The Current Possibilities and Limitations of Thermofuse Digital Printing Plate Technology

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Abstract

Several new insights into the working mechanisms of latex coalescence/latex fusion thermal printing plate technology (commonly also referred to as "Thermofuse" plate technology) have afforded a boost in its pre-press and press performance, as well as a further increase in its versatility. This now allows the design of plate constructions that better fit the needs of both the general-purpose thermal printing plate market ([mildly] alkaline processing) and those printers who require plates that allow for a more convenient processing, either off-press (so-called "gum processing", also referred to as "chemistry-free" processing or simply "clean-out washing") or on-press (so-called "on-press processing").

The chemical concepts that allow for a proper balance between plate sensitivity, clean-out of the non-image areas during processing and on-press robustness are highlighted, as well as the new chemical concepts that allow to create a clear image contrast upon exposure (required in on-press processing applications).

It is shown for example that in order to be able to increase sensitivity by use of small thermoplastic particles with an average particle diameter less than 40 nm, the surface of these particles has to be sufficiently covered with the appropriate anionic IR dyes and/or other anionic "dummy dyes" in order to allow for a solid clean-out performance. The adsorbed amount, without the counter ion taken into account, should be more than respectively 0.80 mg per m^2 (on-press processing or gum processing) or 0.65 mg per m^2 ([mildly] alkaline processing) of the total surface of the thermoplastic particles present in the coating.

In order to create the required visual contrast between the image and non-image areas upon exposure, so-called thermochromic IR-dyes have been designed that form products strongly absorbing in the visual part of the spectrum after exposure to IR light (830 nm) of sufficient energy density (> 100 mJ/cm^2).

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The paper will close with a tentative look at the promises that Thermofuse technology still might hold in the future.

Introduction

Since the introduction of the first thermal digital plate systems in the mid nineties of last century, quite a technological (r)evolution has taken place in this area (Van hunsel et al., 1998) (Goodman et al., 1999) (Vander Aa et al., 2005). Today, thermal plate systems are available on the market that are based on different working principles. Roughly, one can distinguish between the mainstream (alkaline processing suitable) thermal plate system categories as follows:

(i) Negative-working thermal plate systems, such as Kodak's "Thermal Gold" plate system, that require yellow safelight and a so-called pre-heat step (typically at around 140°C) after imaging and before alkaline processing (Walls, 1994). The basic working principle of these plate systems is acid-catalyzed crosslinking of the polymer binder in the coating. The coating comprises a compound that upon imagewise laser exposure to 830 nm (and the resulting heat generation) and pre-heat chemically decomposes into an acid. This acid subsequently acts as a catalyst in the crosslinking process of the novolak based coating.

(ii) Positive working thermal plate systems that can be operated under daylight conditions and do not require a pre-heat step after imaging and before alkaline processing. The basic working principle of these plate systems is a physical transformation whereby the novolak coating imagewise becomes (more) soluble in the alkaline developer (Nagasaka et al., 1997). Several components in the coating such as the IR-dye and/or the contrast dye (e.g., Crystal Violet) interact with the novolak binder and inhibit its solubility. Upon laser exposure to 830 nm (and the resulting heat generation) this inhibiting effect is reduced and the coating becomes (more) soluble. Because of the fact that this transformation is of a purely physical nature, it is in essence reversible and that is why most plate systems of this kind show various degrees of latent image fading. In some of today's available high-end plate systems of this kind, such as Agfa's Thermostar P970 plate system, effective measures have been taken in order to minimize this latent image fading.

Today, plate systems are also available on the market that make use of alternative binders, of which the solubility can be inhibited effectively. As an example phenolic polyvinyl acetal binders can be mentioned (Levanon et al., 2000). The working principle of these plate systems essentially remains the same (McCullough et al., 2005).

Furthermore, so-called "double layer" plate systems are also available in the market, such as Agfa's "Energy Elite" plate system, which allow for a higher chemical and mechanical robustness on-press. Basically, the top player acts here as a positive working mask that can be imagewise made soluble in an alkaline solution in a way as outlined above. The bottom layer basically consists of a binder that is soluble in the alkaline developer used but exhibits a high chemical and mechanical resistance on-press.

(iii) Negative-working thermal photopolymer plate systems, such as Kodak's "ThermalNews Gold" plate system (S. Kull et al., 2005). Also these plate systems require in most cases yellow safelight, but always a so-called pre-heat step (typically at around 130°C) after imaging and before alkaline processing. The basic working principle of these plate systems is free-radical photopolymerization. The coating comprises at least one so-called initiator compound that upon imagewise laser exposure to 830 nm (and the resulting heat generation) generates radicals. These radicals initiate the photopolymerization process that converts the present monomers and oligomers into a three-dimensional network.

In the last couple of years the demand from the printing industry for more convenient and environmentally safe printing plate systems has grown strongly. Today, almost all major printing plate suppliers have introduced thermal plate systems that are suitable for more "convenient" ways of processing. Depending on the approach taken, these systems either are suitable for on-press processing or off-press processing.

