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Conservation problems with paintings containing fluorescent layers of paint

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Abstracts

Français English
L'artiste moderne cherche continuellement de nouvelles techniques. Des nouveaux matériaux tels que l'éponge, le polyester, le sable, etc. sont devenus courants. Ces développements amènent de nouveaux problèmes dans le domaine de la conservation (préventive) des matériaux en question. Chaque matériau doit être analysé individuellement afin de préserver le mieux possible l'intention de l'artiste à long terme. La présente recherche concerne des matériaux très récents: les pigments et les couleurs fluorescentes. Ces derniers n'ont fait leur apparition qu'au vingtième siècle. Pour cette raison les données concernant leur dégradation et leur conservation sont peu nombreuses. La majorité des tableaux fluorescents sont conçus pour être montrés sous éclairage UV. En cas de dommage, si l'œuvre a besoin d'être retouchée, ceci pose un grand problème esthétique. La retouche devient visible sous les lampes UV. La première partie de la recherche concerne la composition des différentes sortes de pigments et de peintures. Par la suite, les différentes causes de dégradation- lumière UV, chaleur, etc.- sont analysées en détail. Pour conclure, un possible remède est proposé.

In modern art we can see that artists are breaking with traditional techniques. New materials like sponge, polyester, sand, etc. are being used. This causes a lot of new problems in the (preventive) conservation of works containing these materials. Every material needs to be researched individually so the exact intention of the artist can be preserved for a (relatively) long period. My research is about very recent materials: fluorescent pigments and paints. These only started to be used by artists from the 60's. That's why there is not much information about their aging and ways to (preventively) conserve them. A lot of fluorescent paintings are meant to be shown under UV-light. If a fluorescent painting has damage and needs to be retouched there is a big esthetical problem. The retouched damage is visible under UV-light. The title of this thesis is born out of this last problem: Conservation problems with paintings containing fluorescent layers of paint. The first topic of research for this thesis concerns the composition of these different sorts of paint and pigments. Afterwards, the causes of damage resulting from UV-light –and other factors- were thoroughly analyzed. Finally, a possible remedy is being proposed.

Index terms

Keywords : phosphorescence, fluorescence, phosphore, luminiscence, vieillissement, peinture, peinture fluorescente, pigment fluorescent, Felix De Switzer, Day-glo, colorant fluorescent
Keywords: fluorescent paint, fluorescent pigment, blacklight, (preventive) conservation, restoration, Felix De Boeck, exhibition, AfrO_Fluo, Switzer, Day-glo, fluorescent dyes, resin, phosphorescence, fluorescence, phosphor, luminescence, aging

Editor's notes
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Full text

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The fluorescence phenomenon – Some definitions

Luminescence effects

1 Before going to the core of this paper, it's important to look closer at some definitions that are related to fluorescence.

2 Luminescence[1] can be divided into two phenomena, which are both categories of photoluminescence[2]: phosphorescence and fluorescence. In phosphorescence, the body continues to light up even if it's no longer illuminated. The Body loads up with daylight and lights up in the dark. After a while it stops glowing. A typical example of this phenomenon are the needles of a wristwatch that light up in the dark. Fluorescence[3], on the other hand, only takes place while the body is being lit.

3 In this paper, we will restrict ourselves to the latter phenomenon when used in paint layers.

4 There are different types of fluorescence. "Ultra-violetFluorescence" is the type of fluorescence that only can be observed in the dark while a UV-light shines on the body. Other substances will exhibit a strong fluorescent effect either under ultra-violet or daylight exposure, and will appear intensely colored, with very bright and pure shades.[4] Such substances are said to exhibit "Daylight Fluorescence". Ultra-Violet fluorescence and most of all Day-light fluorescence are most common types of fluorescent paint layers.

The composition of fluorescent pigments

Components

5 Fluorescent pigments that are being used in paints usually consist of organic fluorescent dyes which are being dissolved in transparent solid carriers such as

polymers consisting of formaldehyde resin, polyvinylchloride, alkyd resin,...[5]

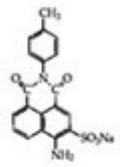
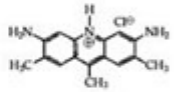
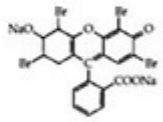
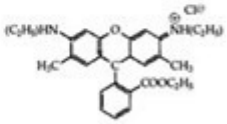
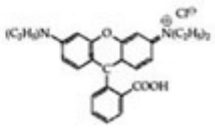
6 A fluorescent dye[6] is not really a dye in the traditional sense but is a solution of certain colorants in a specific matrix which we call carrier or resin. This carrier is responsible for the fact that the electrons of the colorants are being shot 10 tot the 8 times per second from a lower to higher energy level. But due to their instability fall back to their original level.

