Research on Improving Fluorescence and Heterochromatic Phenomena Based on Modules

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Abstract

This article aims to describe the phenomenon of fluorescence and heterochromatic aberration which is occurred in a certain medium size module. Through the analysis of the key material OCA, optical cleal adhesive, the root cause was found from the raw material, and this problem was successfully solved by adding UV absorbers. This makes the screen display clearer, softer, more uniform.

Keywords

Module, fluorescence, hererochromatic, UVcuring, Thermal curing, Photoinitiator, uv absorber

1. Introduction

This article mainly discuss that with the update and iteration of technology, the panel industry has become increasingly demanding in terms of visual requirements, requiring soft and uniform light. A certain medium-sized product in the industry, with its module schematic shown in Figure 1, is prone to visual problems, specifically manifested as the occurrence of blue fluorescence in the middle of the module under the bultraviolet light, and red at the edges under the visible light. After structural analysis, it is inferred that it may be caused by optical clear adhesive, OCA, and a series of experiments are now conducted to verify with it.

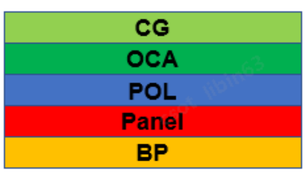

Figure 1. Module architecture of middle size

2. Experiments

Description of fluorescence heterochromatic phenomenon:

As shown in Figure 2, when ultraviolet light is irradiated on the prepared module, fluorescence will be seen, which is called fluorescence phenomenon;

As shown in Figure 3, when a fluorescent lamp is used to illuminate a certain module, red light will be seen at the edge, which is called heterochromatic phenomenon.

The essence of these two abnormal phenomena is an optical phenomenon, which refers to the reflection of light when ultraviolet/visible light is irradiated onto the surface of an object.

Fluorescence heterochromatic phenomenon testing method: 1) Fluorescence phenomenon testing: UV lamp with 365nm wavelength band and 25W light source, observation distance of 30cm; 2) Test for heterochromatic phenomenon: ordinary household fluorescent lamp, 15w, observation distance 30cm.

Figure 2. Fluorescence

Figure 3. Heterochromatic Phenomena

Fluorescence coloration mechanism: When ultraviolet radiation is applied to fluorescent substances, energy level transitions occur, reaching the excited state. When returning to steady state from the excited state, photons are emitted to form fluorescence. This fluorescent substance may be a UV sensitive photoinitiator, benzene ring, etc. from the perspective of OCA.

OCA is generally obtained by UV or thermal polymerization to obtain acrylic resin, which is then crosslinked by two or more crosslinking agents through UV/thermal crosslinking to obtain a network polymer with excellent pressure-sensitive and optical properties.

We have studied the structure of OCA materials from different perspectives and examined their impact on fluorescence heterochromatic aberration.

2.1 The effect of photoinitiator(PI) dosage on fluorescence and heterochromatic pehnomena

The preparation process of acrylic OCA materials can be divided into two parts from the perspective of material reaction: synthesis and crosslinking. These two parts can generally be carried out through UV or thermal methods. When UV method is chosen, a photoinitiator needs to be added. This photoinitiator PI transitions to the excited state under UV irradiation, and its structure is unstable when in the excited state. The weak bonds in it undergo homolysis, producing primary active free radicals and initiating polymerization crosslinking of polymers and active dilution monomers. At the same time, PI may emit photons and form fluorescence when it returns from the excited state to the steady state.

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We have selected several OCA materials for this as follows:

Table 1. The effect of PI photoinitiator dosage on fluorescence heterochromatic aberration

Experiments	Polymer method	Crosslinking method	dosage of PI	fluorescence	heterochromatic
Sample 1	UV	UV	0.4%	10	10
Sample 2	UV	Themal	0.1%	5	5
Sample 3	Themal	UV	0.3%	7	7
Sample 4	themal	Themal	0%	0	0

Note: The scores for fluorescence and heterochromatic phenomena are 10 for the most severe and 0 for no abnormalities

From the performance of different samples, it can be seen that as the amount of PI added increases, the fluorescence heterochromatic phenomenon will become increasingly severe.

