A New Technology of Improved Image Quality and Stable Processing System for Laser Imaging

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Abstract: Recently, super high contrast systems called the fourth generation system have been mainly used for laser imaging such as imagesetter. Fuji HQ System is one of the fourth generation systems and characterized by higher dot quality and wider processing latitude. This system is composed of newly developed films and processing chemicals by the following two main technologies. The first is Charged Accelerator Technology which consists of active hydrazine nucleator and nucleation accelerator. The second is Highly Controlled Image Center Technology, consisting of highly active for nucleation but lower fog silver chlorobromide emulsion.
Further its excellent reproduction of very small dots is suitable for fine printing such as FM screening and high resolution screening methods.

Introduction

The digitalization of pre-press such as spread of DTP(Desk Top Publishing) has resulted in remarkable changes in the film-making process. Scanner input and layout software have replaced the camera and contacting works, on the other hand, explosive increase of imagesetters has raised new demand for recording films in both productivity and quality.

RAS(Rapid Access System)films composed of relatively high contrast silver halide emulsions have been generally used for imagesetter.

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Recently it has been required to develop the super high contrast systems that can accurately reproduce any size dot with high density and sharp edges for use as a plate ready final product. Because these image characteristics are expected to increase reliability in succeeding plate making process.

After DURUPA'95 some film vendors launched new high image quality systems called the fourth generation system such as Fuji HQ system and Kodak 2000 system. These systems are composed of films including hydrazine nucleator and nucleation accelerator, and stable developing solution having relatively low pH(pH≒10.5).

The hydrazine technology is well known to provide super high contrast image by infectious development and it was first introduced in hybrid systems as a third generation. Developing solution used in hybrid systems is unstable to aerial oxidization because of higher pH level(pH≧ 11.5), so much replenishment rates are required to keep the consistency of photographic characteristics. Furthermore, the image amplification level caused by infectious development is too large for a precise dot reproduction.
Although above mentioned problems are fairly improved in the fourth generation systems, more over improved reproductivity in developing process is still needed to be widely used as the main systems.

Main differences in the component between HQ systems and hybrid systems are summarized in Table 1.

Table1 ComparisonbetweenHQsystemancHybridsyst

	Hybrid system	HQ system
Nucleating material	Folmyl-type Hydrazine	Active Hydrazine Nucleation Accelerator
AgX emulsion	AgBr (Unsensitized)	AgBrCl (Chemically sensitized)
Develop solution	High pH(11.5) Amine compound	Low pH(10.5)

Fuji HQ system is one of the fourth generation systems and characterized by higher quality and wider processing latitude. The purpose of this report is to explain new emulsion technologies developed in HQ system and its good performance for imagesetting.

In HQ systems, following two main technologies are developed. The first is Charged Accelerator Technology which consists of active hydrazine nucleator and nucleating accelerator. The second is Highly Controlled Image Center Technology, consisting of highly active for nucleation but lower fog silver chlorobromide emulsion.

New Technologies of Fuji HQ System

1. Charged Accelerator Technology (C.A.T)

hydrazine nucleator

Generally proposed mechanism of hydrazine infectious development[1] is shown in Fig.1. Super high contrast image is achieved by following three successive processes after normal development of exposed silver halide grains.

(1)Oxidation process of acylphenylhydrazide to acylphenyldiazene by oxidative product of developing agent.

(2)Hydrolysis process of acylphenyldiazene to phenyldiazene.

(3)Nucleation process of unexposed and underexposed silver halide grains proximate to exposed grains by phenyldiazene.