Whereas Kodak ("ThermalDirect" [McCullough et al., 2006]) and Fuji ("Brillia PRO-T") in this respect have chosen to develop plate systems based on thermal photopolymer technology and Presstek has taken a totally different approach (laser ablation technology [E. Langlais, 2002]), Agfa from the start has opted to further develop and perfect a basic negative-working thermal plate technology that it pioneered 15 years ago, the so-called latex coalescence/latex fusion plate technology, also referred to as the "Thermofuse plate technology." Agfa believes that this technology offers the required versatility for developing plate systems for different applications (both on-press and off-press processing) and most importantly, plate systems that do not impose any limitations or compromises on the press operator with respect to his working latitude on-press. Agfa currently offers 3 thermal plate systems based on this technology, i.e., ":ThermolitePlus" (for on-press processing), ":Azura" (for gum processing, also referred to as "chemistry-free" processing or simply, "clean-out washing") and ":Amigo" (mildly alkaline processing [pH = 12.5]). In this paper "clean-out" will further be used as the generic term to denote the removal of the non-exposed parts of the coating after imaging.

This paper will highlight the developments of Agfa's Thermofuse plate technology that took place in the last couple of years. New insights into the working mechanisms of the latex coalescence/latex fusion thermal printing plate technology are presented. The newly acquired knowledge now allows the design of new plate constructions that better fit the needs of both the general-purpose thermal printing plate market ([mildly] alkaline processing) and those printers who require plates that allow for a more convenient processing either off-press or on-press. Some of these new plate designs, such as the second-generation ":Azura TS" plate (where "T" stands for "Thermal" and "S" for "Speed") have already been introduced into the market. Some other new plate systems will follow in the months and years to come.

Thermofuse Plate Technology

The Thermofuse plate technology is based on latex coalescence or latex fusion. Upon imagewise laser exposure to 830 nm (and the resulting heat generation) the thermoplastic particles present in the coating melt and/or fuse together and adhere to the anodized aluminum plate substrate. The most important basic Agfa patents related to this plate technology have been filed already in the mid-nineties of last century (Vermeersch et al., 1995).

The working mechanism is presented in Figure 1. Figure 2 shows SEM pictures of both the unexposed (a) and exposed (b) parts of a plate coating. This plate coating, which results from an aqueous coating solution, comprises sub-micron thermoplastic polymeric particles.

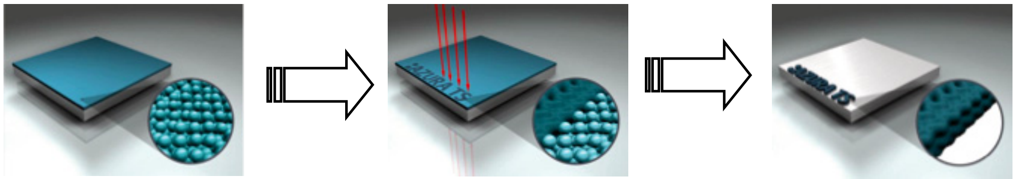
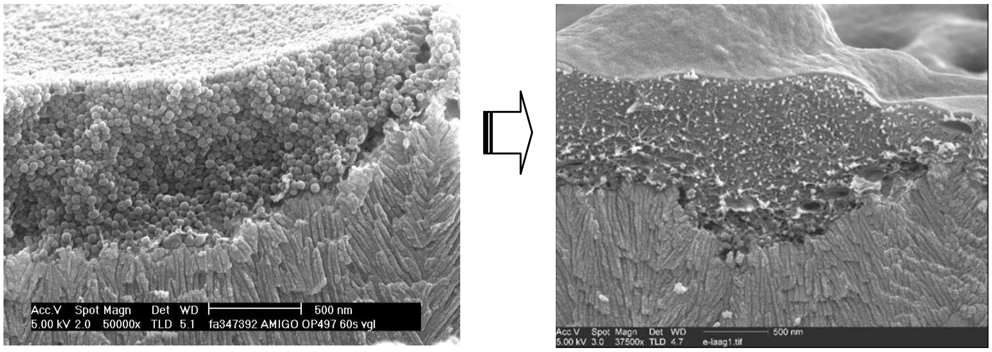


***Figure 1.** Working mechanism of the Thermofuse plate technology.*

In Figure 2(a) one can clearly distinguish the individual polymeric particles held together by a stabilizing binder polymer. This binder polymer is essential in avoiding irreversible coagulation of the particles before thermal exposure and ensuring the stability of the coating even at higher temperatures (storage at 50°C during two weeks causes no degeneration at all of the coating).

Figure 2(b) clearly shows that the polymeric particles upon exposure melt and/or fuse together and adhere to the substrate.



(a) (b)

Figure 2. *Scanning Electron Microscope (SEM) pictures of resp. non-imaged (a) and imaged (b) parts of a Thermofuse printing plate.*

Later on in this paper, it will become clear that also other components of the coating are essential for the stability of the thermoplastic particles and therefore the clean-out performance of the coating.

