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A study on the application behaviors of latent pigment derived from C.I. Pigment Yellow 151

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Abstract

A latent pigment which was a derivative of C.I. Pigment Yellow 151 was prepared. The conversion from latent pigment to parent pigment was studied and proved by UV and IR spectrum. Its application in PVC coloring was also involved.

Keywords: Application behaviors; Latent pigment; C.I. Pigment Yellow 151

1. Introduction

For many years, the dispersion of pigment has been the question that puzzled research workers and users. Although pigments containing heterocyclics had high polarity, thermostability, resistance to solvent and weather, the strong intermolecular hydrogen bonding made their dispersion more difficult. The work of A. Iqbal, J.S. Zambounis and others presented a novel thought on settling the problem. That was the technique of synthesis and application of "latent pigment" [1].

Like leucos of vat dyes, latent pigments were soluble or easily dispersed compounds that made by substituting hydrogens on amino or imino of parent pigment with temporary groups. When they were brought into use, the temporary groups could be broken away through proper treatment after the solvation or homogeneous dispersing in application media having accomplished [2,3]. The process could be expressed by the following equation [4]:

$$-NH_2, -NH- \underset{\text{Proper treatment}}{\overset{\text{(Reagent)}-G}{\rightleftharpoons}} -NG_2, -NG-$$

In this paper, the latent pigment was prepared through the coupling of the diazonium salt of 2-aminobenzoic acid with a compound containing group of *t*-butyloxycarbonyl. The coupling componant was prepared through the reaction of di-(*t*-butyl)-dicarbonate and 5-acetoacetanilido benzimidazolone with *N*,*N*-dimethyl formamide (DMF) as solvent and 4-methyl pyridine as catalyst.

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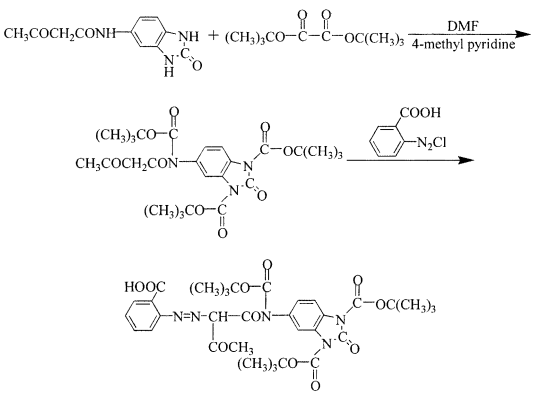


latent pigment of C.I Pigment Yellow 151

2. Experimental

2.1. Preparation of the latent pigment

1.3 g Of acetoacatanilido benzimidazalone, 4.3 g di-(*t*-butyl)-dicarbonate and 0.3 ml 4-methyl pyridine was reacted in 40 ml DMF at room temperature for 12 h. The reaction solution was added at pH 6–7 in 30 min to the diazonium salt solution of 2-amino benzoic acid which was prepared using the conventional method. The coupling product was poured into proper amount of water in order to precipitate fine particles of the light yellow latent pigment.

2.2. Application of the latent pigment to PVC coloring

The solution of 2.5 g PVC and 1 g latent pigment dissolving in 20 ml DMF was coated on glass. After drying at 40 °C, the PVC film containing 40% of latent pigment was obtained. This film was heated at 140 °C for 2 min. The dispersion of pigment in PVC was determined by transmission electron microscope (TEM).

2.3. Structure analysis and characteristic determination

The differences between latent pigment and parent pigment in structure and UV absorption were analysis by FTS 3000 IR spectrograph (BIO-RAD) and HP8453 UV spectrograph (HP), respectively. The thermal stability of latent pigment was determined by thermogravimetric analyzer (PR China) and WRX-IS microscopic thermal analyzer (Shanghai, PR China). And the particle shape was observed through 100CX II TEM (Jeol Company).

3. Conclusions and discussion

3.1. Conversion of latent pigment to parent pigment

Because of low stability, latent pigment containing temporary protective groups would decompose and convert to parent pigment when it was treated with proper way such as heat and acid. In this paper, the conversion between its derivative and C.I. Pigment Yellow 151 was carried out through acid and heat treatment. When chlorhydric acid was added to the solution of latent pigment in acetone, bubbles and yellow deposited matter were observed. In addition, the differences between latent pigment and the yellow deposit in UV and IR spectrum were also obvious.

It was shown in Fig. 1 that, besides the shift of absorption wavelength, the maximum absorption of latent pigment was 290 nm (Curve 1), whereas it of the yellow deposit was 380 nm (Curve 3). Moreover, the absorption curve of C.I. Pigment Yellow 151 (Curve 2) and the yellow deposit were similar except for the difference of absorbance.

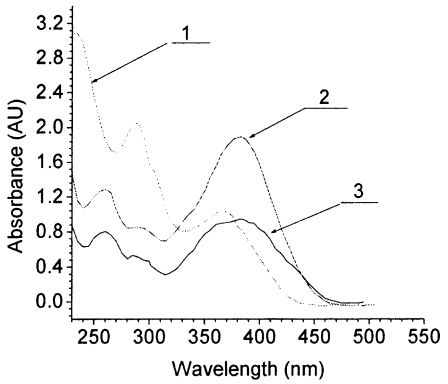
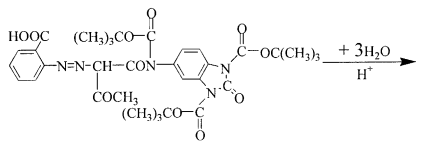


Fig. 1. UV spectrum: 1 latent pigment, 2 C.I. Pigment Yellow 151, 3 yellow deposit.