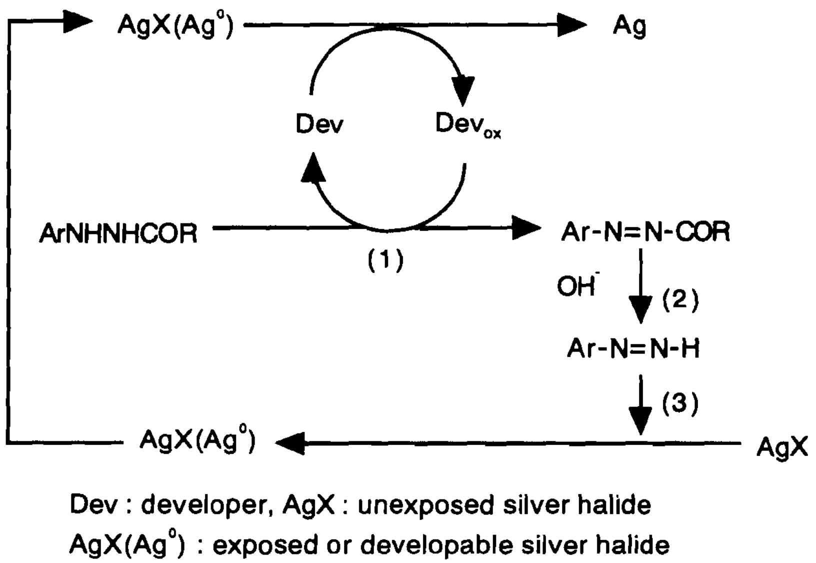


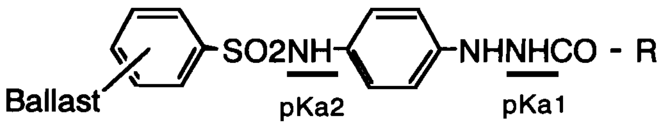
Fig.1 Mechanism of hydrazine infectious development

As already reported, use of sulphonamido-acylphenylhydrazide allowed the infectious development at pH value around 10.5 [2]. Since the pH of developing solution has a significant influence on nucleating efficiency in hydrazine infectious development, reducing pH dependence is most important for stability of the system.

In addition to use of suluphonamido-acylphenylhydrazine, more active and less pH dependent nucleator is developed by reducing pKa of acylphenylhydrazide[3]. Introducing electron withdrawing substituents to acyl group is expected to reduce pKa of hydrazo proton (pKa1) and increase the rates of oxidation process.

Hz-2 (introduced $-CF_3$) brought a low pKa1 value expectedly and higher activity (high γ) comparing to Hz-1 that had been generally used, but at the same time the lack of storage-stability was shown in Table2. It was thought Hz-2 partially dissociated and oxidized even when it was stored in film because of its too low pKa1. After a lot of examination to find moderate pKa of compound, we finally reached Hz-3. Although it has higher pka1 than that of Hz-1, it shows sufficient activity probably due to its high hydrophilicity[3].

Table 2 pKa Value, γ, and Storage-Stability of hydrazides



				Photographic characteristics	
	R	pKa 1*	pKa 2*	γ	Strage stability
Hz-1	H	12.0	9.8	Low	good
Hz-2	CF3	7.7	10.6	17	poor
Hz-3	C2F4COOH	9.1	10.6	18	good

* measured in acetonitorile:H_2O=1:1 at pH=10.5

Further Hz-3 show superior pH dependence in oxidization rates compared to Hz-1 as shown in Fig.2.