7 As a result of this energy is being released in the form of light. For this reason the reflection of a fluorescent color is more than 200 percent. Keeping in mind that the reflection of black is 0 percent, of white 100 percent, and the reflection of each random conventional color is between 0 en 100 percent. A fluorescent color is therefore visible three times faster than a conventional color.

8 Fluorescent dye's used for paints consist mostly of complex molecular structures. The basis of these structures is being formed by benzene rings that are interconnected trough interlinking. Aside from carbon bindings we also find nitrogen, oxygen and sulfur in these structures. Examples are among others Quinine, which was discovered in the 17th century, Fluoresceïne and Pyrazoline, both of which were discovered in the 19th century. All three have nitrogen or oxygen as building blocks of the molecular structure next to the carbohydrates. The chemical composition of dyes is usually not published for reasons of intellectual secrecy (These molecules are largely reviewed in literature.)[7]

Fig. 1: fluorescent dye's

Table 1 Fluorescent Dyes

Dye	Structure	Color under daylight[b]	Fluorescent color[b]
Brilliantsulfoflavine FF (C.I. 56205)[a]		Yellow	Green to yellowish-green
Basic yellow HG (C.I. 46040)[a]		Yellow	Greenish-yellow to yellow
Eosine (C.I. 45380)[a]		Red	Yellow to orange
Rhodamine 6G (C.I. 45160)[a]		Red	Yellow to orange
Rhodamine B (C.I. 45170)[a]		Pink	Orange to red

A table with some exampels of structures of common fluorescent dye's

Credits : SHIONOYA, S., M.YEN, W.,YAMAMOTO, H., *Phosphor handbook*, CRC Press, 2006

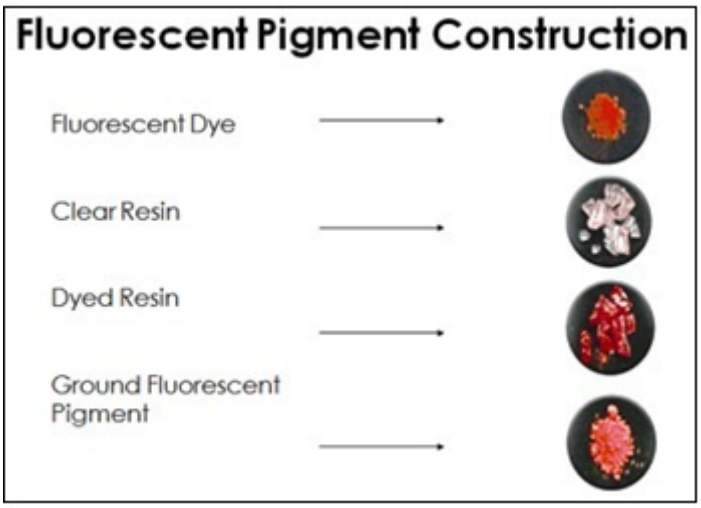
Production process of fluorescent pigments

"The fluorescence of organic dyes is associated with the individual molecules of the dyes, and in order for them to fluoresce efficiently, they must be molecularly dissolved and in fairly low concentrations from about 1 to 4%. In the pure solid state or in very concentrated solutions the dyes have almost no fluorescence and appear as dark or dirty. The individual molecules of the dyes are so close together that they simply quench or reabsorb their own fluorescent light."[8]

9 In a reactor the primary materials are being mixed with the dye (colorants). Sometimes UV-absorbers antifoam and antidust additives are being added. When, the whole reactor is heated the primary materials melt first and form a liquid mass. Around a hundred degrees Celsius, the so called reaction water gets isolated and evaporates before the primary materials react with each other to form large cross-linked molecules. In this molecule that we called carrier matrix or resin before, the dyes are being dissolved. The level of cross-linking determines the quality. The resistance to solvents or compatibility with paint solvents becomes bigger. Because the quality increases over time the primary materials are kept in the reaction process as long as possible. The reaction stops when the highest viscosity of the mixture is reached. As soon as it cools down, the reaction - mixture becomes rock solid. For it to become useable for fluorescent applications it has to be ground. Because of the hardness this happens in two steps. First it goes to a hammer mill, then to a specialized mill that can reduce the pigment particles to 3 to 5 micrometer. Whit this powder pigment the paint manufacturer goes to work. As with conventional pigments a binder thinner and if necessary additives will be added to make a paint that is ready to used by the artist.[9]

> “Fluorescent pigments in various types of paint offer an effective way to impart fluorescence. Because of the inferior light fastness of fluorescent products in thin layers, the paint is generally applied in a 75–150-µm thick layer to optimize the resistance to exterior fading”.[10]

Fig. 2 Fluorescent pigment construction



This scheme shows the production steps until the ingredients become a fluorescent pigment ready for use. (dye mixed with a clear resin, melted together and then grounded until it becomes a pigment)

Credits : General Information sheets Radiant Color NV (Houthalen-Belgium)

Scheme

10 The first fluorescent pigments where mixed in shellac and where thinned out with alcohol. The colors where not quite as bright as they are now and they age a lot faster. Later they started to mix the pigments with gum Arabic. Currently fluorescent pigments are mixed with acrylic which makes it possible to paint on canvas and panel very easily. Gum Arabic is also still being used.[11]

History in application, of fluorescent pigments

11 The brothers Robert C. Switzer (1914 – 1997) and Joe Switzer where the inventors of the first fluorescent pigments wich they called Day-Glo[12]. Although the first fluorescent pigments they discovered didn’t need a UV-light for glowing.

