Long Run Length Positive Thermal CTP System "XL-T"

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Abstract

We have developed a positive thermal CTP (Computer To Plate) plate "XL-T", which employs high durability urethane resin for the photo sensitive layer. XL-T is suitable for long run length jobs, for example, printing of forms, ledgers, magazines, and so on. We have also formulated special developer "XL-D" and replenisher "XL-DR" for XL-T, which can be used in a highly concentrated state. Together with the apparatuses for reducing waste developer/rinse water "XR-2000/5000", the XL-T system realizes reduction of waste solutions equal to that with the XP-series, which are standard positive thermal CTP systems.

1. Introduction

In the printing industries, various approaches have been taken for the reduction of environmental burden. Among them is the Green Printing accreditation and certification scheme which was established by the Japan Federation of Printing Industries to promote the introduction of low environmental burden printing systems.

As a printing plate manufacturer, Fujifilm has engaged in the reduction of industrial waste by designing *computer-to-plate* (CTP) systems to discharge a smaller amount of waste developer and the PLATE to PLATE system to enable closed-loop recycling of the aluminum used as the base material for CTP plates. Also, it has reduced the use of packing materials such as cardboard boxes for external packing and paper and cardboards for inner packing.

In those activities, our main focus has been on eco-friendly CTP systems and we have extended the lineup[1] to include the process-less CTP system "*Eco & Free System XZ-R*" that produces no waste developer and the positive thermal CTP plate "*XP-Series*" that produces much less waste developer by incorporating the waste developer reduction equipment "*XR-2000/5000*".

This paper introduces the positive thermal CTP plate "*XL-T*" (Photo 1, Fig. 1) which has been developed after those efforts to meet the tough requirements of long print runs of forms, ledgers and magazines.

Photo 1 Positive thermal CTP plate XL-T.

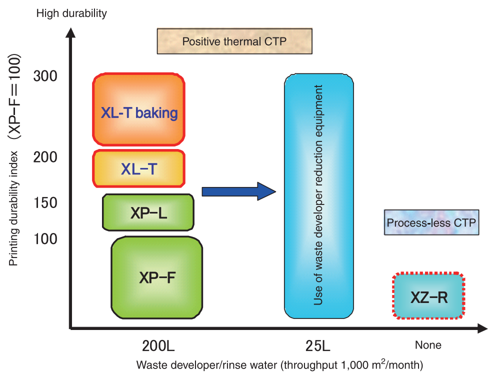

Fig. 1 Quality target for XL-T.

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2. Issues in improving the printing durability of the positive thermal CTP plate

The positive thermal CTP plate "*XP-F*" with standard printing durability has a stratified photosensitive layer. It forms images by breaking the hydrogen bonds of novolac resin using heat generated during image exposure and thereby improving its solubility in alkaline developers. However, the temperature attained by the photosensitive layer near the aluminum base is low because of thermal diffusion to the base during exposure. This prevents sufficient breaking of the hydrogen bonds and, consequently, causes low sensitivity of the layer. Therefore, while the upper layer, which reaches a high temperature, achieves image formation, the underlayer uses acrylic resin to have high developability even in the absence of strong exposure. In addition, it is necessary for the upper layer to be thin and made from novolac resin, excellent in image formation, to create high-sensitivity images[2]. Because novolac resin is inferior to acrylic resin in printing durability, the contribution of the upper layer to printing durability is kept to merely one-fourth that of the underlayer.

As described above, image formation is left to the upper layer and there is little room for changing its design because of many restrictions on materials and the application quantity. Therefore, we sought a way to improve the underlayer as it contributes greatly to printing durability and allows more flexible design, having few restrictions on image formation.