The polymeric particles are designed in order to obtain a sufficient exposure sensitivity and to result in plate image parts after exposure and “clean-out” that ensure good inking-up characteristics, a good lithographic latitude (ink/water balance) and a good resistance towards press chemicals. As indicated before (Vander Aa et al., 2005), a proper choice of the chemical composition of the particles allows for a good chemical resistance of the image parts. As a rule, the thermoplastic polymer particles preferably comprise at least 5 wt. %, more preferably at least 30 wt. %, of nitrogen containing units, such as (meth)acrylonitrile (Van Aert et al., 2001). A correct choice of the particle size allows for a good exposure sensitivity. It was proven that smaller particles allow for a higher sensitivity (Vander Aa et al., 2005).

The aluminum substrate also plays an important role in ensuring a correct plate performance. It has been indicated before (Vander Aa et al., 2005) (Verschueren et al., 2003) that a lower substrate roughness (with an arithmetical mean center-line roughness Ra (as, e.g., determined with a Talysurf 10 from Taylor Hobson Ltd.) lower than 0.45 µm) will result in a better press life and consequently, in a better plate sensitivity (achieving a similar press life on a rougher substrate is only possible by a higher plate exposure).

New Insights in the Working Mechanisms of Thermofuse Plate Technology

As indicated above, gradually decreasing the latex particle size allows for an increase of the plate's sensitivity. However, at the same time it also becomes more difficult to "clean-out" the non-image parts of the plate after imaging. This is the reason why all of Agfa's "first-generation" Thermofuse plate systems failed to achieve a plate sensitivity in the range of 120–180 mJ/cm^2, which is typical for all currently available non-preheat thermal plates suitable for alkaline processing.

The current first-generation :Amigo plate system uses a latex with an average latex particle size of about 45 nm (as determined by hydrodynamic fractionation (HDF) : PL-PSDA volume average (mean) value, see further), which results in a typical practical sensitivity value of about 225–250 mJ/cm^2 upon imaging the plate on a Creo TrendSetter 3244T (40W, 150 rpm). Agfa's first-generation :Azura plate system uses a 55 nm latex, which only allows for a practical sensitivity of typically 275–300 mJ/cm^2.

Continued research w.r.t. the basic working principles of Thermofuse plate technology has revealed that by adjusting the IR-dye concentration so as to ensure a good "coverage" or "wetting" of the latex particles surface with anionic IR dye molecules, a good clean-out performance can be obtained, even when using (very) small latex particles, e.g., smaller than 40 nm (Andriessen et al., 2006). It has been found that the adsorbed amount of anionic IR-dye, without the counter ion taken into account, should be more than respectively 0.80 mg per m^2 (on-press processing or gum processing) or 0.65 mg per m^2 ([mildly] alkaline processing) of the total surface of the thermoplastic particles present in the coating. A possible explanation for this observation may be that (all or part of) the anionic IR-dyes adsorbed on the surface of the hydrophobic latex particles render the particles more dispersible in aqueous solutions (such as the fountain solution or the gumming solution), resulting in an improved clean-out behaviour, or alternatively, the adsorbed IR-dyes present a physical barrier to irreversible coagulation.

The following model experiments serve to illustrate this observation.

A number of printing plate precursors PPP-01 to PPP-05 were made by coating the following compositions (in g/m^2) onto a 0.30 mm electrochemically roughened (HCl) and anodized (H_2SO_4) aluminum substrate with a surface roughness R_a of 0.35–0.4 µm (as measured with a contactless Wyko NT1100 Optical Profilometer from Veeco Instruments Inc.) and with an anodic weight of about 4.0 g/m^2.

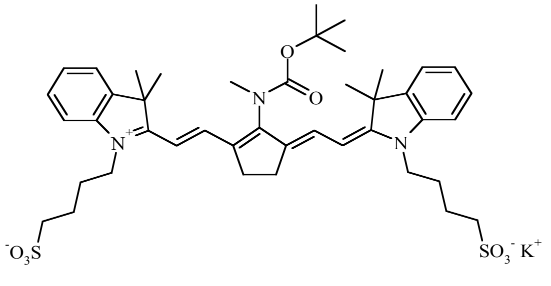
These compositions are given in Table 1:

PPP (g/m^2)	**PPP-01**	**PPP-02**	**PPP-03**	**PPP-04**	**PPP-05**
LX-01	0.439	-	-	-	-
LX-02	-	0.42	-	-	-
LX-03	-	-	0.425	0.409	0.178
IR-1	0.070	0.071	0.070	0.090	0.079
PAA	0.068	0.086	0.079	0.076	0.033
HEDP	0.015	0.015	0.014	0.013	0.006
FSO 100	0.006	0.006	0.010	0.009	0.004
Dry coating weight	0.597	0.597	0.597	0.597	0.300

Table 1. *The composition and total dry coating weight of printing plate precursors PPP-01 to PPP-05.*

where PAA stands for polyacrylic acid, HEDP for 1-hydroxyethylidene-1,1-diphosphonic acid and FSO100 for Zonyl FSO 100, a fluoro surfactant from Dupont.

