Curing the LED way

The topic of UV curing these days tends to focus on UV LEDs, with the main manufacturers of curing systems all having brought new products to market in the last few years. By *Neel Madsen*.

There are many advantages of UV LED curing technology in terms of capabilities, economics and environmental benefits, however, initial costs are still relatively high, and traditional UV curing looks set to dominate the market for some time to come as far as flexo printing is concerned.

Having said that, the curing technology created a real buzz at Labelexpo in Brussels last year, and showed the rapid adoption of UV LED curing. Stacy Hoge of Phoseon Technology said, 'More than 80 UV LED curing lamps were installed on equipment at the 2013 show, up from 10 instances during the 2011 show for an eight fold increase. Curing uses ranged from pinning to full cure and many of the machines were 100% UV LED based.'

During the show, Mark Andy received an award for innovation at the Label Industry Awards for the development of a UV LED curing system, ProLED, which is based on Phoseon's technology and claims to deliver high production rates and energy savings in excess of 50% when compared to traditional Hg UV systems.

The technology could also be seen in action on a Gallus press at the 2013 show. The cooperation between Phoseon, Gallus and Siegwerk had already been demonstrated on a flexo press at the 2009 Labelexpo show where a Gallus press with a UV LED lamp was exhibited. However, the lamps used then were far less powerful than the current ones, which resulted in a number of production restrictions. At 16 W/cm², the radiated power of the Phoseon lamps now available is twice as high, which ensures their efficient use in a wide range of applications.

The FirePower products from Phoseon are water-cooled

IST's MBS-6 system now comes in a UV LED prepared model

The Phoseon FirePower water-cooled products offer intense UV output, which enables end users to print at maximum speeds. These products utilise the company's patented SLM technology to provide intense UV output, while using a fraction of the power required with traditional UV arc lamps.

Stacy Hoge said, 'LED curing technology has advanced significantly in recent years and now offers enough power and capability to support flexographic printing applications. The flexo industry continues to challenge and drive the ink formulation/chemical material suppliers with UV LED wavelength optimised materials. At the same time, UV LED curing units have become more efficient in delivering higher energy to the media thus driving not only environmentally clean, energy efficient solutions, but also increased throughput and process flexibility.'

Be prepared

IST Metz works in partnership with UV LED specialist Integration Technology Ltd both in terms of development and marketing.

Based on its established MBS-6 products, IST has introduced an 'LED prepared' concept which allows the system to be converted to UV LED at a later date. This attempts to give customers the best of both worlds and not miss out on making the most of UV LED when the time is right for them and the return on investment is economically worthwhile. The company does not believe that UV LED for narrow web flexo presses is currently the right choice, but equally wants to put its customers in a position to change over from the established UV technology to the new one at short notice.

At its UV Days in June last year, the company demonstrated UV LED curing on a 430 mm wide flexo press. The water-cooled curing units at that time achieved an output of up to 12 W/cm². Further testing later in the year achieved drying speeds of up to 250 m/min.

'Following the progress made in recent years, the output achieved by LED systems has now reached such a level that standard printing speeds are now being met in label printing,' explained managing director, Dirk Jägers. 'The use of UV LED technology in narrow web printing is thus now within reach. As soon as economic operation can be guaranteed in conjunction with technical feasibility, UV LED is sure to achieve a breakthrough. With the LED-prepared concept the print shops are ready and waiting for this moment.'

UV LEDs: a simple overview

By Dipl.-Ing. Andreas Renzel, uv-technik meyer GmbH

The use of UV radiation for the curing of inks and coatings has been around for many years. The radiation sources that are most frequently used for this purpose are UV medium-pressure lamps. Their spectrum can be easily matched to the photoinitiators of the inks and coatings currently used.

However infrared (IR) accounts for a large proportion of their emitted radiation, and is not normally required. Cold-light mirrors or multilayer-coated glass are often used to filter out part of the IR radiation.

Research regarding alternative radiation sources has been going on for some years aiming to generate 'cold UV light', whilst providing an effective radiation source that allows for easy switching on and off with quick start-up and cooling times.

Limitations due to relatively low total power and the lack of short-wave UV radiation have resulted in UV LEDs mainly being used for niche applications. For example small-area 'point-by point' curing, curing applications, adhesive cross linking, curing of sealing or potting compounds, pinning (pre-gelling), dental applications, and fluorescence examinations (eg in forensics).

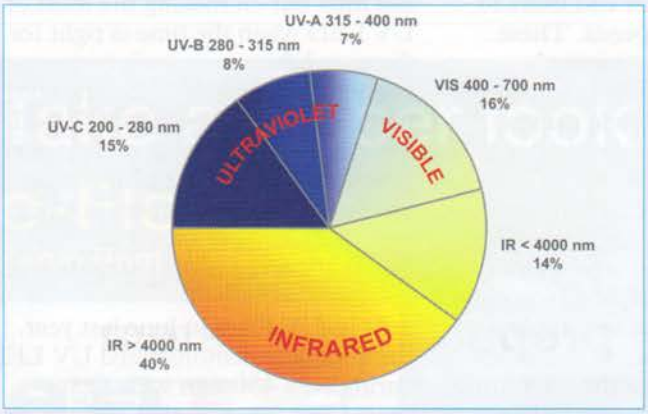

Fig 1. Power distribution of a standard medium-pressure UV lamp (Hg)