The simplest way to enhance the printing durability of the underlayer is to increase the amount of the applied acrylic resin. In fact, XP-L achieves about 1.5 times the printing durability of XP-F by doing so. However, it is not without its problems. Within twelve seconds of the underlayer being soaked in the developer, the exposed area needs to be removed as a result of the development process, while the unexposed area should remain unaffected by the developer that penetrates from the imaging area. Therefore, the increased application of acrylic resin to the underlayer requires a larger *discrimination*, a difference in the speed of development between the exposed and unexposed areas. Otherwise, the exposed area cannot be removed completely during the development and the photosensitive layer will remain as a resist film. That causes printing stains or the so-called side-etching in which the surroundings of the unexposed area are affected by the developer and the image area becomes smaller[2] (Fig. 2).

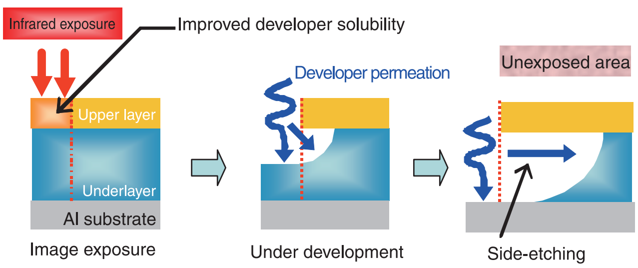

Fig. 2 Mechanism of side-etching.

The target printing durability of XL-T was about twice that of XP-F. That cannot be achieved solely by increasing the amount of the applied acrylic resin because its capacity is insufficient in both printing durability and discrimination. It was necessary to use a durability-enhanced resin for the underlayer without increasing the application amount.

This paper describes the details of the design of the CTP plate XL-T, the developer "XL-D" and the replenisher "XL-DR" which together achieve an optimum printing durability-discrimination balance.

2.1 CTP plate XL-T

High printing-durability resin needs damage-resistant properties to withstand, during printing, the stress applied to the photosensitive layer of the image area by ink rollers and blankets. For example, it may be necessary to increase hardness to suppress deformation and wear or to reduce the stress by utilizing viscoelasticity. We employed urethane resin in XL-T because it exhibits higher printing durability with the same level of developability as acrylic resin and, among the possible alternatives, is excellent in balance with developability. Its high stress-relaxation capability allows easy permeation of developers compared with other hard, high-density resins and this works advantageously on developability. In addition, it has already been used on photopolymer-type CTP plates. We thus selected urethane resin as the replacement for acrylic resin.

There are two improvements to be made when using urethane resin instead of acrylic resin for the underlayer: discrimination and printing durability with UV-ink. The upper novolac layer and the urethane resin underlayer are close in polarity and solvents that do not dissolve the underlayer cannot be used for the coating of the upper layer, which results in the mixture of the layers. In addition, the underlayer does not have a property to inhibit dissolution. Those features are the cause of insufficient discrimination. In a similar way, the cause of insufficient printing durability with UV-ink is the closeness of polarities between UV-ink and urethane resin. This makes urethane resin subject to damage by UV-ink. To solve those two problems, it was essential to design urethane resin so that its polarity is as high as that of acrylic resin used in XP-F and thereby to achieve a polarity far enough from that of novolac resin and UV-ink (Fig. 3).

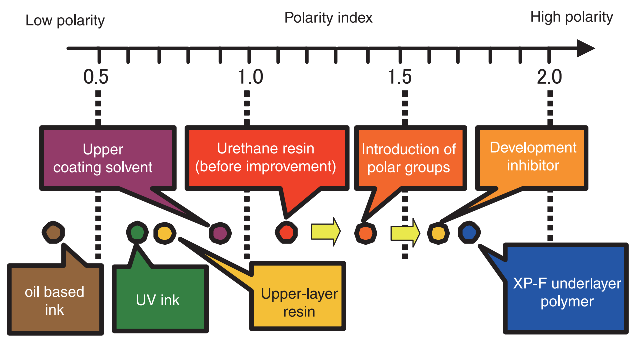

Fig. 3 Process of enhancing dipole moment.