12 Because of a work related accident endured whilst working on the railroads in California, Bob Switzer got into a coma which lasted several months. Afterwards he was advised to stay in a dark room until fully recovered. Out of his passion for magic that he shared with his brother they discovered that certain organic components and minerals fluoresced under black light. Quickly they started using these components to enhance their paints. The experiments with these minerals continued. In 1934 the brothers invested 220 dollars and formed a small company in their mother's kitchen Fluor- S- art company. In the 40s the brothers also discovered daylight fluorescent colors. They called these cold-fire pigments. There first commercially successful products where shiny fluorescent panels made up of cellulose and textile, that were used during world war two by ground troops in north Africa to signal allied bombers. Other colors could not be discerned at large distances and in conditions of poor visibility.

13 Around 1944 artists started to experiment with these pigments sporadically. A certain number of artists appeared in the *American artist magazine* stating that they used fluorescent colors. In 1946 the brothers created Switzer brother inc. in Cleveland Ohio. The name was changed in the 60s to Day-Glo color corporation. In the late 50s fluorescent print inks that could be used on satin canvasses and screen printing where developed. They were also used as press inks and water soluble paints. Posters were also being made using these products. Around the same time they found a method to make the particles smaller without losing the intensity of the colors.

14 Today there is make-up containing fluorescent colors. This would have been impossible a few decades ago because of the high concentration of formol in the pigments. The application of fluorescent pigments today is widespread: magic markers, fishing lures,... Fluorescent ink for jet printers has not been found though because the particles would be too small to retain the intensity of the colors. [13]

Which painters where the first to use fluorescent paint?

15 For this research it was useful to know who in Belgium used fluorescent paints first, so we can see how fast, since the development of fluorescent paints, Belgian artists are getting interested in using these new paints.[14] Felix De Boeck (°1898 - + 1995) is one of those first artists to experiment with fluorescent colors. According to Phil Mertens (conservator at the contemporary art museum in Brussels (Belgium), Serge Vandercam (°1924) and Bert De Leeuw (°1926) started using fluorescent colors around the same time (late 50s and 60s). In 1958 the attic of the Hessenhouse which had been newly renovated was made available for an exhibition that made it possible for unknown artists to show their work. The critics attention was immediately caught by two relief paintings made by Bert De Leeuw. These where made of fluorescent colors and showed very peculiar effects. Critic Mark Callewaert noted that Paul Van Hoeydonck (°1925) was also experimenting with fluorescent paint. Later on, several pop art artists would use these materials including R. Raveel (°1921) (The way to Brussels please and Men considering this age).[15]

The relationship between Felix De Boeck and fluorescent paint

16 Felix De Boeck is an important painter both for his innovation in techniques and his use of materials. He was clearly inspired by (post-)impressionists, most notably by Vincent Van Gogh. Like the impressionist who tried to capture light through paint, De Boeck made it his main objective to display light on the canvasses. In this he even went a step further. White light consists of primary and secondary colors according to Newton. He used mainly primary and secondary colors. "*A painting by the Boeck is first and foremost a captivating play of colors around an always present center of light*".[16]When fluorescent paints became commercially available he saw a chance to

make his paintings literally light up. His friend and composer Louis De Meester would bring him fluorescent gouache from Germany because they were not yet available in Belgium (around 1954[17]).[18] Certain letters written by De Boeck around that time can prove this fact. These letters are being kept in the Felixart museum in Drogenbosh.

17 "*He starts to experiment with the paint and gets filled with enthusiasm*".[19] It seems as light was a common thread in his thinking. His works never consisted fully of fluorescent colors. It seems their effect was too dominant to fill up the whole canvas with them. He painted these works in the same way as the non-fluorescent ones. The only difference is that he used a wood lamp (a type of black light). His fluorescent paintings can be shown both under day-light and black light. The ideal way of presenting these works is to combine daylight and black light. We will come back to this point later.

18 The Boeck only made eighteen fluorescent paintings. " *He used earlier grafisms – mostly self-portraits, portraits of Vincent Van Gogh and a few abstract works"*. He soon realized that fluorescent paints have a limited lifespan. This painter made his works for eternity.[20]

Three case-studies

19 For this research- project three of the Boeck's fluorescent paintings were made available. It is important to know that no fluorescent- work of this artist has ever been conserved. The paintings where made subject of both dermatological and non-dermatological testing. The point of these tests was to gain greater knowledge of the aging of fluorescent paint layers in order to adapt and enhance the preventive conservation.