IR-1 is a thermochromic cyanine IR-dye (see further) with the following chemical structure:



Three different latex formulations LX-01, LX-02 and LX-03 were used, comprising particles of the same chemical composition (copolymer of styrene en acrylonitrile) but with a different particle size and accordingly, a different specific particle surface.

Two techniques were used to measure the particle diameter of the hydrophobic thermoplastic particles:

(i) $\varnothing_{PCS}$ is the particle diameter obtained by Photon Correlation Spectroscopy.

The measurements were performed according to the ISO 13321 procedure (first Edition, 1996-07-01) with a Brookhaven BI-90 Analyzer from Brookhaven Instrument Company.

(ii) $\varnothing_V$ is the volume average particle diameter obtained by hydrodynamic fractionation (HDF). The measurements were performed with a PL-PSDA (Polymer Laboratories Particle Size Diameter Analyzer) from Polymeric Laboratories Inc.

From the volume particle size distribution, obtained with the PL-PSDA, the total surface of the hydrophobic thermoplastic particles (S or Surface [m^2/g]) is calculated. These calculations have been performed with a density (ρ, [g/cm^3]) of the particles of 1.10 g/cm^3. Since all particles LX-01 to LX-03 have the same chemical composition, they all have the same density. The density of the particles LX-01 to LX-03 (skeletal density according to the ASTM D3766 standard) was measured using the gas displacement method with an Accupyc 1330 helium-pycnometer (from Micromeritics Instrument Corp.).

As an approximation, the total surface of the hydrophobic particles S can also be calculated taking into account only the volume average particle size ($\varnothing_V$):

$$S\ (m^2/g) = \frac{6}{\rho \cdot \varnothing_V\ (nm)} \cdot 10^3$$

In Table 2 $\varnothing_{PCS}$, $\varnothing_V$ and the total surface of latex formulations LX-01 to LX-03 are given.

	LX-01	LX-02	LX-03
$\varnothing_{PCS}$ (nm)	59	37	21
$\varnothing_V$ (nm)	53	34	22
Surface (m^2/g)	98	160	216

Table 2. *$\varnothing_{PCS}$, $\varnothing_V$, and total surface of latex formulations LX-01 to LX-03.*

Each of the printing plate precursors PPP-01 to PPP-05 was subsequently exposed on a Creo TrendSetter 3244T platesetter (40 W head, 150 rpm) at respectively 300 – 250 – 200 – 150 – 100 mJ/cm^2 with a 200 line per inch (lpi) screen at an adressability of 2400 dpi. The exposed printing plate precursors were subsequently mounted on a Heidelberg GTO46 printing press without any prior processing step or pre-treatment. A compressible blanket was used and printing was done with 3% Agfa Prima FS101 (fountain solution) and K+E 800 black (ink). The following start-up procedure was used: first 5 revolutions with the dampening form rollers engaged, then 5 revolutions with both the dampening and ink form rollers engaged, then printing was started. 1000 prints were made on 80 g/m^2 offset paper.

Evaluation of the printing plate precursors was performed using the following parameters:

Sensitivity 1:	Plate sensitivity (2% dot) (mJ/cm^2) or the lowest exposure energy density at which 2% dots (200 lpi) are perfectly visible (by means of a 5x magnifying glass) on the printed sheet 1000.
Sensitivity 2:	Plate sensitivity (1x1 CHKB & 8x8 CHKB) (mJ/cm^2) or the interpolated exposure energy density where the measured optical density on the printed sheet 1000 of the 1 pixel x 1 pixel (1x1) checkerboard (CHKB) pattern equals the measured optical density of the 8 pixel x 8 pixel (8x8) checkerboard pattern. This method allows for a more precise determination of the relative imaging sensitivities of Thermofuse technology printing plates.
Clean-out on-press:	The number of printed sheets needed to yield an optical density value in the non-image areas on the printed paper of less than 0.01. A well performing plate should have a score here of 25 sheets or less (critical press start-up procedure).

The optical densities referred to above were all measured with a GretagMacbeth D19C densitometer.

In Table 3 the lithographic properties of all printing plate precursors PPP-01 to PPP-05 are given, together with their following characteristics: $\varnothing_{PCS}$, $\varnothing_{V}$, Surface (m^2/g) (see above) as well as:

(i) IR-dye/Surf.: amount of IR-dye (mg), without taken into account the counter ion, per m^2 of the total surface of the particles (mg/m^2).

(ii) Latex wt. %: amount of latex relative to the total amount of ingredients in the coating (wt. %).

(iii) Latex/PAA: amount of latex relative to the amount of the polyacrylic acid (PAA) binder.

(iv) Dry Coating Weight: total amount of ingredients in the dried image-recording layer (g/m^2).