To achieve high polarity in urethane resin, two approaches were taken.

The first approach was to introduce to urethane resin a structure that had already been employed in the acrylic resin underlayer of XP-F to achieve a higher polarity. This structure can also increase solubility in alkaline developers without impairing developability and allows application with few quantitative restrictions. As a result, we achieved the target UV-ink printing durability. However, the mixing of layers during the application of the upper layer could not be prevented with this structure and discrimination was yet to be improved.

The second approach was to establish ionic interactions with the acid group of urethane resin. This led to a further increase in the polarity of urethane resin and, finally, solved the problem of mixing layers.

As those interactions protect the acid group, the dissolution of urethane resin in developers can also be inhibited, that is, a development inhibition effect appears. This effect is cancelled by heat generated during image exposure at the same time as it happens in the upper novolac layer and thereby provides the required discrimination to the underlayer.

The optimization of the polarity, molecule size and hydrophilic/hydrophobic property of this development inhibitor enabled the maximization of discrimination and, by using it in combination with the special developer described below, achieved the design of a CTP plate with high sensitivity equivalent to that of XP-F without forming a resist film or side-etching.

Fig. 4 shows the enhanced discrimination when the development inhibitor was added to the underlayer. The more dosage of the inhibitor, the longer it took before the photosensitive layer of the unexposed area was permeated by the developer.

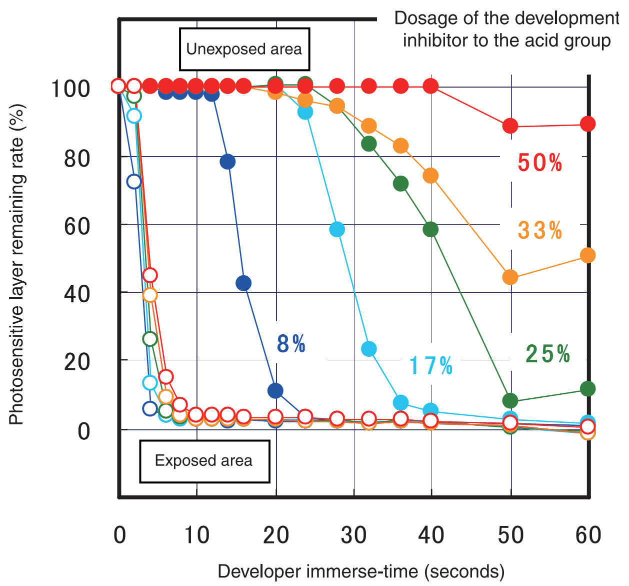

Fig. 4 Effect of development inhibitor.

Photo 2 provides two electron micrograph images of a 50% halftone-dot amplitude modulation screen. Before improvement, the halftone dot size was small because of side-etching and the peaks of the upper layer left at the edges of the image area bent to be deposited as residuals. In the XL-T product, they were eliminated.

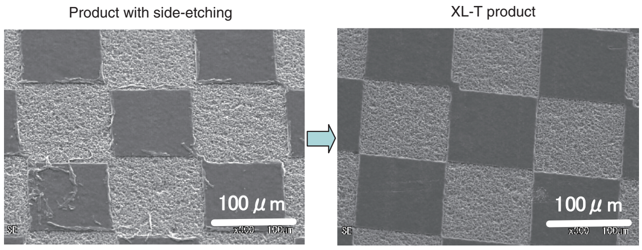

Photo 2 Effect of side-etching control.

Moreover, the structure of the urethane resin is designed to exhibit a thermosetting property at the range of temperatures of the heating process (baking) after development. This property further increases printing durability by at least 1.5 times and greatly enhances durability against UV-ink and its cleansing agent. The applicability of the baking process to some tasks is one of the biggest features of XL-T (Fig. 1).

