

Study on Luminescent Properties of Green Fluorescent ink-jet ink

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Abstract

Fluorescent ink-jet ink is composed of phosphor, resin, solvent, assistant agent etc, presswork is formed by ink-jet printing, which emits fluorescence under the short-wave ultraviolet light excitation. Without ultraviolet light, the ink-jet ink could present colorless state. Ultraviolet stimulate illuminant and Fluorescence luminous wavelength are depended on the interior structure of fluorescent material. In order to prepare the fluorescent ink-jet ink which could emit green fluorescence under short-wave ultraviolet exciting, formulas of green fluorescent ink-jet ink had been designed and samples of ink had been prepared, the effect of content of fluorescent powder, different solvents and resins had been studied on the fluorescence intensity, fluorescence spectrum of the fluorescent ink-jet ink. The result indicated that content of fluorescent powder, the sorts and amounts of solvent and resin have a great influence on fluorescence intensity of green fluorescent ink-jet ink, fluorescence spectrums have the same tendency, excitation wavelength and stokes shifts have slightly differences. Green Fluorescent ink-jet ink has the biggest luminous intensity which is prepared by mixed N, N-dimethyl formamide with propylene glycol monomethyl ether acetate, 1.1% content of fluorescent powder, polyurethane resin.

Key words: Fluorescent ink-jet ink; Luminescent Properties; Short-wave ultraviolet; Green

Introduction

With the development of printing technique, the people's requirement is increasing day by day about the functions of ink, such as the ink with the characteristic of fluorescent security, that is, the information about texts, numbers, marks, bar codes are recorded to mediums, then the fluorescence ink-jet ink emits color of lights when mediums are exposed to UV-light, therefore confidential and security information beyond visible information can be recorded [1]. People are getting increasingly vital concerns about this kind of new fluorescent ink-jet ink [2]. The best proportion of solvents and resins was confirmed by the formula design method in this study, and the formula of green fluorescent ink-jet ink was optimized. The luminescent properties of green fluorescent ink-jet ink were improved to satisfy the needs of printing industry.

Experiments

Experimental materials

Resins: Epoxy resin (EP), Acrylic Resin 8, Acrylic Resin 5391(AZ-5391), polyurethane resin (PU-431)

Solvents: Propylene glycol methyl ether acetate (PMA), Propylene glycol monomethyl ether (PM): AR, Tianjin Guangfu Fine Chemical Research Institute; Dimethyl sulfoxide (DMSO): AR, Sinopharm Chemical Reagent Co., Ltd; N, N-dimethyl

formamide (DMF): AR, Sinopharm Chemical Reagent Co., Ltd; Diethylenetriamine(DETA): AR, Tianjin Guangfu Fine Chemical Research Institute; Methylpyrrolidone (NMP): AR, Tianjin Guangfu Fine Chemical Research Institute.

Dye: Green short-wave ultraviolet fluorescent powder

Equipments

Fluorescence spectroscopy: RF-5301PC, Shimadzu Corporation;

Combined Time Resolved and Steady State Fluorescence Spectrometer: FLS920, British Edinburgh;

Equipment methods

Firstly, the resin was dispersed into organic solvent in room temperature, keep stirring until the resin dissolved completely, at the same time the fluorescent powder was dissolved into the other part of organic solvent, standing until it dissolved completely, then the two parts were mixed and stirred for half an hour, the samples of green fluorescent ink-jet ink were prepared.

Results and Discussion

Effects of content of fluorescent powder on the fluorescence intensity of green fluorescent ink-jet ink

In order to investigate the effects of content of fluorescent powder on the fluorescence intensity, fluorescence intensity of twenty ink samples were measured, shown in Fig.1.

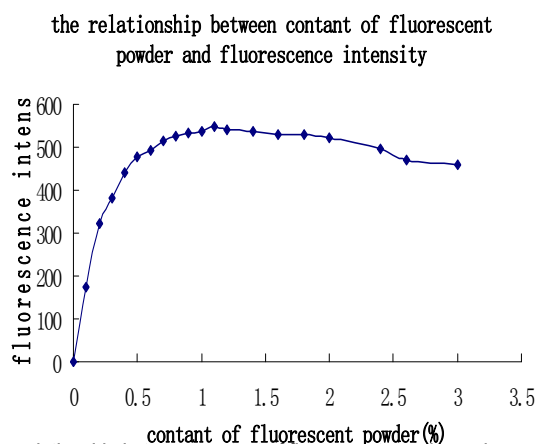


Fig. 1 the relationship between content of fluorescent powder and fluorescence intensity

Fig. 1 shows that with the increase of fluorescent powder, the fluorescence intensity of ink system increases with the bounds of 1.1%. When content of fluorescent powder is over 1.1%,

fluorescence intensity decreases with content of fluorescent powder increasing gradually, the reason is when the density of fluorescent powder is too high, the intermolecular forces make quenching of fluorescence.