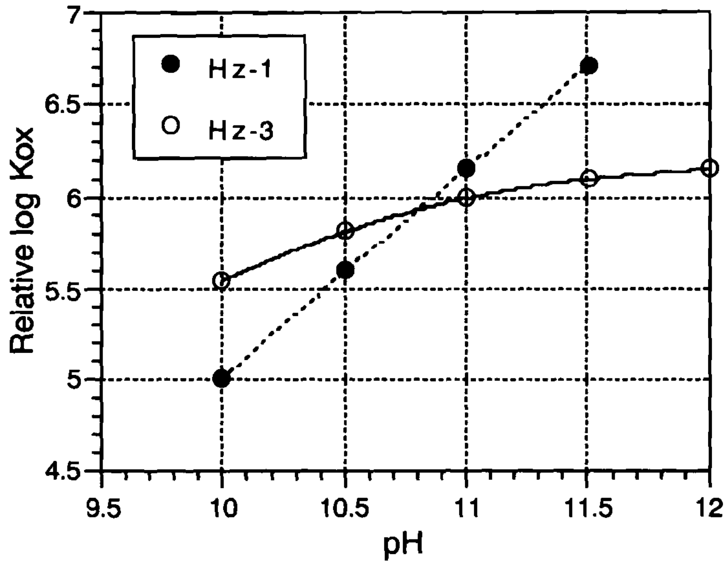


Fig.2 pH dependence of oxidation rates measured in Acetonitrile : H_2O=1:1

CA type Accelerator

It is necessary to include nucleation accelerator into film that promote the nucleating reaction in addition to active nucleator for amine-free and such a lower pH level(≒10.5) developer. Amine compounds are most general as accelerator but they often cause problems of decreasing the stability of other organic materials and appearance of black spots called pepper fog. A novel accelerator CA-1 shown in Fig.3 is developed.

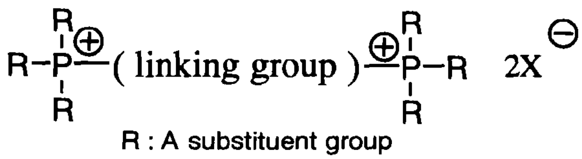


Fig.3 Formula of CA-1

This is an excellent compound which has efficient accelerating effect without problems described above. It is reported that amine compounds accelerate oxidation process in the nucleating mechanism[4], therefore, this effect is dependent on pH level of developer. On the other hand, it is expected CA-1 accelerate the electron injection process to silver halide grains from model experiments.

2. Highly Controlled Image Center Technology(H.C.I)

Silver halide emulsion for fourth generation system is required to have high activity for nucleating. Therefore, it is important to develop the highly concentrated image center emulsion that has enough sensitivity for very short exposure and high efficiency of latent image formation using electron injected by nucleating species.

Chemically sensitized AgBrCl emulsion is used in HQ system for this purpose. Both high nucleating activity and low level of fog are achieved by Highly Controlled Image Center Technology. Silver halide emulsion is manufactured under carefully controlled metal doping and chemical sensitizing.

As shown in Fig.4, starting point of development was observed at one corner, which suggests the concentration of latent image center in new emulsion.

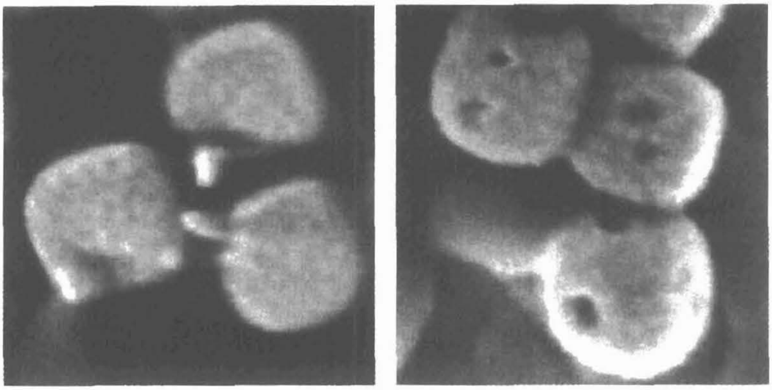


Fig.4 Electron photomicrograph of starting point of development
left : new emulsion, right : emulsion for Hybrid system

Performance of HQ system

The fourth generation system brings a lot of improvement in performance compared with Hybrid or Ras system. Fuji HQ system especially gives the chief advantage in terms of both its excellent image quality and high stability in development.

Excellent image quality

A lot of imagesetters with different light source and scanning way has been already installed. HQ film line-up for each kind of laser makes the range suitable for use with almost all types of imagesetter.

Comparing the dot quality for three different type of Imagesetters between HQ and conventional RAS systems, shown in Fig.5, HQ provides the same sharp dot structure, resulted in output device-independent system.