Fig. 3 Abstract, Felix De Boeck 1954

left daylight, right black light

Credits : Stéphanie De Winter

Fig. 4 Mask, Felix De Boeck, 1956

left daylight, right black light

Credits : Stéphanie De Winter

Fig. 5 Portrait of Vincent Van Gogh, 1957

left daylight, right black light

Credits : Stéphanie De Winter

20 The three paintings are made out of a base of oil paint in combination with fluorescent gouache on prepared unalit - panels. The gouache was added using a wood lamp. Unalit consists of fybrefyed poplar wood. These are soft fiber - plates that are also being used as separation wall or under floor. It is clear that the painter used some cheap, recycling materials. The ground layer that he used was possible latex paint.[21]

21 Felix De Boeck developed the technique that would determent the rest of his work in the mid thirties. " With the point of a compass or a needle he carved the outlines of the shaves in the ground layer of the panel and repeated this when adding the color. This became known as the De Boeck technique, consisting of transparent layers of colors with a circular drawing. The drawing arises out of crossing points of the circles and bent lines that had been engraved by the compass."

22 The painter varnished all his fluorescent paintings. The brand of the varnish is possible, *vernis a tableau J.G. Vibert ref. 1251 Lefranc & Bourgeois M8024*. This is most likely the case because a few bottles where found along with fluor-art thinner in his workshop that's been conserved.

Fig. 6 Materials that were found in the workshop of Felix De Boeck

Left: Fluoart gouche paint, middle: Fluoart thinner, right: vernis à tableau J.G. Vibert ref. 1251 Lefranc & Bourgeois M8024

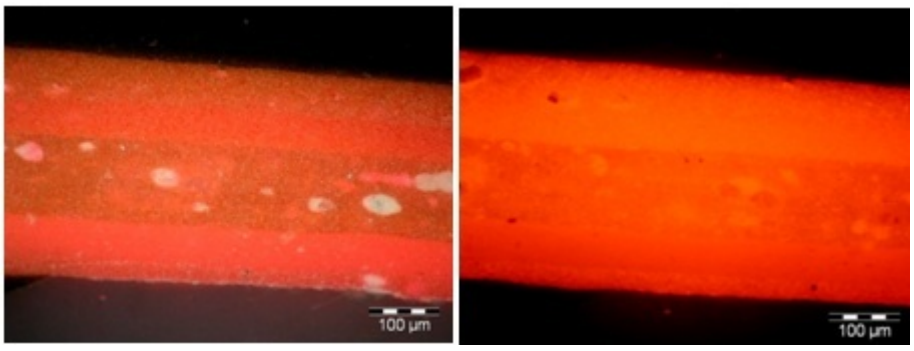
Credits : Stéphanie De Winter

Comparative quality testing of a number of fluorescent pigments and paints

23 To gain an idea of the level in which the fluorescent pigments of different brands differ in quality, a paint sandwich was made. A spur of about 100 nanometre of each type of fluorescent acrylic paint was placed on silicon paper. Different pigments with the same colors were placed on top of each other like a sandwich in order to take a sample. These parts of larger paint sandwiches where imbedded in resin after which they where polished. After this process was done it became possible to visualize the different sorts of sequence paint layers under a microscope.

24 In general we perceive two or three different tints. The pigment monsters coming from companies showed the best color intensity and fluorescence under UV-light. The layer with the lowest color intensity and fluorescence was always the ready-made fluorescent acrylic paint. Acrylic paint from tubes usually has a lower pigment concentration than oil paint due to many additions: half of the paint mass consists of water or solvent. Some manufacturers use a content amount of binder, even when it's not required by a certain pigment, to prevent cracks in the paint during or after the drying process[22]. Because of this, the colors seem less saturated and less opaque.

Fig. 7 Stratigraphy of different pink fluorescent paint layers (microscope)