PPP	**PPP-01**	**PPP-02**	**PPP-03**	**PPP-04**	**PPP-05**
$\varnothing_{PCS}$ (nm)	59	37	21	21	21
$\varnothing_{V}$ (nm)	53	34	22	22	22
Surface (m^2/g)	98	160	216	216	216
IR-dye/Surf.(mg/m^2)	1.55	1.00	0.74	0.96	1.96
Latex wt.%	73.47	70.30	71.10	68.41	59.49
Latex/PAA	6.5	4.9	5.37	5.37	5.4
Dry Coating Weight	0.597	0.597	0.597	0.597	0.300
Sensitivity 1 (mJ/cm^2)	150	150	-*	100	200
Sensitivity 2 (mJ/cm^2)	228	168	-*	127	221
Clean out on-press	1	20	>1000	10	1

* : not measurable due to the amount of toning on the printed sheet.

Table 3. *Coating characteristics and lithographic performance characteristics of printing plate precursors PPP-01 to PPP-05.*

From Table 3 it is clear that a significant sensitivity increase can be realized by decreasing the latex particle size below 40 nm. However the latex concentration needs to be kept at a concentration level well beyond 60 wt% (see PPP-05). Only when adapting the IR-dye "latex coverage" beyond 0.8 g/m^2 (i.e., the amount of IR-dye (in mg) divided by the total amount of latex surface available per sqm of plate), a good clean-out performance of the plate can be obtained.

Many additional experiments have shown that this correlation is valid, independent of the total coating weight, the latex particle diameter, the chemical structure of the IR-dye, etc. The minimum latex coverage required however seems to be dependent on the clean-out process used. For on-press processing and/or gum processing, the "latex coverage" needs to be at least 0.80 mg/m^2, whereas for (mildly) alkaline processing, the "latex coverage" only needs to be at least 0.65 mg/m^2.

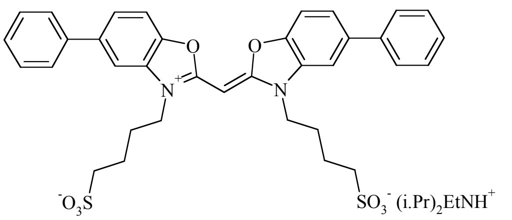
This discovery directly allows the design of Thermofuse plate systems with a sensitivity in the range of 120–180 mJ/cm^2.

However, using smaller latex particles (increased specific particle surface) in order to increase the sensitivity of the plate to a significant extent also means that the IR-dye concentration needs to be increased considerably. As a result, the optical density at 830 nm of the coating can become so high that the plate sensitivity suffers again and the advantage of the use of smaller latices is lost completely (a good adhesion of the melted latex particles to the substrate is only possible if enough light reaches the substrate and therefore the optical density of the coating should be limited). The plate optical density (at 830 nm) of a Thermofuse plate preferably should not be higher than 1.0 and most preferably not higher than 0.5. Another consequence of using smaller latex particles and subsequently increasing the IR-dye concentration is a decreased latex content in the coating, which is disadvantageous for the plate's press life.

It is clear that a reconciliation of both requirements (a proper IR dye "coverage" or "wetting" of the latex surface and a low enough plate optical density) will be more difficult when going to smaller latices (in order to improve the plate sensitivity). One way to reconcile both requirements is to lower the effective coating thickness, but this will negatively affect the physical robustness of the plate, both before and after imaging and "clean-out": the plate will become more sensitive to marking and scratching, which will jeopardize its handling latitude, and its press life will be affected substantially.

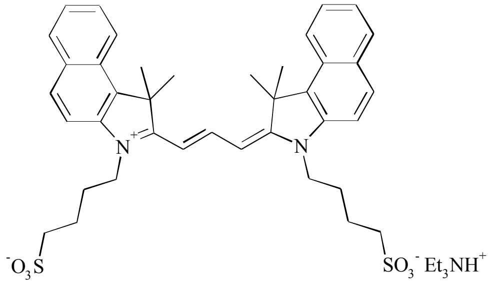
An alternative method has been developed that allows for a reconciliation of both requirements without affecting the layer thickness and consequently the physical robustness of the plate. This method entails the introduction of so-called "dummy dyes" in the layer (Callant et al., 2006). These compounds are characterized by a good "wetting" behaviour of the latex surface on the one side and good hydrophilic properties on the other side. As a result, they mimic the behaviour of the anionic IR dyes commonly used in latex coagulation plates, without absorbing any IR radiation. Consequently, they will favour a good clean-out performance of the plate, even with very small latices in a coating of sufficient thickness in order to allow for proper physical properties and a good press life.

