Effect of Several Inhibitors on Contrast of Silver Halide CTP Printing Plate

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Abstract

With the development of information technology, the most recent evolutions in litho printing plate technology for computer-to-plate imaging became more and more important. Especially, a silver halide diffusion transfer type of plate is widely applied. High contrast is essential for this type of plate technology. Traditionally, inhibitors inhibit chemistry development and reduce the fog in negative film system. Several such inhibitors have been introduced into developers for Silver Halide Diffusion Transfer System. Effect on contrast were studied by linear CCD technique through characteristic curve (reflection light intensities vs. Log E) of physical developed silver. It was found that effect of the inhibitors with mercapto-group on contrast was of greatly relationship with their molecular structure. Because different molecular structures caused distinct adsorption of the inhibitors on silver, the differences in improving the contrast were resulted.

Introduction

The silver halide diffusion transfer reversal system (DTR) has been widely used in offset materials, stencil printing systems and instantaneous photography [1]. In recent years, CTP (Computer-to-Plate) printing plate based on the one-sheet DTR system has become the most popular CTP plate since it owns very high sensitivity [2, 3]. In this type of plate, the image contrast is the most important in order to obtain good halftone image. Several approaches have been proposed to obtain high contrast in chemical development, for instance litho development [4], hydrazine [5] and iodide anion infection [6]. Inhibitors also can be used to improve the contrast. Sahyun [7,8] claimed that NBM (6-nitrobenzimidazole) greatly improved the contrast when it was synergetic with iodide anions. He also found that the effect of BTA (benzotriazole) on contrast was negligible. In addition, the effects of some other inhibitors on contrast were also examined by many researchers [9,10]. Concerning influence on contrast in physical development, however, there is few to be found in publication. In this paper, the effects of several inhibitors on contrast of physical development of the one-sheet DTR system have been studied with the self-established CCD instrument.

Experiments

The experimental plate

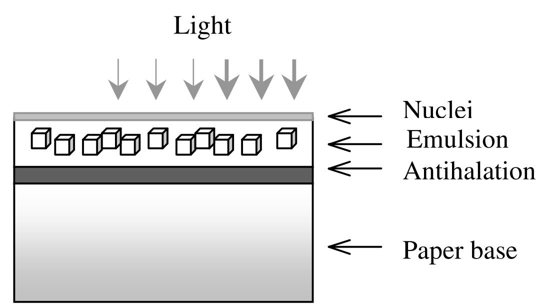


Fig. 1 Cross section of CTP printing plate

The experimental plate was prepared as described in the previous paper [11]. The cross sections of plate were shown in figure 1. An anti-halation layer containing hydroquinone and Metol was firstly coated on a plastic-coated paper and then silver chloride emulsion layer sensitized to green light was coated on the dried anti-halation layer. After these two layers were hardened, colloidal metal sulfide was coated on the surface of emulsion layer as nuclei of physical development. After exposure and development, filament silver was formed in the emulsion layer whereas physically developed silver was deposited on surface of the nucleus layer. The physically developed silver deposited on the surface looks like a metal membrane and has nice reflecting property.

Developer solution

The general composition of the developer solution was:

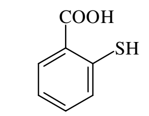
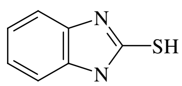
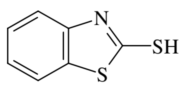
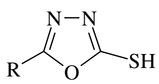
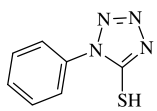
Potassium hydroxide	5 g
Sodium sulfite	50g
Sodium carbonate	5g
Sodium thiosulfate	5g
Add water to	1 liter.

Inhibitors were added optionally.

Inhibitors

Five inhibitors with mercapto-group were used in the experiment. Their molecular structures were listed in table 1.