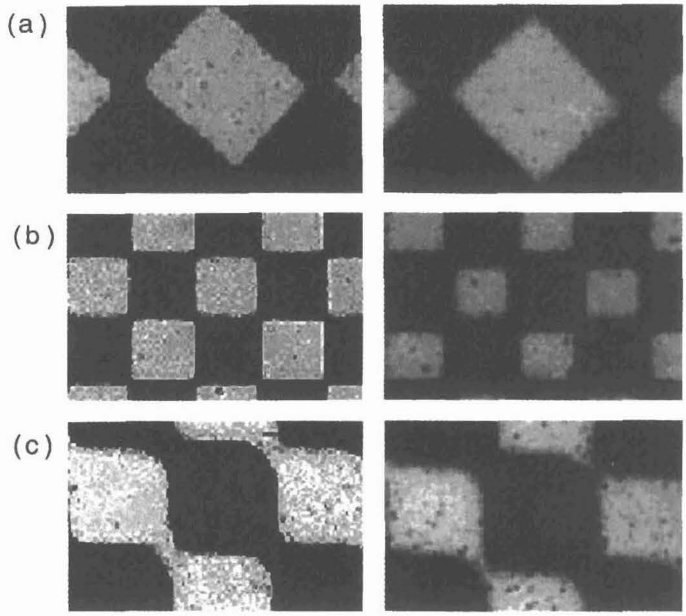


Fig.5 photomicrograph of dots with three different imagesetters
left : HQsystem   right : RAS system

As HQ system can reproduce even extreme small dots with high Dmax shown in Fig.6, it is suitable for high quality printing such as high resolution screening and FM screening methods.

Since HQ system is designed to reduce excessive image amplification as shown in Table 3, it can exactly reproduce from small dot to large dot as shown in Fig.7. this accurate liniality may decrease troublesome adjustment of output condition.

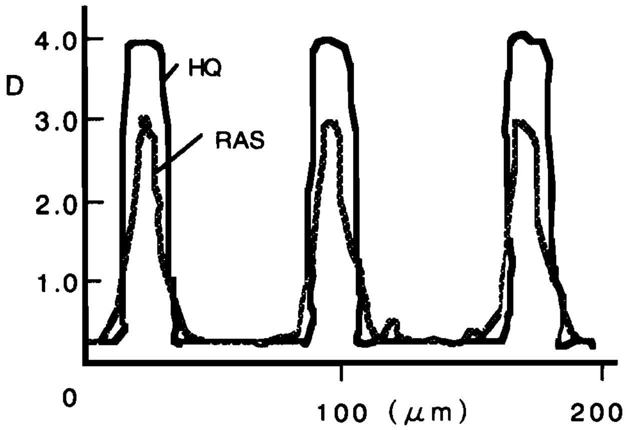


Fig.6 Micro-densitometric profile of very small dots

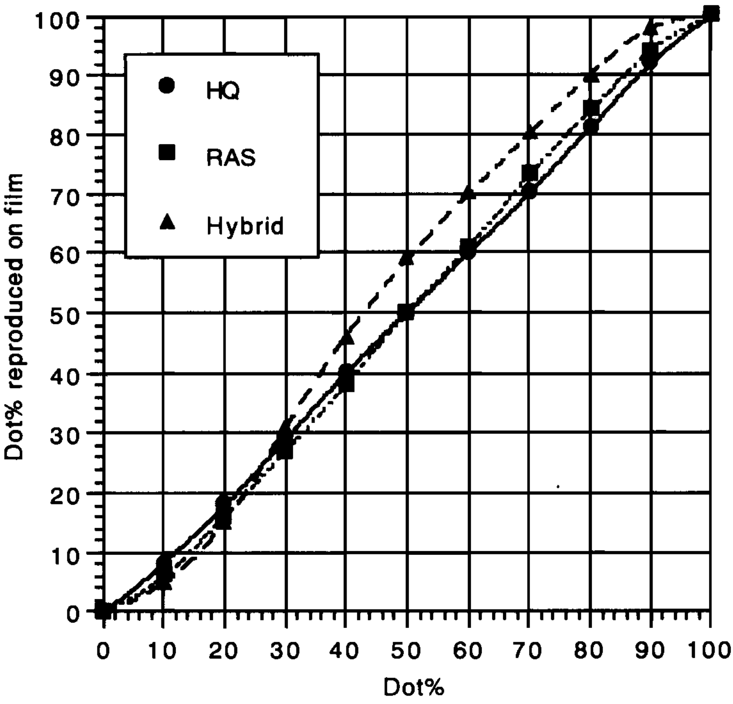


Fig.7 A example of a liniality curve
SG-608(Dainippon Screen) 175lp

Table3 Image amplification level

System	RAS	Hybrid	HQ
Image amplification	0μm	more than 10μm	less than 5μm

measured by using Xray exposure equipment [5)]