Either colourless "dummy dyes" (that do not absorb in the visual part of the spectrum, nor in the IR part of the spectrum) or "dummy dyes" that absorb in the visual part of the spectrum can be used. Colourless dyes are clearly preferred when considering plates designed for on-press processing (e.g., :ThermolitePlus), because they cannot jeopardize the efficiency of the colour switching effect of the plate upon imaging (when use is made of a suitable colour switching or "image print out" technology, see further). Furthermore, ink colour contamination effects on-press are excluded in this way (e.g., yellow ink contamination). An example of a suitable "dummy dye" that essentially does not absorb in the visual part of the spectrum is:



(λ_{max} =389 nm, i.Pr = isopropyl, Et = ethyl)

The use of dyes that absorb in the visual part of the spectrum class is clearly preferred when considering plates designed for off-press clean-out (e.g., in plain water, gum or [mildly] alkaline developer), because they allow to (partially) avoid the use of traditional contrast pigments (which have proven to have a negative impact on the clean-out performance of the plate). An example of a suitable "dummy dye" that absorbs in the visual part of the spectrum is:



(λ_{max} =588 nm)

It has been shown in experiments similar to the ones given above that a good clean-out performance can be achieved when the the total amount of dye (IR-dye + "dummy dye") is higher than respectively 0.80 mg per m^2 (on-press processing or gum processing) or 0.65 mg per m^2 (alkaline processing) of the total surface of the thermoplastic particles present in the coating.

Continued research w.r.t. the interaction between a coating that comprises at least 60 wt% of submicron thermoplastic particles and an aluminum substrate has revealed that specific double post-anodic treatments of the grained and anodized aluminum substrate will allow for even more clean-out latitude, especially for plates that have been exposed to warm and humid conditions (Andriessen et al., 2007).

Suitable Colour Switching or "Image Print Out" Technology for Thermofuse Technology Plates

Printing plates suitable for on-press processsing, such as Agfa's :ThermolitePlus plate, typically do not comprize any pigment or dye substances absorbing in the visible part of the spectrum so as not to affect the colour fidelity of the printed matter. As a result, plates suitable for on-press processing typically show a weak to very weak so-called “imaging contrast” or “image print out.”

While studying the basic working principles of Thermofuse plate technology, it was found that suitable anionic IR-dyes (that hardly show any absorption in the visible part of the spectrum) could be designed, which change structurally into dyes absorbing in the visible part of the spectrum upon imagewise laser exposure at 830 nm (and the resulting heat generation). The basic patent applications on this so-called “thermochromic” IR-dye technology have been filed already in 2005 and 2006 (Callant et al., 2005 and 2006).

The basic principle of this new IR-dye technology is a structural change of one or more substituents on the chromophore upon exposure so as to change its light absorption characteristics to a significant extent. One possible approach is image-wise transformation of the meso-substituent on a cyanine dye structure from an electron acceptor to an electron donor, as represented in Figure 3 (note: the basic cyanine dye structure depicted here is just one out of many possible structures).

An example of such a thermochromic IR-dye is given in Figure 4, which also shows the strongly colored (contrast) dye which is formed upon 830 nm laser exposure (and the resulting heat generation).

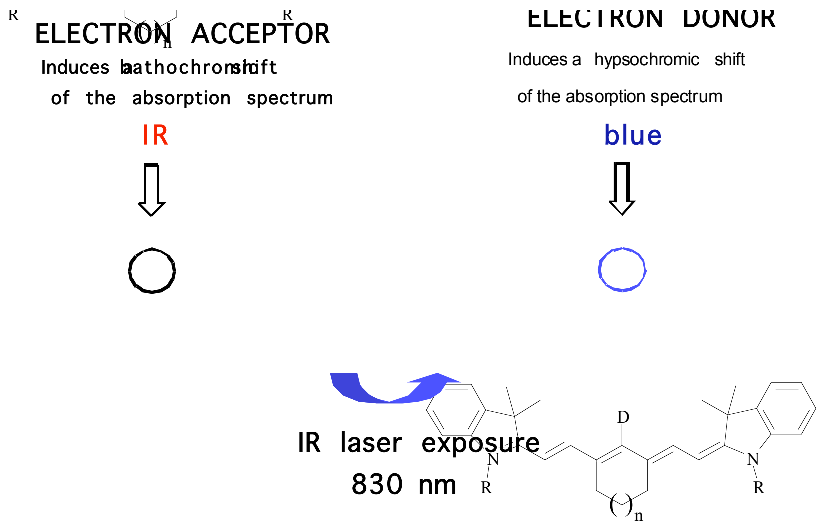


__Figure 3.__ Basic principle of Agfa’s new thermochromic dye technology.

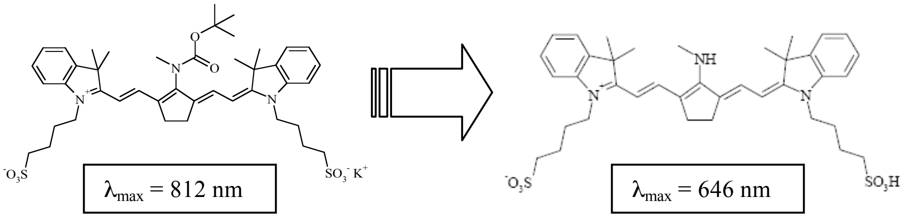
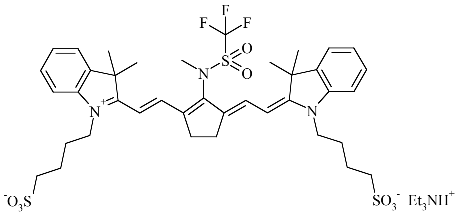


Figure 4. *Structural change of a cyanine IR-dye leading to a shift of the absorption maximum into the visible part of the spectrum.*

Figure 5 displays the change of the absorption spectrum of the IR-dye in Figure 4 as a function of the exposure energy density.