The IR spectrum gave a further proof that acid treatment could make the latent pigment convert to C.I. Pigment Yellow 151 in the following manner.



C.I. Pigment Yellow 151

The IR spectra of yellow deposit (Fig. 2, 3#) was very similar to it of C.I. Pigment Yellow 151 (Fig. 2, 2#). And in both of the two spectrum, the characteristic absorption of –NH– at about 3600 nm were obvious. But in Fig. 2 (1#), the absorption peak disappeared, because the hydrogen on imino was substituted by *t*-butyloxycarbonyl (BOC).

Heat treatment at 160 °C gave out the same results (see Figs. 3 and 4).

3.2. The application of latent pigment

In order to determine the decomposition temperature, the thermagravimetric analysis of latent pigment was done. Fig. 5 showed that the decomposition started at about 120 °C, and accomplished at 140 °C.

Therefore the yellow PVC film containing 40% latent pigment was heated at 140 °C and was observed the dispersion of pigment. It was shown in Fig. 6 that the diameter of most pigment particles was 20–40 nm.

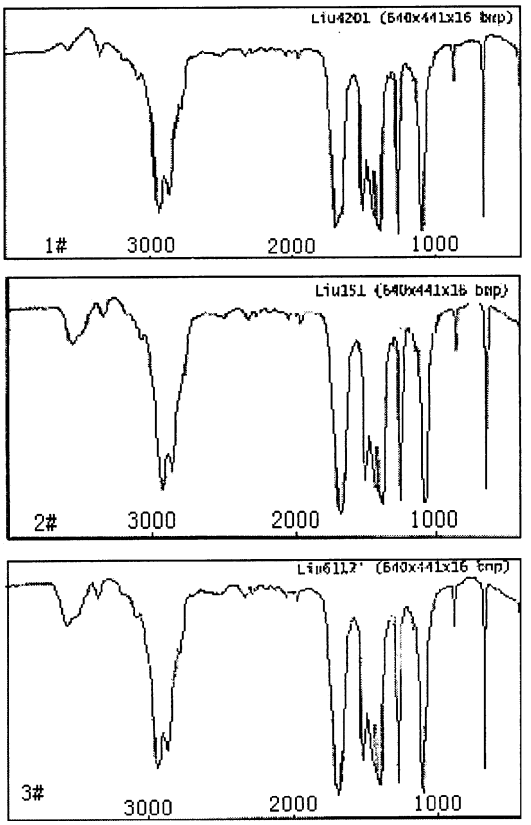


Fig. 2. IR spectrum: 1# latent pigment, 2# C.I. Pigment Yellow 151, 3# yellow deposit.

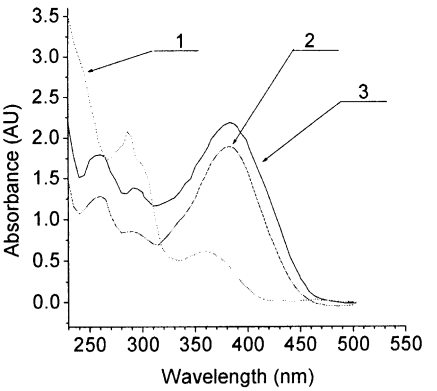


Fig. 3. UV spectrum: 1 latent pigment, 2 C.I. Pigment Yellow 151, 3 production of heat treatment.

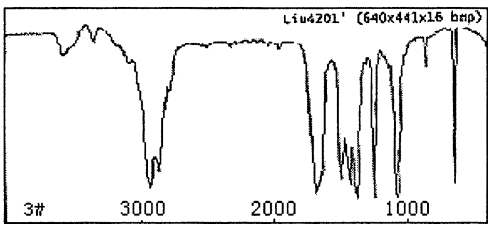


Fig. 4. IR spectrum of production of heat treatment.

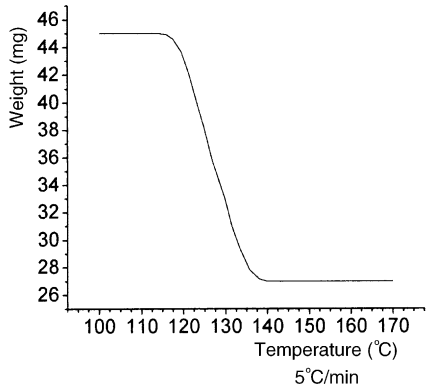


Fig. 5. Thermagravimetric analysis of latent pigment.

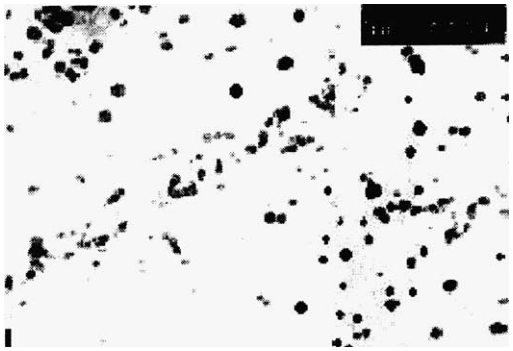


Fig. 6. TEM of PVC film containing latent pigment.

4. Conclusion

1. The latent pigment which was a derivative of C.I. Pigment Yellow 151 could be obtained through the using of material containing temporary group, and could convert to parent pigment through acid and heat treatment.
2. The application of latent pigment to PVC film coloring gave out good dispersion and the diameter of pigment particles was 20–40 nm.

Acknowledgements

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