Left: dark field, right : UV

Credits : Stéphanie De Winter

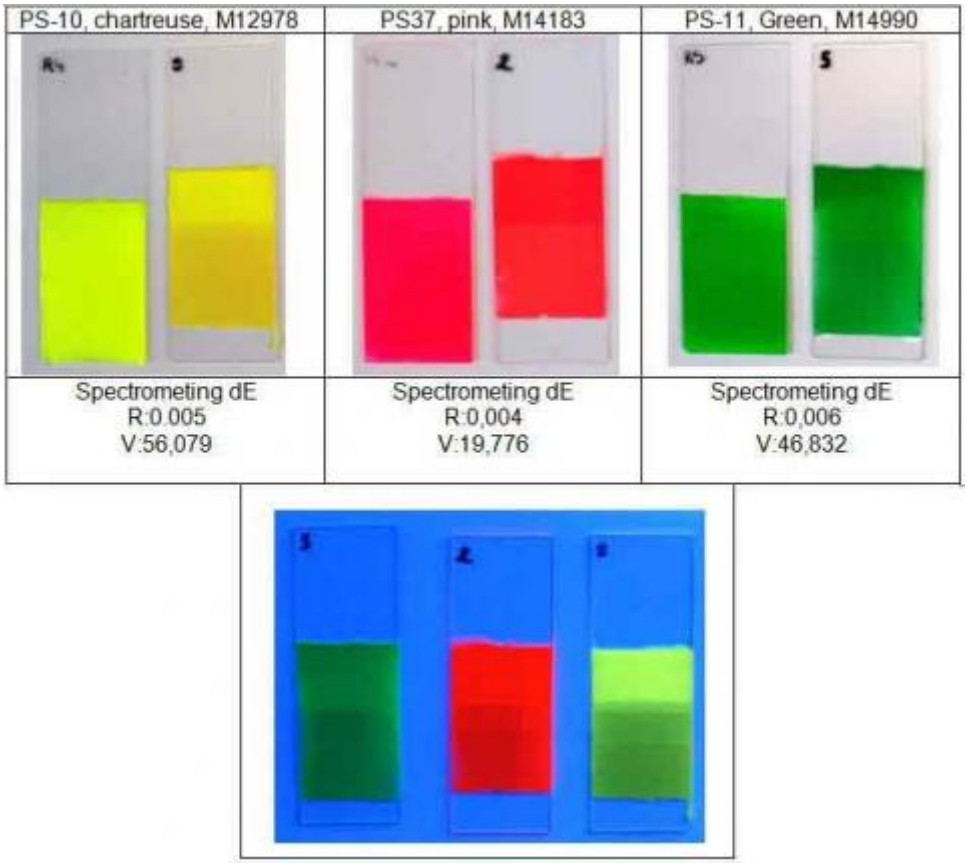
Comparison in quality and degradation of fluorescent paint layers

25 The biggest problem with fluorescent paints and pigments is the uncontrollable fading which is the result of a number of parameters. Fluorescent paint layers reflect light but at the same time they gradually lose their color intensity. (It is well known that fluorescent pigments do fade, the fluorescent and/or brightening agent which they are mixed with are also not stable. That is one of the reasons why fluorescent pigments are

incorporated in resin matrix for improving their light fastness.) The degree in which both cases appear varies and is difficult to predict. The fluorescent paint layer darkens and there is a gradual decrease in fluorescence. Consequently the fluorescent layer blanches. This combination of blanching and decrease in fluorescence causes problems in the conservation of contemporary art. (The so-called loss of fluorescence is an irreversible physical process.) Namely, retouching and slowing down the fading of the fluorescence and color intensity.

26 Fluorescent pigments hold their maximum effect only for a limited period of time.[23] The tests show that parameters such as light, humidity and heat increase the speed of this process[24]. Concern for the preservation of their works is causing many contemporary artists to stay away from fluorescent paint. Spokesmen of lithos Benelux and radiant color nv[25]. inform us that many new developments are on their way. There is a continuous search for better encapsulation - materials and for methods that increase the lifespan of these pigments. Technology evolves and so does the development of fluorescent and other new types of pigments.

Fig. 8 Aged samples



Aging machine: Suntest CPS+ samples: acrylic paint on glass plates

Credits : Stéphanie De Winter

Conservation methods for fluorescent paintings

Most suited consolidation medium for paintings with fluorescent layers

27 For these, a test board with fluorescent gouache was made on very smooth carrier in order to accelerate the cracking's in the paint a point where a fixative is needed. A clear gelatin hardly fixated the paint and caused a slight difference in color and in fluorescence (visual interpretation: white glow). The surface was also slightly glossy.

Fish glue gives better results; in this case there was no difference in color and the fluorescence was not affected. It stayed mat. The binding was better than in the case of gelatin, but still not optimal. Wax/resin binds very well, but is dirty and gives the whole paint layer a gloss. This causes an effect of pollution under UV, the fluorescence is not as bright as it used to be. Plextol B500[26] is the most effective of the four fixatives. The acrylic dispersion resin does not fluoresce. It fixates outstandingly without gloss or changes in color. Under UV-light there is almost no difference in fluorescence noticeable. Fish glue and plextol age very well. They have almost no yellowing. It should be noted that information regarding the aging of these fixatives when used in combination with fluorescent paint is not known, so it is hard to tell whether there will be a change in color after a few years. More testing on this issue is needed.

