complete darkness, using the black lights (as described above), the camera mounted on a sturdy tripod, triggered using camera's self timer or remote cable. Exposure was determined by internal camera centre-weighted photometer and compensated if necessary, when appreciating the resulting image and corresponding histogram on the DSLR screen.

Results and Discussions

In figure 1 one can appreciate the strong yellow fluorescence present on the B+W 415 filter, a Kodak Wratten 2E equivalent, and the absence of internal fluorescence on the other filters (interference type B+W 486 and Baader UVIR rejection filter).

The figure 2 (a, b and c) shows the results obtained when applying the filters for their practical use, mounted on a camera lens to reduce UV reaching the camera. The figure 2.d shows the same picture captured without filters mounted on the lens; here it is possible to assess the effect of undesired UV presence.

Fig. 1. From left to right: B+W 415 filter, glowing with internal fluorescence; B+W 486 interference filter; Baader UVIR rejection interference filter. Filters receiving direct UV radiation from Wood's lamps (for other relevant data from image capturing and post-production, please read "Materials and Methods").

To capture the figure 1 demonstration, the filters were exposed to direct UV radiation. When using the filters mounted in front of a camera lens, in a real world practical use, and in some cases using a shade mounted after the filter, the quantity of UV rays can be reduced substantially and the filter fluorescence is not so strong as seen in the figure 1. But even like that there will always be present some undesired internal fluorescence that will impact the image quality, as seen in the figure 2.a.

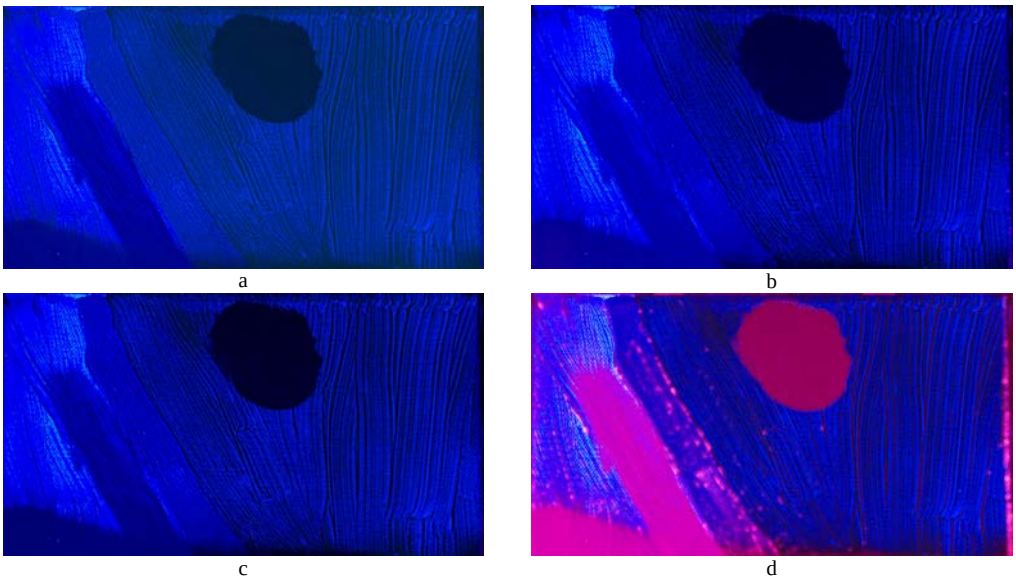

Fig. 2. Painting receiving direct UV radiation from Wood's lamps (for other relevant data from image capturing and post-production, please read "Materials and Methods"): **a -** image captured with B+W 415 filter, b - image captured with B+W 486 UVIR cut filter, **c -** image captured with Baader UVIR rejection filter, d - image captured without any filter mounted on the lens.

Conclusions

With the same methodology previously used on B+W 415 UV cut filter (equivalent to the Wratten 2E), on the images captured with the interference filters, a better overall contrast and image legibility were obtained, as one can appreciate in figure 2.b. and figure 2.c. It can be concluded that the internal fluorescence of the B+W 415 filter, even when minimal, reduces the final quality of the resulting image (Fig. 2-A), even if it is preferred to not use any filter at all (Fig. 2-D).

It seems more appropriate to use UV rejection interference filters than the traditional Wratten 2 type filters or equivalents, when the goal is to reject the UV radiation in fluorescence photography.

Even like that, the interference filters have to be used with an appropriated technique, as mentioned above in the Introduction, but they are not a *Panacea* for general use in all the circumstances. However, when using DSLR cameras with DX sensors([ix]) for UV fluorescence photography with 50 to 60mm focal length lenses, the interference filter shows very good results, better than the traditional filters.