Effects of solvent on the fluorescence intensity and fluorescence spectrum curve of green fluorescent ink-jet ink

Solvent is an important component of green fluorescent ink-jet ink, and the solvent polarity has a great effect on the performance of fluorescent ink-jet ink. In order to investigate the influence of single solvent on the properties of sample ink, four samples of green fluorescent ink-jet ink were prepared and numbered under the content of fluorescent powder was 0.4% and EP resin was 3%. Solvents were DMSO (sample 1), DMF (sample 2), NMP (sample 3), DETA (sample 4), and fluorescent powder (sample 5). The fluorescence spectrum curves of five samples are showed in Fig.2.

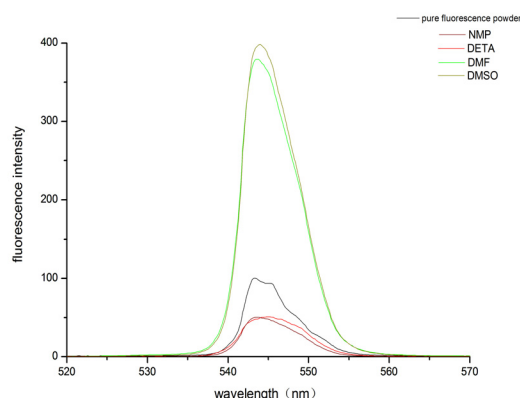


Fig. 2 The fluorescence spectrum curves of five samples of ink

Fig. 2 shows that the reason for using the fluorescence spectrum curve of pure fluorescent powder as reference curve is that fluorescent powder and resin could not be mixed uniformly. DMSO and DMF can enhance the fluorescence intensity of fluorescent ink-jet ink, while DETA and NMP can weaken sharply the fluorescence intensity of samples of ink. The shapes of fluorescence spectrum curves have the same tendency. The max emission wavelength is 544nm, and the max excitation wavelengths have some differences. The data of four samples of ink are showed in Tab.1.

Tab.1 the data about fluorescence spectrum curves of four samples of ink

Types of solvents	λ_{ex}^{max}	λ_{em}^{max}	stokes shift/nm	Emission Intensity
Fluorescent powder	-	544	-	100.321
Sample1(DMSO)	304	544	240	398.533
Sample2 (DMF)	305	544	239	379.438
Sample3 (NMP)	306	544	238	50.341
Sample4(DETA)	311	545	234	51.003

Tab.1 tells that the order of luminous intensity of four samples of ink with different solvents is sample 1>sample 2>sample 4>sample 3. It is because the polarity of solvents is different, causing different influences on the luminous property of the green fluorescent ink-jet ink. The phenomenon of blue shifts occurred in four samples of ink. Stokes shifts are almost 240nm. Because NMP and DETA have a large matting property, PMA and PM are added to mix with DMSO and DMF, in order to study further the effect of solvent on the luminous intensity of green fluorescent ink-jet ink, Tab.2 is drafted according to the design of simplex center of gravity of four components.

Tab.2 the table of simplex center of gravity of complex solvents

Test number	DMSO	PMA	PM	DMF
1	19.32	0	0	0
2	0	0	0	19.32
3	9.66	9.66	0	0
4	9.66	0	9.66	0
5	9.66	0	0	9.66
6	0	9.66	0	9.66
7	0	0	9.66	9.66
8	6.44	6.44	6.44	0
9	6.44	6.44	0	6.44
10	6.44	0	6.44	6.44
11	0	6.44	6.44	6.44
12	4.83	4.83	4.83	4.83

Content of resin is 3%, and content of green fluorescent powder is 0.5%.

Samples of ink were prepared on the basis of tab.2, and the fluorescence spectrum curves are showed in Fig.3.

