ULTRA-FAST LASERS – A ROUTE TO PAIN-FREE CTP?

ABSTRACT

The Miracle Plate (MP) has attracted much attention since it's dissemination into the public domain last year, but the technology behind the idea is more than just a truly process-less plate, or even a re-useable process-less plate. The use of Ultra-Fast (U-F) lasers has been shown to convert a hydrophobic metal/ceramic surface into a hydrophilic surface but the application of U-F lasers to lithographic plates holds even more surprises when these lasers are applied to conventional analogue and digital lithographic plates and offers the potential to improve the existing technology platform.

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Ultra-fast lasers are interesting devices. Firstly a femto-second is a billion millionth of a second – it is a time frame shorter than chemical reactions take place and is the realm of the atom. The lasers utilised in the MP technology deliver what seems like a very modest pulse energy – just a few micro Joules (μJ) – but because of the short time frame this is delivered in, the power is huge - 100s of megawatts (MW). To put this in perspective, the Scottish power station Langannet is rated at 2300 MW which means our U-F lasers are delivering 5 minutes of full power station output in a few femto seconds. At this level of electromagnetic intensity we might expect unusual observations – and indeed we see them!

In addition to the ground breaking MP technology which converts metal oxide surfaces from hydrophobic to hydrophilic with no chemical processing, there are other surprising phenomena which have been experimentally observed by JPI that involve conventional, coated litho plates.

The first of these is that the coating of a commercial printing plate can be exposed irrespective either of the wavelength of the U-F laser or the wavelength the plate has been designed to be sensitive to.

Once upon a time plate-makers used a UV light source in an exposure frame which was matched with plates that had coatings designed to be sensitive at the same wavelength as the light source. All plates were based on the same types of chemistry – diazo (negative), and diazide (positive) and the same exposure device could image both types and from any supplier – no restrictions.

Enter CTP and almost every part of the visible spectrum has been utilised since 1990 to produce plate-setters with bespoke media resulting in a loss of flexibility for the plate-maker regarding product and supplier.

A U-F laser makes no distinction between these niches. JPI have clearly demonstrated that a single U-F laser can expose many different commercially available plates irrespective of the plate sensitivity or its wavelength of coating absorption. So, for example, our infra-red U-F laser exposes Agfa, Kodak and Fuji conventional positive plates with the same efficiency as their thermal CTP positive plates. The reverse is also true in that our UV U-F laser exposes both thermal CTP and conventional positive plates equally well as does our green frequency doubled YAG U-F laser. Table 1 illustrates some selected examples from our work.

Supplier	Product	λ/nm	μJ/pulse	λ/nm	μJ/pulse
Fuji	FPSE	775	3.5	388	1.3
Kodak	New Capricorn	775	1.3	388	1.7
Agfa	Amigo	775	3.1	388	2.0
Rekoda	Thermax	775	1.5	388	2.0

Table 1

We affectionately refer to our plate-setter concept as the OmniSetter – a single device with a single U-F laser capable of exposing conventional positive and negative plates as well as thermal positive, negative and process-less plates with equal efficiency in addition to being able to produce the truly process-less Miracle Plate. Flexibility of product and supplier is returned to the plate-maker.

The second point is not so much a new phenomenon but a consequence of the first point. By some margin the leading CTP plate technology is thermal no-pre-heat positive plates, such as Kodak's Electra, exposed on devices such as the Trendsetter. This has been a very successful technology but it has been established with a high degree of pain for both plate manufacturer and plate-maker. This pain is derived from the fact that the dissolution rate contrast of the plate (exposed versus unexposed) is much less than a conventional positive plate by a factor of 5 or more.

These CTP plates utilise alkali soluble polymers which have their dissolution, or solubility, in alkali developer inhibited by one or more components in the coating which form a network of inter-molecular hydrogen bonds. This process takes a long time at ambient temperatures but can be accelerated by mild heating over a few days to produce the finished product. Without this additional heat process the product will not be stable in the supply chain. On exposure to heat from the thermal laser, the molecules are forced to move further apart from each other which allows developer to fill the newly created spaces and so dissolve the coating away where it has been exposed. This is a reversible process –there is no chemical change just a re-alignment and over time the coating, if not processed, will re-orientate itself and become developer resistant again.

It is a fact that the same principles are employed in a conventional positive plate (although these do not require the heat stabilising process) but the difference is that the inhibitor in a conventional plate is a UV sensitive material called a naphthoquinonediazide (NQD).