Table 1: molecular structure of inhibitors

Molecular structure	Name	Abbreviation
	2-mercaptobenzoic acid	MBA
	2-mercapto-benzimidazole	MBM
	2-mercapto-benzithiazole	MBT
	2-mercapto-5-heptyl-oxidiazole	MHO
	1-phinyl-5-mercapto-tetrazole	PMT

CCD instrument

In CCD instrument, a lamp with a red filter was fixed at the upper side of a developing solution cell in which a strip of plate was developed. The illumination was 12.9 lux and the incident angle was about 45 degree to the plate surface. A one-dimensional CCD (TCD102C type, 2048 pixels) was installed to collect the reflective light at every 200 ms for about 20 seconds from the normal direction to the plate. The whole instrument was put in a dark box.

Results and discussions

1. Characteristic curve monitored by CCD instrument

When we tried to determine contrast through the characteristic curve (reflection density vs. Log H) of the one-sheet DTR plate in our experiments, some difficulties were confronted with. Because the measured reflection density is a comprehensive value with physically developed silver on the surface and chemically developed silver in the gelatin layer , obtained characteristic curve is different from either the characteristic curve of physically developed silver or chemistry developed silver. Therefore the conventional reflection density is not suitable for describing the characteristic curve of physically developed silver in such a one-sheet DTR system and new approaches is expected to be introduced into this field.

In our earlier researches [12,13], a one-dimensional CCD instrument was successfully established to monitor the kinetics of physical development in real time and in situ. In this paper, we attempted to apply it to study the characteristic curve of physically developed silver on the one-sheet DTR plate. Especially the effects of several inhibitors on contrast of physical developed silver of the one-sheet DTR system would be studied from characteristic curves.

When a strip of plate was developed in the developing cell, the reflective light of physically developed silver on each step was collected by the pixels of CCD and transferred to the connected computer. The changes of reflection light intensities with time in different exposed level were shown in Figure 2. In this Figure, reflection light intensities decreased with exposure level increased. Furthermore, when development is finishing , the relationship of reflection light intensities and exposed level was shown in Figure3. The curve Fig. 3 was similar to a conventional reversal characteristic curve.

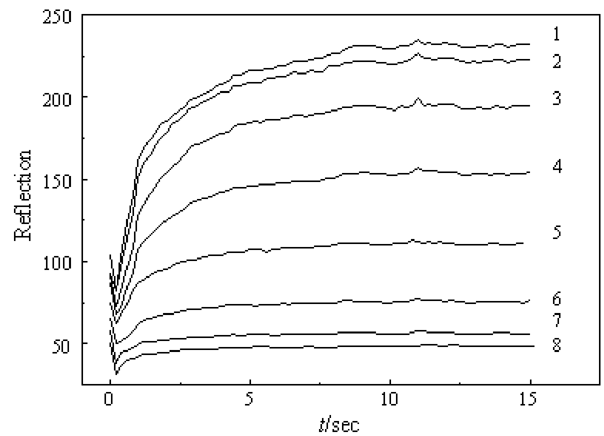


Fig.2 the relationship of reflection light intensities and time in different exposed level with CCD exposure Increased with sequence 1 to 8

As has been reported in our earlier experiment [14] , The reflection intensity was approximately proportional to the amount of the physically developed silver per unit area (g/m^2), and had little correlation with chemically developed silver in the gelatin layer. Hence the reflection intensity could be adopted to indicate the amount of physically developed silver at a certain exposure level.

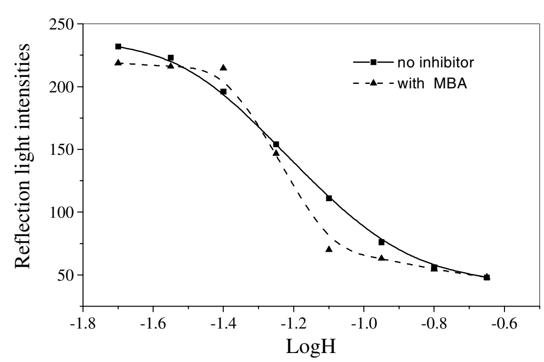


Fig. 3 The relation of reflection light intensities and exposed level

For conventional characteristic curve, the contrast coefficient γ could be calculated by expression (1)[15]:

$$\gamma = \Delta D / \Delta \log H \qquad (1)$$

In this experiment, similarly, it could be obtained from the expression (2), in which ΔI was a change of reflection intensity at a linear portion of the curve:

$$\gamma = - \Delta I / \Delta \log H \qquad (2)$$

From Figure 3, after adding inhibitor, linear portion of the curve became steep obviously, which show that inhibitor improved the contrast of physical development silver.