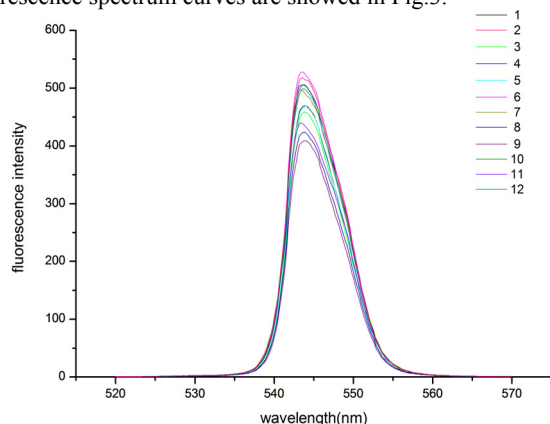


Fig. 3 the fluorescence spectrum curves of 12 samples of ink prepared by complex solvents

Fig.3 reveals that the fluorescence spectrum curves of 12 samples of ink have the same tendency with the green fluorescent powder, which indicates the four solvents didn't destroy the structure of the fluorescent material. The max emission wavelength is 544nm, the fluorescence intensity of sample 6 prepared by PMA and DMF mixed is 528.419, which is the

strongest. The second is sample 2, and its fluorescence intensity is 517.703.

Effects of resin on the fluorescence intensity and fluorescence spectrum curve of green fluorescent ink-jet ink

15 samples of ink were prepared by the design of simplex center of gravity of four components for discussing effects of single resin and complex resins on the fluorescence intensity and fluorescence spectrum curve of green fluorescent ink-jet ink. Tab. 3 is showed.

Tab. 3 the table of simplex center of gravity of complex resins

Test number	EP	PU-431	Acrylic resin8	AZ-5391
1	1.6	0	0	0
2	0	1.6	0	0
3	0	0	1.6	0
4	0	0	0	1.6
5	0.8	0.8	0	0
6	0.8	0	0.8	0
7	0.8	0	0	0.8
8	0	0.8	0.8	0
9	0	0.8	0	0.8
10	0	0	0.8	0.8
11	0.53	0.53	0.53	0
12	0.53	0.53	0	0.53
13	0.53	0	0.53	0.53
14	0	0.53	0.53	0.53
15	0.4	0.4	0.4	0.4

The complex solvents are DMF and PMA, the content of resins and green fluorescent powder is separately 8%, 0.5%.

Samples of ink were prepared according Tab.3, and the fluorescence intensity is showed in Fig.4

the relationship between resins and fluorescence intensity

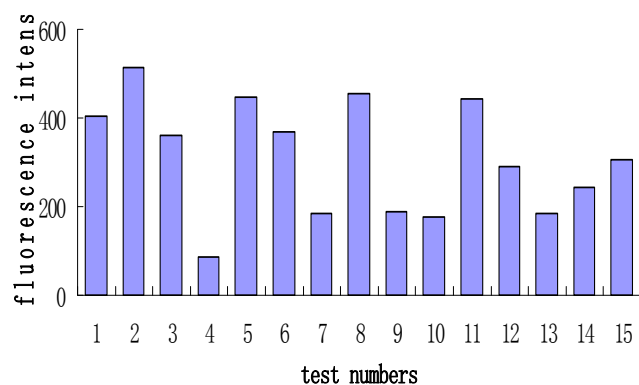


Fig. 4 the relationship between resins and fluorescence intensity

The fluorescence intensity of the sample of ink with PU-431 resin is stronger than any other resins, and the fluorescence intensity of the sample 2 is strongest, which is up to 514.519. The second is sample 8 of ink with mixed PU-431 and Acrylic resin8, the fluorescence intensity is 453.572.

Conclusions

(1) Content of fluorescent powder must be suitable for the green fluorescent ink-jet ink system, when content of fluorescent powder is over 1.1%, fluorescent material quenches, and the fluorescence intensity decreases. The suitable content of fluorescent powder is 1.1%.

(2) Solvents and resin are two components of fluorescence ink-jet ink system, which have a great influence on the fluorescence spectrum curve and fluorescence intensity. Good quality of ink needs to satisfy lots of performance indexes. Complex solvents of NMP and PMA have the best effect on the luminous intensity of the green fluorescent ink-jet ink.

(3) The green fluorescent ink-jet ink is prepared by PU-431 resin, NMP and PMA has high fluorescence intensity.

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