2.2 Developer XL-D and replenisher XL-DR

Even after the introduction of the above-described technology, urethane resin with high printing durability is still inferior in discrimination and dispersibility into developers, compared with the acrylic resin used in XP-F. Therefore, with the developer XP-D used for XP-F, development is delayed, which results in the formation of a resist film of residuals on the photosensitive layer. If urethane resin is designed to have higher developability in the exposed area to inhibit the formation of the resist film, the endurance of the unexposed area against the developer becomes insufficient, which causes dissolution (Fig. 5).

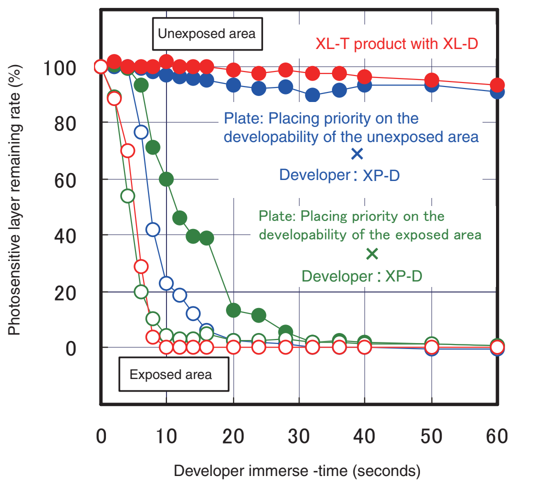

Fig. 5 Discrimination of developed and undeveloped areas.

As a breakthrough for this interrelation, we decided to increase discrimination by improving the developer.

To that end, it was necessary to provide the developer with properties that inhibit the development of the unexposed area while promoting the development of the exposed area. We achieved those properties by using a development activation regulator. The regulator inhibits the permeation of the developer in the unexposed area by interacting with the surface of the upper novolac layer. On the other hand, in the exposed area, the dissolution of novolac resin, whose developability is increased, becomes dominant and the development of the upper layer thus advances. Furthermore, when permeating the underlayer, the developer interacts with the urethane resin and promotes the dissolution and dispersion of that layer. By controlling the interaction of the resins used in the upper and under layers properly, the two antithetic properties of inhibiting and promoting development have become compatible (Fig. 5, Fig. 6).

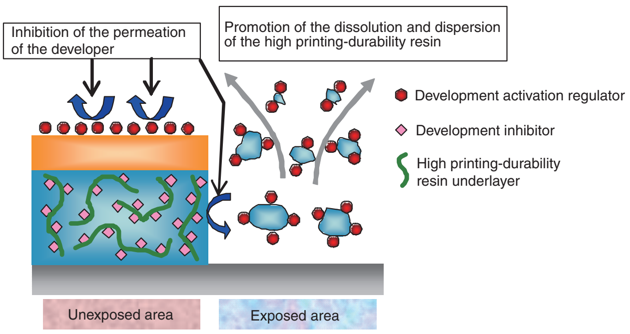

Fig. 6 Development mechanism of XL-T.

Fig. 7 shows the results for a simulation of the dissolution and dispersion of the photosensitive layer of XL-T soaked in the developers, XP-D and XL-D. The former could not achieve sufficient developability and, thus, development advanced while the photosensitive layer was dispersing in a lump. In contrast, the latter dissolved the layer completely.

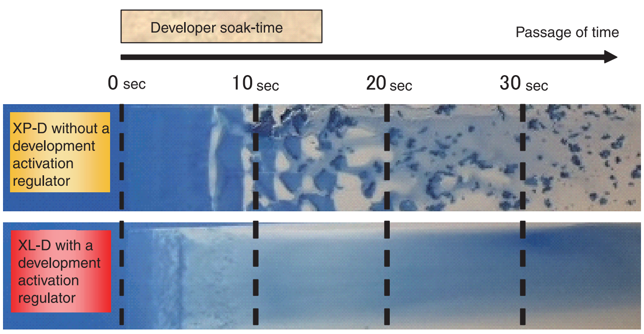

Fig. 7 Dispersion promoting effect of XL-D.