Another example of a suitable thermochromic IR-dye is:



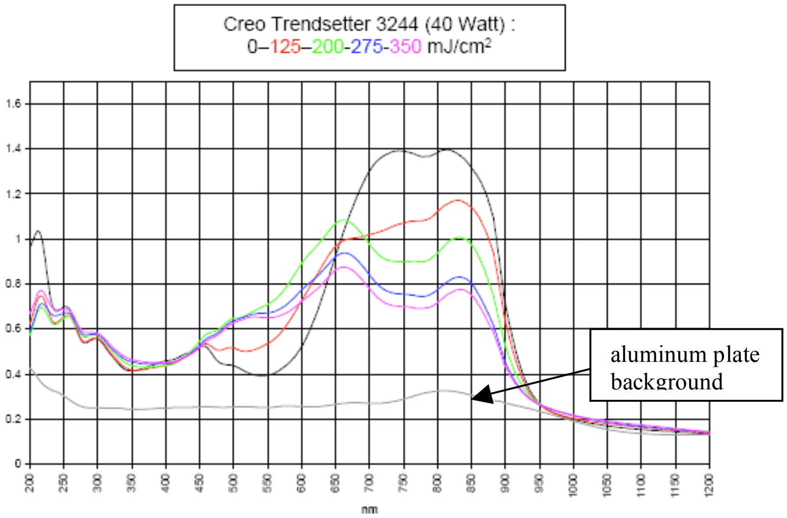


Figure 5. *Shift of the absorption spectrum of the (IR-)dye in Figure 4 as a function of the exposure energy density.*

Performance of the New :Azura TS Plate System

During drupa2008 Agfa introduced its second-generation ":Azura TS" plate system. Some of the new chemical concepts described above have been implemented in this new plate system. The improvements vs. the first-generation ":Azura" system are given in the Table 4.

It should be stressed that the autonomy (bath-life) of both the :Azura and the :Azura TS plate system is only limited by the gum solution becoming so strongly coloured that the plate non-image parts also start to pick up colour (cosmetically unfavourable). From a functional performance point of view, the autonomy of certainly the :Azura TS plate system is at least 100 m^2 higher than indicated.

Both the :Azura and :Azura TS plate system further show the following performance characteristics:

- a shelf life of more than 24 months
- a more than excellent full daylight compatibility (more than 24 hours)
- a virtually unlimited latent image stability
- a very wide clean-out latitude (no performance differences for gum temperatures ± 10°C and gum dwell times ± 10 s.)
- a more than excellent chemical resistance (pressroom chemicals)

Both plate systems also enjoy a very wide production latitude.

	:Azura	**:Azura TS**
Sensitivity (mJ/cm^2)	275–300 mJ/cm^2	200 mJ/cm^2
Image Contrast (upon imaging and clean-out)	Good*	Excellent*
Intrinsic Plate Resolution Capability	Better than 10 µm	Better than 10 µm
AM Screening Compatibility	2%–98% @ 200lpi**	2%–98% @ 200lpi**
FM/XM Screening Compatibility	25 µm microdot FM screening compatible / Agfa :Sublima 240-lpi compatible	20 µm microdot FM screening compatible / Agfa :Sublima 240-lpi compatible
Press Life Capability	Up to 100 K impressions***	Up to 100 K impressions***
Clean-out Latitude	Good	Excellent
pH of gum soutien	5.3 ("WG100")	7.0 ("Azura TS Gum")
Autonomy (COU with 15 liter tank)	300 m^2	> 300 m^2

* see Figure 6. Press-ready :Azura TS plates can be read with all available densitometers and plate readers, ** dependent on imaging conditions (platesetter type used, etc.) and press conditions, *** dependent on press conditions, ° (Bartels et al., 2002)

Table 4. *A comparison of the main plate performance characteristics of :Azura and :Azura TS.*

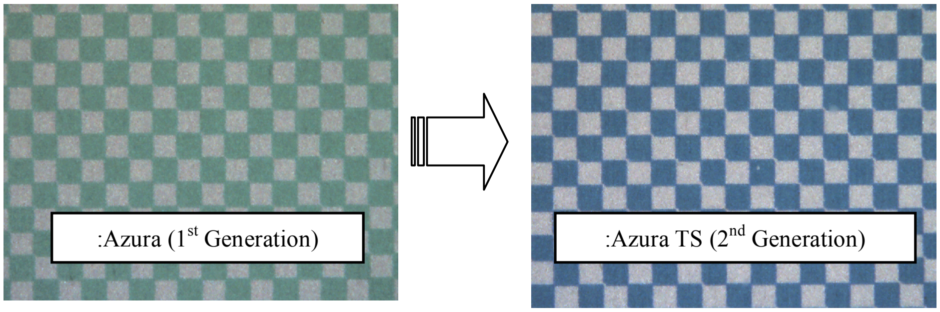


Figure 6. *Image contrast improvement brought by the introduction of :Azura TS (8 pixel x 8 pixel (8x8) checkerboard pattern @ 2400 dpi).*

The :Azura TS plate system improvements will certainly further strengthen the position of the :Azura product line as the currently single most successful "convenient processing" plate system in the market. Today, more than 2500 Azura (TS) platemaking systems have been installed worldwide.

