# Research on Photoinitiator for UV Curable Jet Ink

*Jie Wei, Zhi Tao and Hongmei Shi ; College of Materials Science and Engineering, Beijing University of Chemical Technology; Beijing, China*

## Abstract

*The present paper contains an experimental study of photoinitiator system which is using for UV curable jet ink. The change of curing time and apparent capability aroused by different dosage of the single photoinitiator systems and composite photoinitiator systems for color jet ink are discussed. According to the experiment, there is much difference in the curing time when the photoinitiator was changed. Irgacure369 and Irgacure819 are better of the curable performance for single initiator, Irgacure369/ITX and Irgacure184/Irgacure819 are better for composite photoinitiator.*

**Keywords:** UV curing; Ink-jet; photoinitiator

## 1. Introduction

Such as electrofax and thermal imaging, the ink-jet is not impact printing [1]. On the contrary, the process is drips of ink fell down the backing and then the imaging is forming. It has many advantages, just like high print speed, high quality, low price; vivid color image and it can print for user need. In traditional UV curable ink, the curing process is a photo-reactive monomer cross-linked with the oligomers or prepolymers by using irradiation[2].The reasons for using UV curable inks are as follows: It can be installed on existing coating and presses for on-line processing; higher speeds, instant drying; little or no VOC (volatile organic compound) emission; space saving installations and potential for energy saving; high mechanical and chemical resistance of surfaces and no paper dry-out[3]. UV curable jet ink is not only more advanced and more economical, but also easier to use and manipulation. It contains all the advantages of ink-jet and UV curable ink. Such as no VOC emission; energy saving; instant drying; suitable for many kinds of substrates; never become dryness before curing; the nozzle is unable to plug up; frozen composition; nice print quality and resistance of friction; saving ink and so on. It is reported that the UV curable jet ink is one of the technology which have happy future in the subject of radtech in the 21st century [4,5]. UV curable jet ink is consisted of monomers, oligomers, photoinitiators, colorants and some additives. Thereinto the photoinitiators play the key part one.

UV curable ink can be come into solid from liquid immediately by irradiation of UV light wavelength (200-450 nm). In this case photoinitiators can effectively absorb the energy of UV and produce free radicals, which initiate monomers and oligomers forming a polymer network. Therefore the optical physical and chemical property of photoinitiators has a significant effect on how to control the process of the photochemical initiation and polymerization.

## 2. Experimental

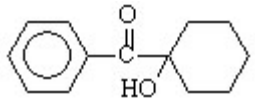
Photoinitiators Irgacure184, Irgacure651, Irgacure907, Irgacure369, Irgacure819 and ITX supplied by TH-UNIS Insight Co. Ltd, China. The pigments: yellow (HR:H4G), magenta (HF4C), blue (15:3), black (FW200) supplied by Beijing Saven Times Digital Technology Co. Ltd, China. The oligomer Viajet 100 and monomer Viajet 400 supplied by UCB Group, Belgium.

UV absorption spectrum of pigments and photoinitiators is determined by HITACHI U-3000 spectrophotometer. According to the formulation, the monomer, oligomer, photoinitiator and pigment were mixed together and dispersed by supersonic. It is coated the quantitative printing ink on the aluminum sheet and cured by irradiation of UV light (80W/cm).

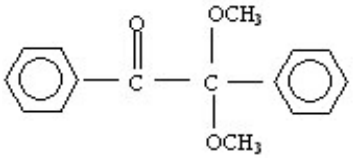
## 3. Results and Discussion

### 3.1 UV absorption spectrum of pigments and photoinitiators

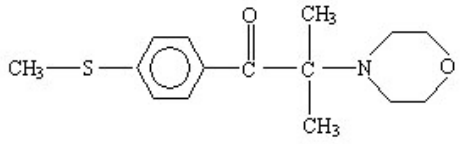
Photoinitators Irgacure184, Irgacure651, Irgacure907, Irgacure369, Irgacure819 and ITX were chosen for a contradistinction (the molecular formulas and UV absorption spectra are shown in Figure 1 and Table 1). UV absorption spectra of pigments are shown in Figure2~ Figure6.