Which filling to use for paintings containing fluorescent layers

28 The difficulty here lies in approximating the color of the original filling as much as possible. As stated, fluorescent paints are transparent. Only after a few days their colors come out optimally. Another requirement was a ground-layer that was as white as possible in order to support the color reflection. When a lacune has to be filled, it is the conservator's task to determine which ground layer the artist used. Once this is known, it is possible to apply the same white ground-layer in the filling

Retouching lacunes in fluorescent layers

29 One of the most important and most difficult aspects of conservation is the retouching of lacunes. Especially with fluorescent paints this becomes an even greater challenge.

30 As stated earlier, fluorescent layers darken first and then have their colors fade. This behavior is applicable to all fluorescent paints. On top of this, the intensity of fluorescence diminishes. Both these forms of aging increase the difficulty of retouching fluorescent works significantly. Retouching with non-fluorescent pigments causes us to lose the luminescent effect although the color can correspond. Mixing regular with fluorescent pigments creates 'dirty' colors and is therefore not an option. The only case in which the use of non-fluorescent pigments is advocated is when the original fluorescent layer has aged considerably and when there is barely any fluorescence left. In this condition the fluorescent colors will have a milky appearance.[27]

31 Literature informs us that there is only one effective method to solve this problem. First we need to know the exact age of the painting. Once the exact age of the painting is known the fluorescent pigments can be aged until the colors closely match. This matching of the aged pigment on the original paint layer happens visually. The most effective way is to age three different samples of the same color in a different way. After comparison the closest color will be used for retouching.

A possible protection layer for a fluorescent painting

32 A varnish layer fluoresces mostly green under UV-light after several months/years.[28] This phenomenon occurs sooner with natural varnishes such as dammar then with synthetic varnish such as paraloid B72. Paintings that are not meant to be presented under UV-light are best varnished with a synthetic layer. Recently an additive for a protection layer was specially designed for fluorescent paint layers (UV-screen). This protection layer consists of a great number of UV-absorbers that cause the fluorescent layer not to reflect and thus slow down the aging. This protection layer is still subject to

amendment since it tends to become yellow and the effects concerning reversibility have not been tested yet.

The possibility of conserving preventively

33 How is it possible to conserve the intensity of the fluorescence as long as possible? Knowing that this intensity will decline fairly rapidly can be quite frustrating for conservators and especially for artists. Would it be possible to freeze them? Cold temperatures considerably slow down the emission process. Would it be best to keep them in a dark closet and only take them out when they have to be exhibited?

34 In some cases artists will make more than one work containing fluorescent colors in one genre. For example Frank Stella, Ryan McGinness and Peter Halley each create works with an almost mathematical exactitude. Would it be an option to make a double and only present that; preserving the original? Showing pictures is not an option because cameras are not capable of capturing the fluorescence.

35 A painting containing fluorescent colors can be displayed in several ways. Frank Stella and Peter Halley produce works that are meant to be shown in daylight. Ryan McGinness however, makes paintings that are only to be displayed in a darkroom under UV-light. The works of Felix De Boeck are best seen in a half-darkened room with UV-light, because they combine fluorescent an non-fluorescent paint. This illustrate another difficulty in the preventive conservation of fluorescent paintings: the choice of space and lighting for the exhibition of the paintings.

Fig. 9: Aesthetic comfort, Ryan McGinness 2008

Composition of fluorescent paintings shown under black-light

Credits: © Ryan McGuiness

Figure 10: Gallery space with fluorescent works from Peter Halley

Composition of fluorescent paintings shown under white light (daylight)

Credits: © Peter Halley

36 For fluorescent paintings being presented in a dark room with UV-light, it is strongly advisable to use an automatic lighting system. That way a spectator who comes near the work will cause the blacklights to turn on automatically. For example, trough a sensor picking up movement. After a few minutes without detection of movement the lights turn off. The same applies for works needing to be shown under regular light.

37 Fluorescent painting only last a short time. Even if the works are conserved optimally, the first signs of intensity loss will be visible after five years. Therefore, it might be wise to cut the time of exhibition in half.

Conclusion

38 Fluorescent paints are creating a new dimension in contemporary art. Since their inception there has been extensive experimenting with luminescent pigments, although it was assumed from early age on that their longevity was limited. The aging tests that where done for this research confirm this assumption. Most artists use the fluorescent colors as an addition to the conventional color pallet. Only very few work exclusively with fluorescent colors that where shown under UV-light. The former is illustrated in the early works of Felix De Boeck.

39 Conserving fluorescent materials is much more complex than maintaining regular colors because of the varying lighting conditions they have to be exhibited in. While a fluorescent painting can seem perfectly restored by daylight, it can lose its effect under UV-light because of non-matching retouches or fillings that are either too light or too dark. Unlike with regular paintings, fillings and retouches are being applied directly onto the painting without intermediary buffer. This causes a dilemma because reversibility has to be sacrificed. The importance of research cannot be stressed enough. The works need to be dated meticulously and if possible, the type of paint has to be determined before the actual restoration can start. When it comes to protection layers, the UV-screen seems a promising solution for those paintings that don't have to be shown under UV-light.