The main advantages of the :Azura (TS) plate-making process (using an :Azura C95 or C125 Clean-Out Unit [COU]) can be seen by inspection of Figure 7 and can be summarized as follows:

- Less maintenance and service
- No storage of hazardous (highly alkaline/caustic) chemicals
- Less waste
- Smaller system footprint
- Higher quality consistency (less remakes, etc.)
- Shorter make-ready time

All of which results in a substantially reduced plate production cost. The :Azura C95 or C125 Clean-Out Unit constitutes a closed-loop system ("batch processing" principle with one single pH-neutral (pH 7) "gum solution" [no regeneration]). As a consequence, no connection is required to the water mains and no draining of "gum solution" or wash/rinse water takes place at all. Because of the very wide clean-out latitude, there are no parameters to adjust and no temperature control is required. All of these features makes the :Azura (TS) plate-making system very "office-friendly."

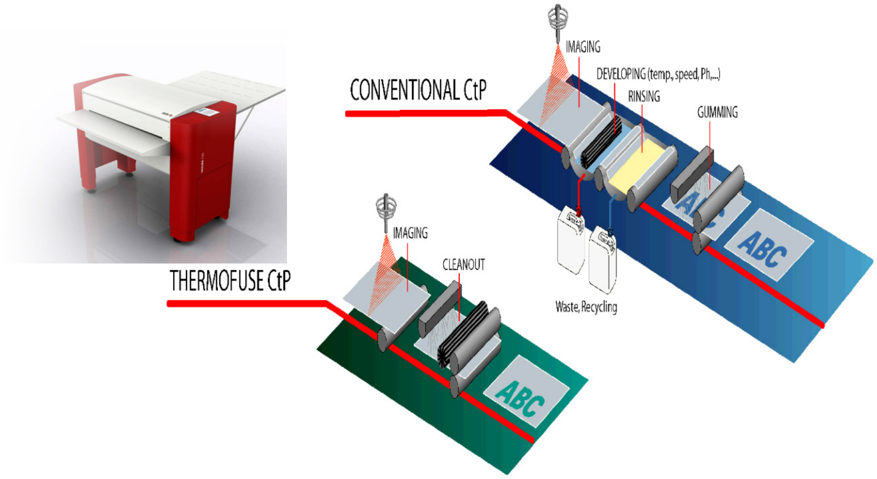


Figure 7. *Side-by-side comparison of the conventional positive working thermal plate-making process (no preheat or pre-wash required) and the :Azura (TS) plate-making process.*

A “Life Cycle Assessment” (LCA) recently carried out by VITO (Flemish Institute for Technological Research, Mol [Belgium]) concluded that the “Eco-Indicator” for both the :Azura & :Azura TS platemaking system is 80% lower than that of a conventional positive thermal platemaking system (Agfa-Gevaert, 2008). This analysis excluded the ecological impact of those elements that are common to all plate systems investigated, such as the aluminum substrate and the plate packaging (production and disposal). In this analysis the “Eco-Indicator 99” methodology was used, which is recognized as one of the most scientifically sound methods of expressing the environmental impact of a product or system in one figure.

What Promises Might the Thermofuse Plate Technology Still Hold?

Today it is clear that the ultimate performance “boundaries” of the latex fusion/coalescence plate technology have not yet been reached. Further improvements w.r.t. the sensitivity/clean-out performance balance are possible, as well as improvements of its mechanical and chemical robustness on-press. The market introduction of a “general-purpose” thermal plate suitable for mildly alkaline processing (pH = 12.5 or lower) with a sensitivity in the range of 120–180 mJ/cm^2 and a press life of 150 K impressions (unbaked) seems to be well within reach now. Furthermore, a “developer” consumption as low as 10 ml. per m^2 seems to be feasible here or in other words, a system autonomy of more than 50 m^2 per liter (which is up to 5 times higher than what typically can be achieved with the currently available single-layer positive-working thermal plate systems suitable for alkaline processing).

Based on these promising results with mildly alkaline processing, it may even be possible in the future to design plate systems with similar pre-press and press performance characteristics that are compatible with a pH-neutral clean-out washing process.

Agfa is committed to continue to invest in this promising plate technology and has worked out a clear product and technology roadmap in this respect. A new two-year research program supported by the Flemish Government (Belgium) recently has been approved and will involve the collaboration with several universities and research institutes. As even more advanced techniques will be used to study the working mechanism of this plate technology, new concepts will be developed to enhance its capabilities.

It is believed that this will finally allow Agfa to introduce a range of Thermofuse technology plates that will optimally fit the needs of tomorrow's printers and this at no compromise with regard to their press working latitude.

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