We don't need to explore the chemistry in detail but suffice it to say that on exposure to UV, this inhibitor undergoes a chemical reaction which has been estimated to produce localised heating to a temperature of $200^{\circ}C$. This heat does the same job as in the thermal plates by disrupting hydrogen bonds. But there is more. Each exposed NQD inhibitor spits out a molecule of Nitrogen gas again creating more space for developer. It undergoes contraction producing a chemical product smaller in size than was present originally – more free space for developer to enter. This exposed chemical species is also far more soluble than the original NQD and is consequently much more readily soluble in the developer. Finally this reaction is irreversible – there is no going back.

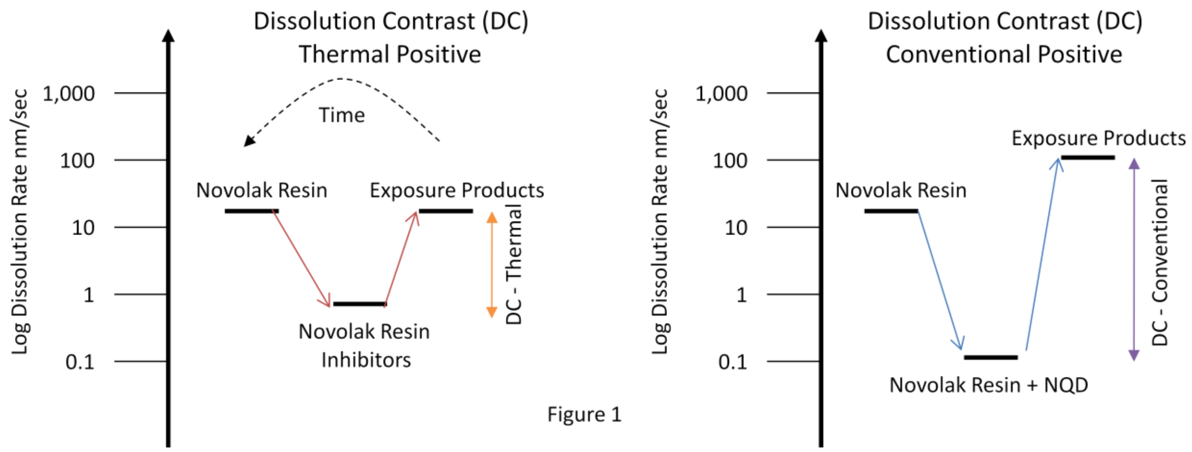

Figure 1

All of these factors add up to a very high dissolution rate contrast (Figure 1) between the unexposed and exposed states of the coating and is the primary reason why conventional positive plates are so robust to processing conditions and to manufacture.

The pain for plate manufacturers is derived from the lower signal to noise ratio for thermal CTP compared to conventional positive plates because the dissolution contrast is low (Figure 2).

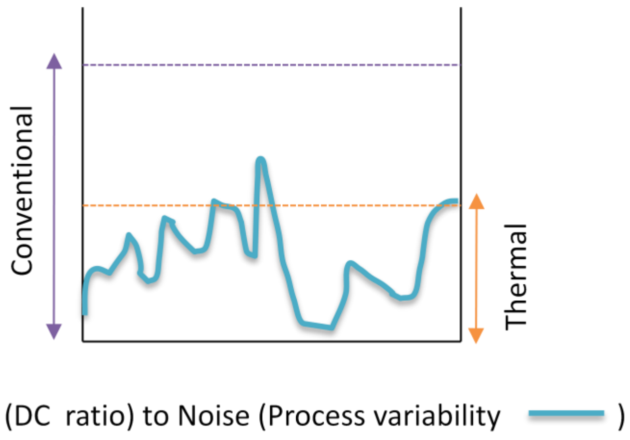

Figure 2

To manufacture thermal CTP successfully, production processes need to be tightened up, materials more carefully specified, conditions such as humidity and air quality controlled, packaging designed to avoid pressure, scuffs and scratches. The pain for the plate-maker comes from the need to very carefully control exposure and processing conditions, the susceptibility to variations such as batch to batch consistency of developer, developer temperature and condition etc etc. Both plate-maker and manufacturer can feel the pain of insufficient thermal stability within the supply chain.

So why not make a conventional positive plate and include some infra-red absorber in the coating to get the benefits of both worlds? It has been tried but it does not work because the remarkable chain of chemical reactions generated by the NQD inhibitor are not initiated by infra-red light and at the intensity generated by commercial plate-setter lasers only the disruption of the hydrogen bonds takes place. This means a very high level of energy would be required to overcome the strong inhibiting effect of the NQD.

However, with the properties of the U-F laser there could now be an alternative way to capture the best of both worlds. A thermal U-F laser can expose a conventional positive plate, with its very high dissolution ratio contrast, with the same efficiency as it exposes a thermal CTP plate enabling vastly improved processing latitude and higher yields in manufacture.

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