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Notes

1 Luminescence (Latin word lumen =light) is a body's ability to emit lightwhen illuminated by a light source.Scientifically speaking, luminescenceis the optical radiation of a physicalsystem produced during the transferfrom an excited condition to a basic condition. Light emission is triggeredby excitation in the UV, IR or visiblelight range.(ZEISS, C., Innovation 14, 2004 chapter 1: the fluorescence phenomenon, p. 4, link: http://www.zeiss.com/C125716F004E0776/0/74E9C59C374EFCF2C1257177006 9E9ED/$File/Innovation_14_4.pdf)

2 Photoluminescence is a process in which a substance absorbs photons (electromagnetic radiation) and then re-radiates photons.

3 Colors we see and ascribe to substances are related to the selective absorption of light incident upon their surfaces. If spectral components of the visible spectrum are absorbed, visible color will result. The perceived color then depends upon the wavelengths of the reflected or transmitted light. In case of conventional colors, the absorbed light excites the substance to higher energetic states resulting in increased molecular movements, collisions and vibrations, and if energy levels achieved are high enough, chemical reactions and even decomposition may follow. Some particular substances under specific conditions however, are capable of converting the absorbed energy by reemission of radiation. Such processes are generally termed "Fluorescence".(cfr: http://www.radiantcolor.com/fileshare/applications/general.pdf)

4 The perceived color here is a composite of the normal color, due to reflection of emission. These substances absorb UV-light or the short waves of the visual spectrum, or both, and convert them to a visible radiation, reinforcing the normal color. (cfr: http://www.radiantcolor.com/fileshare/applications/general.pdf)

5 General Information sheets Radiant Color NV (Houthalen-Belgium)

6 “dye” is a synonym for “colorant”. In this article both words will be used.

7 p: 771-773 (chapter: 11) SHIONOYA, S., M.YEN, W.,YAMAMOTO, H.,, Phosphor handbook, CRC Press, 2006

8 RYAN, P.J. (Swada (London) Ltd.), “Daylight fluorescent pigments and colours”, Pigment & Resin Technology, Vol. 1 Iss: 9, pp.21 - 26

9 Information André Smeets Radiant Color NV (Houthalen-Belgium)

10 P 17-19 KIRK-OTHMER, Encyclopedia of Chemical Technology,John Wiley & Sons, Inc

11 Information André Smeets Radiant Color NV (Houthalen-Belgium)

12 Day-Glo: Blacklight paints can be mixed with similar shades of normal pigments, "brightening" them when viewed in sunlight. Day-glo is a tradename, and a common name for these sorts of paints. (Information André Smeets Radiant Color NV (Houthalen-Belgium)

13 K. STRATIS, Harriet, SALVESEN, Britt, The Broad Spectrum, text: Daylight fluorescent Colors on artistic media

14 In this case only Belgian artist because of the restoration of three fluorescent paintings painted by the hand of a Belgian artist named Felix De Boeck.

15 P: 68 CASSIMAN, B., proefschrift ter verkrijging van de graad licentiaat: Felix De Boeck of de weg van de plastique pure sentimentale naar een vergeestelijkt realism, Rijksuniversiteit Gent, Hoger instituut voor kunstgeschiedenis en Oudheidkunde 1984 (zie bijlagen)

16 DUSAR, A., Felix De Boeck retrospectieve tentoonstelling begijnhof Hasselt 10 nov-1dec 1968, Hasselt 1968

17 Felix De Boeck his earliest painting made with fluorescent paints was made in 1954.

18 DE BOECK ,F., Mijn leven en mijn werk, in Flits,nr.29, lente 1977, p. 21-28 meerbepaald p.25

19 p 70, DUSAR, A., Felix De Boeck retrospectieve tentoonstelling begijnhof Hasselt 10 nov-1dec 1968, Hasselt 1968

20 P 72, DUSAR, A., Felix De Boeck retrospectieve tentoonstelling begijnhof Hasselt 10 nov-1dec 1968, Hasselt 1968

21 This information is based on the results of different kinds of research by the author herself.

22 For example: fluorescent paint series from Daler & Rowney, System 3 (acrylic paint)

23 Information received from Marcel Vrijsen, Lithos Benelux

24 Some tests were done to see what would happen to a dummy with different brands of fluorescent pigments and paints over a period of two months. One dummy was putted in a cabinet with UV-light during two months. Another dummy was putted in an oven (35°C) during five days and one was kept above a reservoir of water during two months. There was a reference dummy saved in a dark room for comparing. Almost all the paint layers from the tests where visually aged.

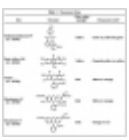
25 These are the companies that sponsored some fluorescent pigments for this research.