Stability in development

Owing to the combination of developer reducing aerial oxidation and films with CA and HCI technology , remarkable stability in developing is achieved in HQ system. Superior developing latitude of HQ system is compared with that of hybrid system in Fig.8 .

It is the greatest subject for system to keep the consistency of photographic performance against change of developing solution composition by exhaustion. Developing solution is generally deteriorated mainly due to aerial oxidation and processing exhaustion which depend on processing film quantity. In HQ system, high Dmax and consistent dot area is kept with as small amount of replenishment as conventional RAS system regardless processing film quantity (Fig.9).

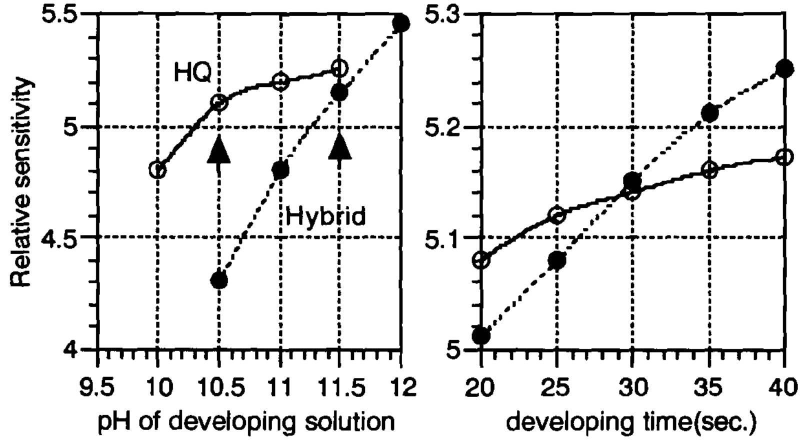


Fig.8 Photographic sensitivity change in developing conditio

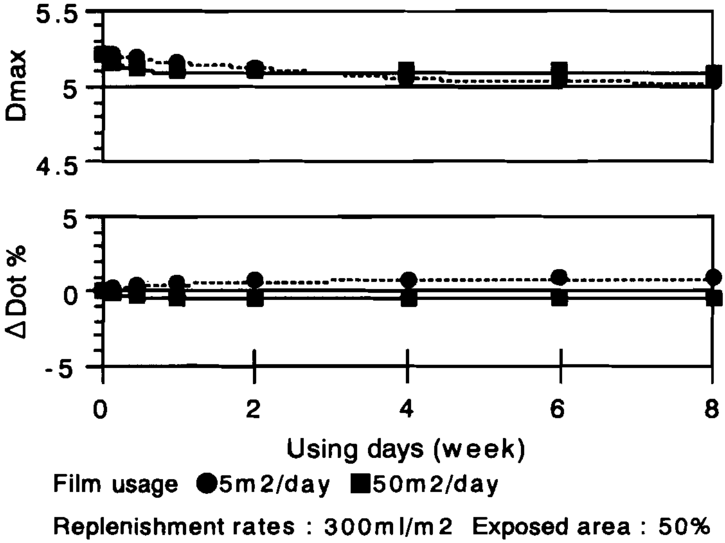


Fig.9 Aresurt of plactical running use

Conclusion

The Fourth generation systems have been mainly used for imagesetting because of its high quality and accurate reproduction . New photographic technologies called CAT and HCI stand both high quality and stability in developing in HQ system. A consistent high quality output in HQ system will be able to contribute higher quality and grater productivity in the digital pre-press process.

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