2.2 Effect of benzene content on fluorescence heterochromatic aberration

Due to the presence of conjugated large π bonds in the benzene ring, it is prone to become an excited state under UV irradiation and emits fluorescence during the process of returning to steady state. To verify this, we conducted a series of experiments using OCA obtained through thermal polymerization and thermal crosslinking processes.

Table 2. The effect of benzene dosage on fluorescence heterochromatic aberration

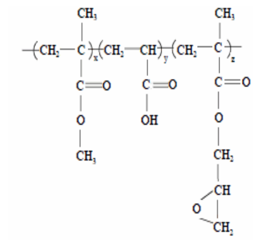
Experiments	benzene content	fluorescence	heterochromatic
Sample 4	0	0	0
Sample 5	1%	0	0
Sample 6	5%	0	0
Sample 7	10	0	0

From the data, it can be seen that adding a benzene ring does not produce fluorescence heterochromatic phenomenon.

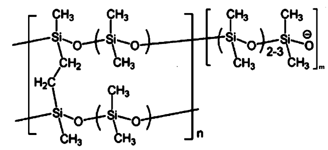
2.3 The influence of different adhesive systems on fluorescence heterochromatic aberration

Due to the fact that acrylic OCA and organosilicon OCA belong to different adhesive systems with completely different structures, they may exhibit different behaviors under ultraviolet and visible light

Acrylic structural formula:



Organic silicon structural formula:



So we designed two of experiments, both using a thermal polymerization system

Table 3. The effect of different adhesive on fluorescence heterochromatic aberration

Experiments	Adhesive	fluorescence	heterochromatic
Sample 4	Acrylic	0	0
Sample 8	silicone	0	0

From the data in the table, it can be seen that both acrylic and organosilicon systems do not exhibit fluorescence discoloration.

2.4 The effect of UV blocking agents on fluorescence heterochromatic aberration

Due to the characteristics of UV polymerization and UV curing OCA, which do not require the addition of solvents and are environmentally friendly, most OCA Manufacturers on the market adopt this process. However, as mentioned in section 2.1 on the effect of photoinitiator dosage on fluorescence heterochromatic aberration, PI can cause fluorescence heterochromatic aberration. Therefore, we added a UV barrier to investigate its impact on fluorescence heterochromatic aberration and UV curing performance, and used long wavelength PI for validation experiments.

Table 4. The effect of UV absorber on fluorescence heterochromatic aberration

experiment	UV cut content	fluorescence	heterochromatic
Sample 1	0%	10	10
Sample 9	0.1%	3	3
Sample 10	0.3%	0	0

From the data, it can be seen that when a certain dose of UV absorber is added, it can avoid the fluorescence heterochromatic phenomenon caused by PI. However, in the actual formula, we cannot add too much as it may affect the performance of OCA, so a balance point needs to be found in the future.

3. Results and discussion

Based on the previous experiments, it can be seen that:

1) The PI content has a crucial impact on fluorescence heterochromatic aberration. When the content is as high as 0.4%, the phenomenon of fluorescence heterochromatic aberration is very serious.

2) Although benzene is easily excited by ultraviolet light to produce luminescent particles, it does not emit fluorescence under 365nm ultraviolet irradiation. Therefore, OCA containing benzene will not cause fluorescence heterochromatic phenomenon in this module.

3) From the perspective of acrylic ester and organosilicon OCA, if thermosetting method is used, there will be no fluorescence heterochromatic phenomenon, indicating that the difference in adhesive type will not cause fluorescence heterochromatic phenomenon

4) After adding UV absorber, the fluorescence heterochromatic phenomenon of UV cured OCA will be better, which may be due to the UV cutting agent absorbing ultraviolet light instead of emitting photons.

From the perspective of the panel industry, the vast majority of OCAs use UV polymerization. Therefore, in order to avoid fluorescence discoloration, we recommend that OCA manufacturers add UV CUT agents to UV cured OCAs. For thermosetting OCAs, as there is no fluorescence discoloration, there is currently no need for improvement.

4. conclusion

For the panel industry, there is a phenomenon of fluorescent discoloration in the certain modules. Through a series of experiments, we finally added a small amount of UV cutting agent to the UV cured OCA to solve this technical problem, making the color development softer and more uniform.

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5. References

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