2. Effects of inhibitors on contrast

If the contrast coefficient of a developed plate without any inhibitor in developing solution was taken as 1.00 (as a reference value), then the relative contrast coefficients with a variety of inhibitors listed in Table I could be calculated and illustrated in figure 4. it could be seen that the concentration ranges and the improvements of contrast to some extent for all inhibitors were quite different. Generally, the contrasts increased with concentrations of inhibitors, reached a maximum and then went down except for PMT. sequence of improvements extent on contrast was MBA > MBM ≈ MBT > MHO > PMT. While sequence of concentration ranges used in developing solution was just opposite.

Among the inhibitors used in our experiment, two mercapto-compounds (namely MBT and MBM) which have similar structures: benzo-heterocycle with a mercapto-group at the same position, were studied as a pair. It could be seen in Fig.4 that their effects on the image contrast were also quite similar: both of the concentration ranges of inhibitors and extent of the improvement on the contrast were almost the same. Thus, It may be reasonable to deduce that the structure of inhibitor molecular affected the image contrast.

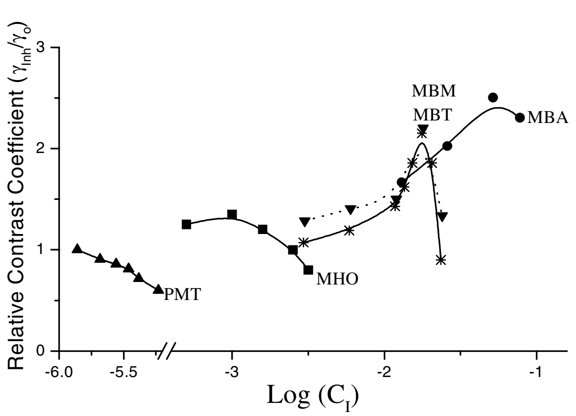


Fig. 4 Effects of inhibitors at different concentrations on relative contrast coefficients

Chen [16] studied the effect of inhibitors on contrast in chemical development and found the inhibitors, which were adsorbed moderately on silver, could improve the contrast greatly. He attributed such an improvement to the selective inhibition on small latent image centers in low exposure area. For those inhibitors that have over high or over weak tendency to be absorbed on silver, large or small latent centers would be inhibited without difference or not affected at all. As a result, little influence on contrast would be observed.

From the molecular structures listed in table 1, The first three mercapto-compounds were attached by short hydrophobic groups in their molecular structures and their adsorption on silver was moderate [17], then they selectively inhibit latent image centers. So it was beneficial to the improvement of contrast. MHO had a long hydrocarbon chain in the other terminal of its molecular and a strong tendency to be adsorbed onto silver, as reported in our earlier paper [11]. The adsorption of PMT on silver, owing to formation of Ag-PMT salt on the silver surface [18], was even stronger. As a result, the over strong adsorption on silver greatly inhibited the latent image centers and suppressed the contrast ultimately. So effect of inhibitor on chemical development probably resulted in the differences in improving contrast of physical development on CTP plate .

Conclusion

CCD technique was applied to study the characteristic curve of one-sheet DTR system and to examine the effects of several inhibitors on contrast of physically developed silver. The results showed that inhibitors were effective in improving the contrast in physical development. In addition, inhibitors, adsorption of which on silver was affected by their molecular structures, resulted in the differences in improving the contrast.

Acknowledgements

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Biography

Xiujie HU was born on Feb. 1964. She graduated from the Department of Chemical Engineering ,Tsinghua University in 1987, And got her MS degree in 1990. Now, she is working as an associate professor in the Institute of Photographic Chemistry, Chines Academy of sciences, engaging in the research of CTP printing material.