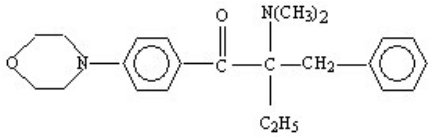
Irgacure184



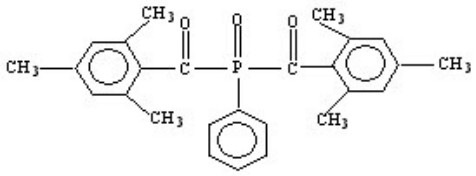
Irgacure 651



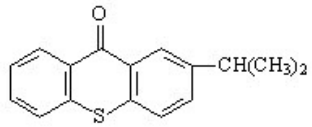
Irgacure 907



Irgacure369



Irgacure819



ITX

***Figure 1.*** *Schematic diagram of photoinitiators*

**Table 1. Absorption Spectra of Photoinitiators**

| | Absorption peak(nm) | Largest Wavelength(nm) |
|---|---|---|
| I184 | 240-250,320-335 | 246,333 |
| I651 | 240-270,315-360 | 254,337 |
| I907 | 220-245,260-325 | 232,307 |
| I369 | 230-250,324-335 | 233,324 |
| I819 | 360-370,405 | 370,405 |
| ITX | 240-270,380-430 | 258,382 |