As the developed photosensitive layer is stable in XL-D, the inside of automatic developing equipment is less prone to contamination. Photo 3 shows the states of the developing bath of automatic developing equipment before and after a long-term continuous use test. There are no residuals of the photosensitive layer observed after the test. Cleaning requires only rising with water. The developer is thus excellent in maintenance for replacement.

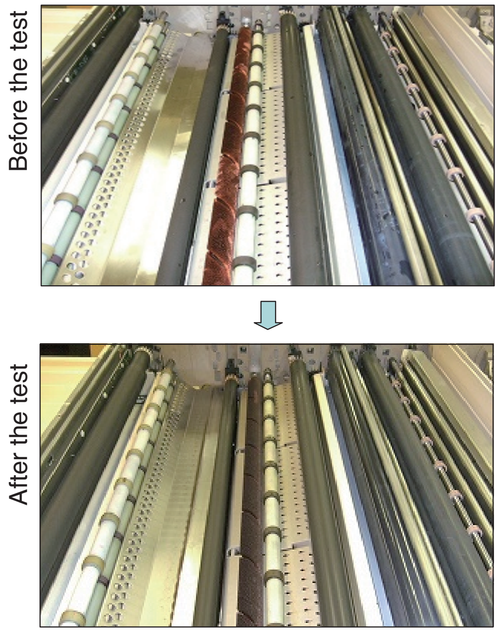

Photo 3 XL-D keeping developer bath clean.

To achieve a developer that had a similar low waste generation to the XP-series, we selected a development activation regulator with a high pH so that salting-out would not occur even at a high ion concentration. This property realizes the high-concentration replenisher XL-DR and, consequently, enables the reduction of waste solution overflow. In the vacuum-distillation waste developer reduction equipment XR-2000/5000, it has become possible to concentrate waste developer together with rinse water to about one-eighth (Fig. 8).

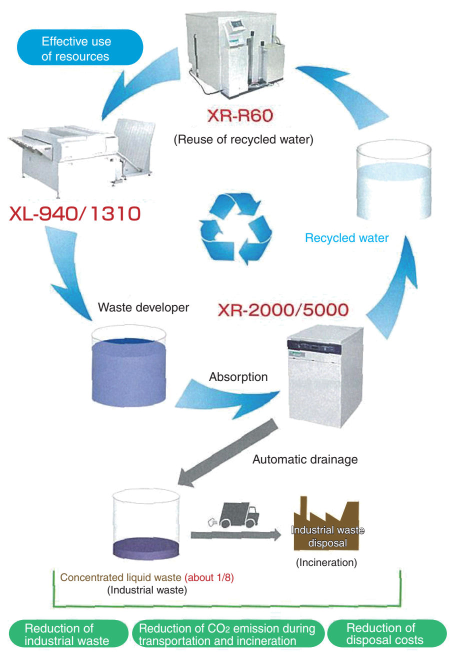

Fig. 8 Systematic view of reducing waste developer/rinse water.

3. Conclusion

As described, XL-T improved printing durability dramatically while generating a low level of industrial waste (i.e., waste developer) equivalent to that of conventional products. This is a CTP plate optimal for long run-length jobs such as the printing of forms, ledgers and magazines and, with it, baking is also possible.

Our lineup of eco-friendly, positive thermal CTPs, covering the commercial printing market overall, has thus been completed. With these products, we expect to contribute to the reduction of the environmental burden of the printing industries.

References

1) Aoshima, N.; Watanabe, T. Development of Environmentally Friendly Thermal CTP System “ECONEX”. Fujifilm Research & Development No. 56, 16-19 (2011).
2) Kawauchi, I.; Nakamura, I. Function Enhancement of Double-coated Positive Thermal CTP Plate. Fujifilm Research & Development No. 51, 48-51 (2006).