From our practice since 2007, when we needed to capture images of UV fluorescence we have preferred the use of an interference Baader UVIR rejection filter and we had almost give up the use of the B+W 415, because from the appreciation of the captured images, as mentioned before, we could obtain better results in this way. Since then we have accumulated a positive experience of photographing UV fluorescence with this new type of filters in some hundreds of paintings from different periods and techniques, not shown on this article([x]), with old natural varnishes, in some cases, or with synthetic varnishes applied, when the Works of Art are from a recent period or when they were undergone a previous restoration. Therefore, we believe that we have already an experience long enough to validate the use of interference filters as Wratten 2 series replacements.

Acknowledgements

I would like to acknowledge my PhD Coordinators, the Professor Ana Calvo and the Professor Paulo Fiadeiro, for there constant support and to Fundação para a Ciência e Tecnologia in Portugal for the PhD grant SFRH / BD / 39192 / 2007.

References

[1] A. Aldrovandi, M. Picollo, **Metodi di documentazione e indagini non invasive sui dipinti**. Il Prato, Padova, 2001, pp. 67-85.

[2] R. Williams, G. Williams, **Medical and Scientific Photography: Ultraviolet induced fluorescence: Filters**. [Online]. http://www.mediphoto.com.au/Article_02/02d.html [Accessed: 25 Aug. 2010].

[3] E. R. de La Rie. *Ultraviolet radiation fluorescence of paint and varnish layers*, **Scientific Examination of Easel Paintings** (coord. R. Van Schoutte, H. Verougstraete-Marcq) Strasbourg: Council of Europe, PACT 13, 1986, pp. 91-108.

[4] L. A. Carcelén, A.G. Mozo, *Uso de la luz ultravioleta para el estudio del estado de conservación de la pintura de cabalette*, **Investigación en conservación y restauración – II Congreso del GEIIC**, 9th – 11th November 2005, Valencia, Spain, pp. 43-52.

[5] L. Chambers, **Diglloyd – Filters: B+W 486 UV-IR cut**. [Online]. http://diglloyd.com/articles/Filters/spectral-B+W-486.html [Accessed: 25 Aug. 2010].
[6] M. L. Carden, *Use of Ultraviolet light as an aid to pigment identification*, **APT Bulletin, 23**, 3,1991, pp. 26-37.
[7] S. Elen, **Beyond Visible – Basics: Luminescence, Reflected Ultraviolet and Infrared Photography**. [Online]. http://www.beyondvisible.com/BV0-Barebasics.html [Accessed: 25 Aug. 2010].
[8] S. Rørslett, **All You Ever Wanted to Know About Digital UV and IR Photography, But Could Not Afford to Ask - 6. Filters for UV**. [Online]. http://www.naturfotograf.com/UV_IR_rev04.html [Accessed: 25 Aug. 2010].

Notes

[i] UV: Ultraviolet electromagnetic radiation
[ii] IR: Infrared electromagnetic radiation
[iii] However, our practice with digital photography seems to show that in many cases a post-production on digital images with a custom white balance using a grey card as neutral reference, in some cases, or a specular metallic reflection, in other cases, can replace the use of the yellow and cyan filters.
[iv] It is not our goal in this article to discuss the utility of the UV reflected or the UV fluorescence applied to the study of the works of Art, subjects well documented in books and other articles about scientific examination using this type of radiation or photography in this specific field.
[v] DSLR: Digital Single Lens Reflex camera.
[vi] RAW: a type of digital image file, non-processed "raw" data from the sensor, with maximum quality.
[vii] ACR: Adobe Photoshop Camera RAW file converter plug-in.
[viii] JPEG: Joint Photographic Experts Group, a type of digital image file.
[ix] DX sensor: a sensor smaller in area than the 35mm film; currently the most frequently used in digital DSLR cameras like the Nikon D300 and D70, but that gives a different angle of view with the same lenses when compared to "full frame" or 35mm size sensors. The focal length of the lens gives with DX sensors an angle of view equivalent to what is obtained with a lens with a focal length 1,5 times longer applied on a 35mm format camera (digital or analogical).
[x] Since the mentioned works belong to external entities or to clients of our Restoration Centre, we have for ethical reasons decided not use them for demonstration or test purposes in the current article. However, the final results and conclusions, when using other works of Art, should be identical or equivalent to what is presented here, at least in the qualitative parameters compared here.

Received: August 6, 2010
Accepted: August 26, 2010