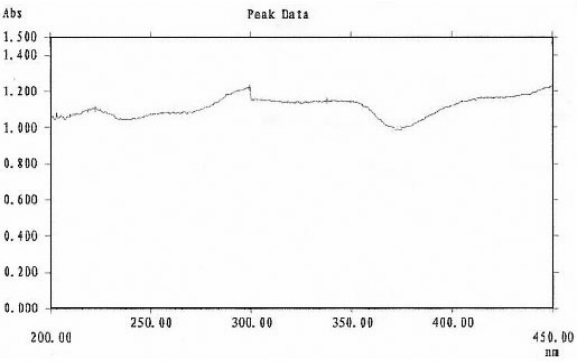



***Figure 2.*** *UV absorption spectrum of magenta HF4C*

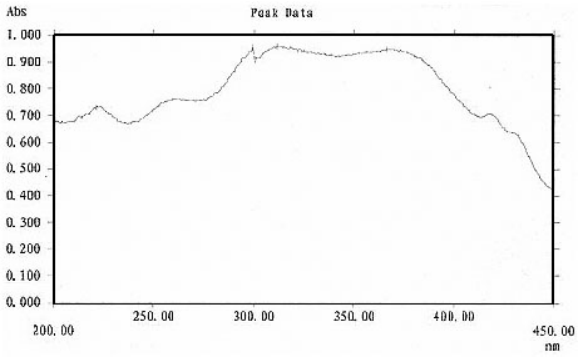



***Figure 3.*** *UV absorption spectrum of blue 15:3*

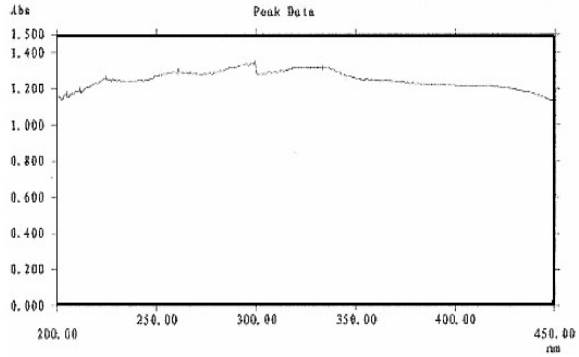



***Figure 4.*** *UV absorption spectrum of yellow HR*

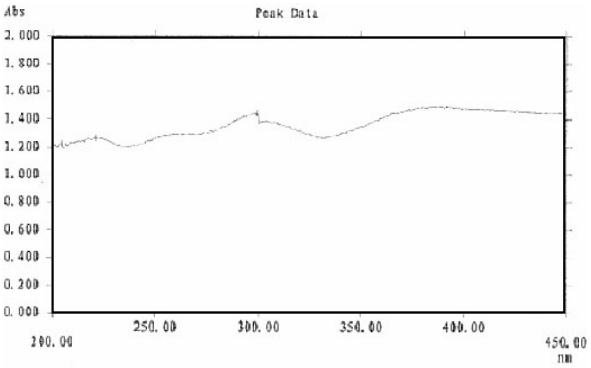



***Figure 5.*** *UV absorption spectrum of yellow H4G*

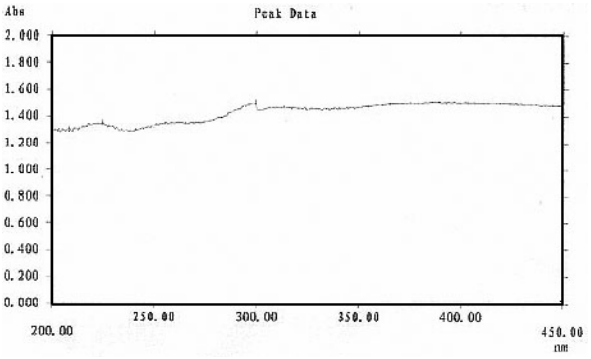



***Figure 6.*** *UV absorption spectrum of black FW200*

## 3.2 Photoinitiator selection for Magenta UV curable jet ink

Magenta UV curable jet ink was prepared with different photoinitiators and the curing speed were determined. The results are shown in Figure 7.

As show in Figure 7, the curing time of Irgacure369 is less than other photoinitiators in single initiator system. Because there are two weak absorptions at 200nm-300nm and 400nm-450nm for mangenta. Irgacure369 just has absorption here, and its largest wavelength is longer than others. It matches with lamp sources emission spectrum. Therefore this kind of photoinitator has the highest curing speed. The curing time of Irgacure369/ITX was less than others in composite initiator system and Irgacure369. Because the largest wavelength of ITX is longer and eliminate smooth coefficient of ITX is greater than others.

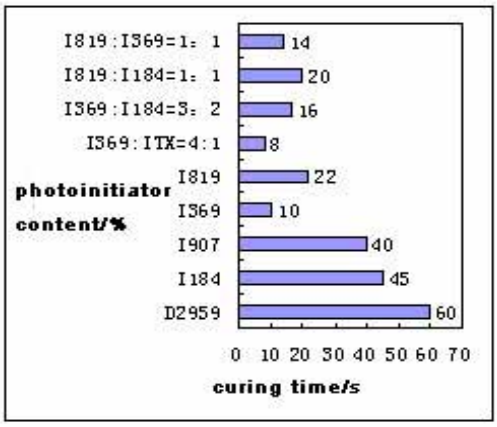



***Figure 7.*** *Curing time vs. initiator for magenta*

### 3.3 Photoinitiator selection for blue UV curable jet ink

Blue UV curable jet ink was prepared with different photoinitiators and the curing speed were determined. The results are shown in Figure 8.

As show in Figure 8, the curing time of Irgacure369 and Irgacure819 were less than other photoinitiators in single initiator system. Because there are two lower absorptions at 200nm-300nm and 400nm-450nm for blue pigment. Irgacure369 and Irgacure819 just have absorption here, and the largest wavelength are longer than others. The curing time of Irgacure369/ITX was less than others in composite initiator system and Irgacure369. Because the largest Wavelength of ITX is longer and eliminate smooth coefficient of ITX is greater than others.

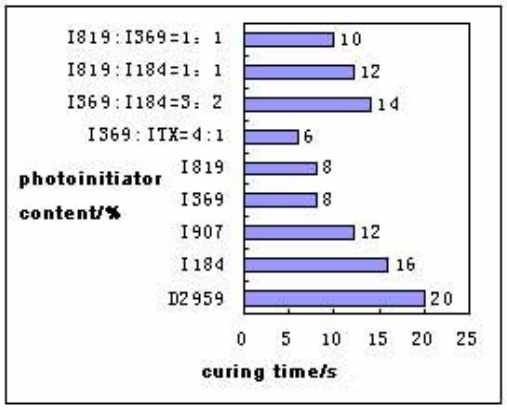



***Figure8.*** *Curing time vs. initiator for blue*

### 3.4 Photoinitiator selection for yellow UV curable jet ink

Yellow UV curable jet ink was prepared with different photoinitiators and the curing speed were determined. The results are shown in Figure 9.

As show in Figure 9, the curing time of Irgacure369 was less than other photoinitiators in single initiator system. Irgacure369 just has absorption here, and its largest Wavelength is longer than others. It matches with lamp sources emission spectrum. The curing time of Irgacure369/ITX was less than others in composite initiator system, and it was faster than Irgacure369. Because the largest Wavelength of ITX is longer and eliminate smooth coefficient of ITX is greater than others. Besides Composite initiators were prior to single initiators in curing time, because UV absorption spectrums of HR and H4G locate in 350nm two sides (Figure 4, Figure 5) and Composite initiators situate here each other.