26 Plextol B500 is commonly used as an adhesive for canvas lining and for consolidation treatments. It is an aqueous dispersion of a butyl acrylate and methyl mathacrylate based copolymers. (Lascaux data sheet)

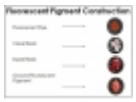
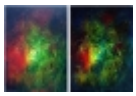
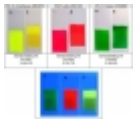
27 K. STRATIS, Harriet, SALVESEN, Britt, The Broad Spectrum, tekst: Daylight fluorescent Colors on artistic Media

28 NICOLAUS, K, The Restoration of Paintings:“varnish layer” p: 310-371

List of illustrations



Title	Fig. 1: fluorescent dye’s
Caption	A table with some exampels of structures of common fluorescent dye’s
Credits	Credits : SHIONOYA, S., M.YEN, W.,YAMAMOTO, H., *Phosphor handbook*, CRC Press, 2006
URL	http://journals.openedition.org/ceroart/docannexe/image/1659/img-1.jpg
File	image/jpeg, 36k

 **Title**	Fig. 2 Fluorescent pigment construction
Caption	This scheme shows the production steps until the ingredients become a fluorescent pigment ready for use. (dye mixed with a clear resin, melted together and then grounded until it becomes a pigment)
Credits	Credits : General Information sheets Radiant Color NV (Houthalen-Belgium)
URL	http://journals.openedition.org/ceroart/docannexe/image/1659/img-2.jpg
File	image/jpeg, 24k
Title	Fig. 3 Abstract, Felix De Boeck 1954
 **Caption**	left daylight, right black light
Credits	Credits : Stéphanie De Winter
URL	http://journals.openedition.org/ceroart/docannexe/image/1659/img-3.jpg
File	image/jpeg, 36k
Title	Fig. 4 Mask, Felix De Boeck, 1956
 **Caption**	left daylight, right black light
Credits	Credits : Stéphanie De Winter
URL	http://journals.openedition.org/ceroart/docannexe/image/1659/img-4.jpg
File	image/jpeg, 44k
Title	Fig. 5 Portrait of Vincent Van Gogh, 1957
 **Caption**	left daylight, right black light
Credits	Credits : Stéphanie De Winter
URL	http://journals.openedition.org/ceroart/docannexe/image/1659/img-5.jpg
File	image/jpeg, 52k
Title	Fig. 6 Materials that were found in the workshop of Felix De Boeck
 **Caption**	Left: Fluoart gouche paint, middle: Fluoart thinner, right: vernis à tableau J.G. Vibert ref. 1251 Lefranc & Bourgeois M8024
Credits	Credits : Stéphanie De Winter
URL	http://journals.openedition.org/ceroart/docannexe/image/1659/img-6.jpg
File	image/jpeg, 28k
Title	Fig. 7 Stratigraphy of different pink fluorescent paint layers (microscope)
 **Caption**	Left: dark field, right : UV
Credits	Credits : Stéphanie De Winter
URL	http://journals.openedition.org/ceroart/docannexe/image/1659/img-7.jpg
File	image/jpeg, 24k
Title	Fig. 8 Aged samples
 **Caption**	Aging machine: Suntest CPS+ samples: acrylic paint on glass plates
Credits	Credits : Stéphanie De Winter
URL	http://journals.openedition.org/ceroart/docannexe/image/1659/img-8.jpg
File	image/jpeg, 24k
Title	Fig. 9: Aesthetic comfort, Ryan McGinness 2008
 **Caption**	Composition of fluorescent paintings shown under black-light
Credits	Credits: © Ryan McGuiness
URL	http://journals.openedition.org/ceroart/docannexe/image/1659/img-9.jpg
File	image/jpeg, 28k
Title	Figure 10: Gallery space with fluorescent works from Peter Halley
 **Caption**	Composition of fluorescent paintings shown under white light (daylight)
Credits	Credits: © Peter Halley
URL	http://journals.openedition.org/ceroart/docannexe/image/1659/img-10.jpg
File	image/jpeg, 33k

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Stefanie De Winter, “Conservation problems with paintings containing fluorescent layers of paint ”, *CeROArt* [Online], EGG 1 | 2010, Online since 17 November 2010, connection on 04 August 2021. URL: http://journals.openedition.org/ceroart/1659; DOI: https://doi.org/10.4000/ceroart.1659

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- Álvarez-Martín, Alba. De Winter, Stefanie. Nuyts, Gert. Hermans, Joen. Janssens, Koen. Van der Snickt, Geert. (2020) Multi-modal approach for the characterization of resin carriers in Daylight Fluorescent Pigments. *Microchemical Journal*, 159. DOI: 10.1016/j.microc.2020.105340

About the author

Stefanie De Winter
Stefanie De Winter is a recent graduate from the Royal Academy of Fine Arts of Antwerp, majoring in painting conservation. After doing an internship in New York City, she came back to Belgium and started researching the conservation of fluorescent layers. Besides that, she’s a painter herself, constantly trying to explore and develop new techniques and materials.

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