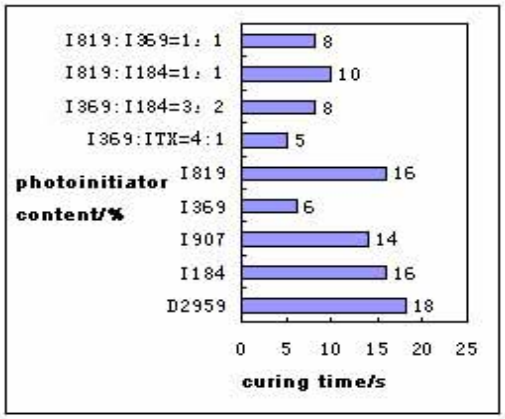



***Figure 9.*** *Curing time vs. initiator for yellow*

### 3.5 Photoinitiator selection for black UV curable jet ink

Black UV curable jet ink was prepared with different photoinitiators and the curing speed were determined. The results are shown in Figure 10.

FW200 had a strong absorption for both the visible and UV light. It was hardly can be permeated by light. But this kind of pigment had a faintish absorption below the wavelength of 300nm. In other word, there was a “spectrum window”. The curing speeding of yellow UV curable jet ink can be improved very much by use of these “spectrum windows” availably.

As show in Figure 10, the curing time of Irgacure819 was less than any other photoinitiators in single initiator system. And the curing time of Irgacure907 was slower because Irgacure907 has not absorption below 300nm; however, Irgacure819 has absorption below 300nm. And largest Wavelength of Irgacure819 reaches 450nm. It is important that Irgacure819 breaks up four active free radicals, their reaction are supernal. The curing time of Irgacure184/ Irgacure819 was less than others in composite initiator system, because their UV absorptions take effect mutually in different weak absorption of pigment.

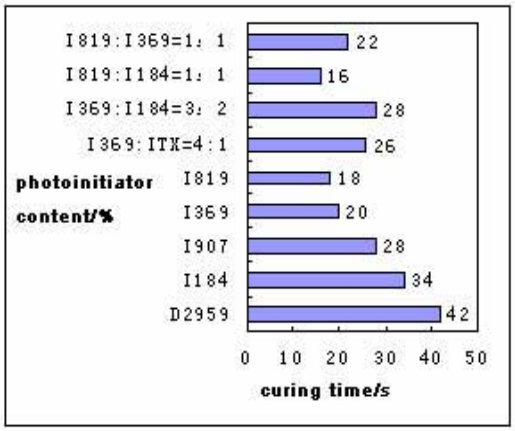



***Figure10.*** *Curing time vs. initiator for black*

## 4. Conclusion

In single initiator system, for magenta UV curable jet ink and yellow UV curable jet ink, the curing time of Irgacure369 was less than other photoinitiators. For blue UV curable jet ink the curing time of Irgacure369 and Irgacure819 were less than others. FW200 had a strong absorption for both the visible and UV light. It is hardly can be permeated by light. So the curing time of black UV curable jet ink was the longest. The curing time of Irgacure819 was less than others.

In composite initiator system, for magenta UV curable jet ink, blue UV curable jet ink and yellow UV curable jet ink, the curing time of Irgacure369/ITX was less than other photoinitiators. For black UV curable jet ink, curing time of Irgacure184/ Irgacure819 was less than others.

## References

[1] Li Lu-hai, Zhang Shu-fen, Yang Jin-zong, Zou Jing. The Actuality and Evolvement of Jet-ink Technology. Image Technology, pg.5. (2003).

[2] Chen De-shan, Ren Feng-xia. UV Curable Ink, Silk-screen. Beijing: The Publishing Company of Chemical Industry, pg.20-22. (2003).

[3] Wang De-hai, Jiang Ling. UV Curable Materials. Beijing: The Publishing Company of Science, pg. 225-262. (2001).

[4] David Harbourne . UV/EB curing-a blobal Update. Radtech Report'04, China, pg. 1-8. (2004).

[5] Jeffey Klang,James,Balcerski. UV Curing Technology. Issues for Inkjet Formulations. Sartomer Company

## Author Biography

*Jie Wei received her BS in polymer science (1985), MS in Chemical Engineering (1993) and her PhD in applied chemical (1998) from Beijing University of Chemical Technology (BUCT). Since then she has worked in the Information Recording Materials Division at College of Materials Science & Engineering, BUCT. Her work has focused on the development of photopolymerization and information recording materials. She is a member of Chinese Society for Information Science and Technology and RadTech China.*