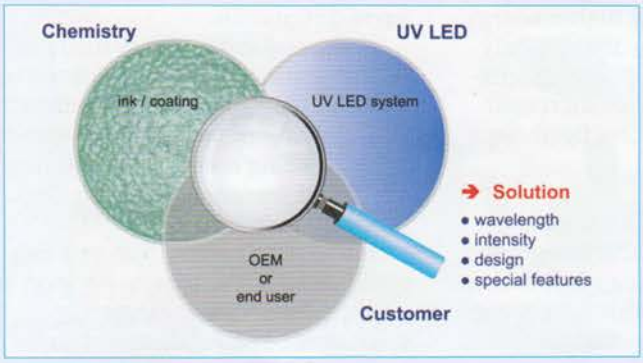

Fig 2. To find the best solution for the customer the LED supplier, ink supplier and the machine manufacturer must be involved

To find the right UV LED curing solution all components must fit together. The chemistry must match the wavelength and the UV intensity must be sufficient for the application. Therefore there needs to be a close cooperation between the UV LED system supplier, their customers and their suppliers (see fig 2).

Efficiency of UV LEDs

Some publications praise the high efficiency of UV LEDs. This may be due to the fact that LEDs are increasingly used for general lighting purposes, the efficiency of LEDs in comparison with gas discharge lighting lamps is clear. However in UV curing terms UV LEDs offer relatively low efficiency, currently slightly lower than medium pressure lamps.

An argument that is often put forward in favour of UV LEDs is cold UV radiation. It is a fact that no IR radiation is emitted in the direction of the substrate to be cured but the heat generated from the back of the LED substrate must still be dissipated or it will harm the structure of the semiconductors.

If a high power UV LED is measured using an accurate spectrometer, it can be seen that the irradiance at a specific wavelength, eg 395 nm can be higher than a UV medium-pressure lamp at the same wavelength.

An example of this is shown in fig 3. The green solid line shows that the 395 nm peak is significantly higher than the 365 nm peak of a mercury lamp. However LEDs with shorter wavelengths show a lower intensity.

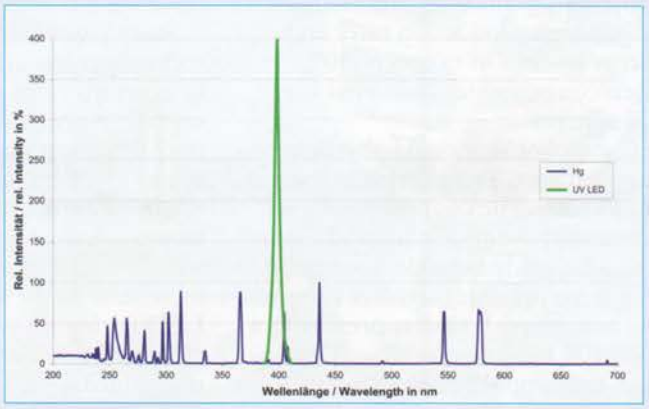

Fig 3. Comparison spectra of a UV medium-pressure lamp and a UV LED

Although UV LEDs have a higher peak at a specific wavelength they have a narrower bandwidth of energy, this is the reason why specially tuned and 'sensitised' 'long-wave' inks and coatings are commonly used in the market with a higher level of photoinitiator ('UV LED inks'). Different photoinitiators have a wavelength-specific sensitivity curve. Therefore the photoinitiators used must accurately match the radiation source.

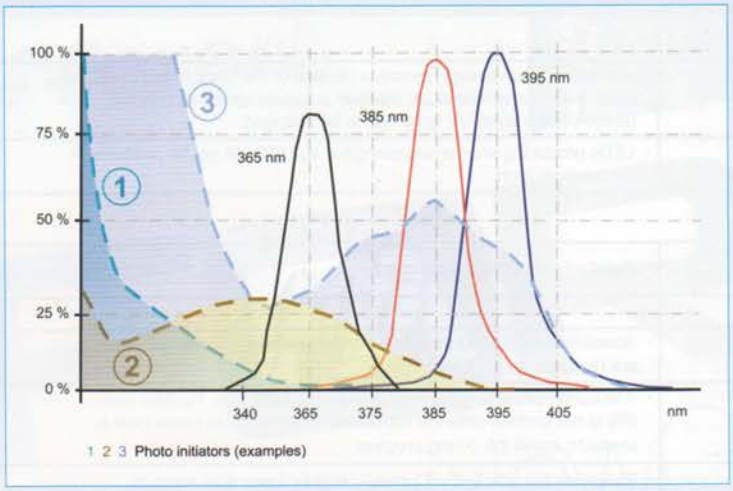

Fig 4. Three different emitted wavelengths of UV LEDs and their proportional outputs are shown. You can see that sensitivity curves of photoinitiator 1 or 2 will not result in a good match. However photoinitiator type 3 is compatible with the 385 nm UV LED.

Required irradiance

The intensity required to cure should refer to the radiation actually hitting the surface of the substrate. Irradiance is normally measured in mW/cm² or W/cm². It is relatively difficult for the end user to ascertain how 'powerful' a UV LED module really is, as distance is so critical. Manufacturers' specifications mostly refer to 'calculated values' with reference to the chip surface.

The required UV radiation dose is normally determined empirically, by experimentation, just as with the UV medium-pressure lamps. The aim however should be to position the UV LED unit as close as possible to the substrate to be cured.

Measuring the irradiance of UV LED modules requires appropriate UV measuring equipment. A radiometer measuring system specially adapted to the UV LED radiation is sufficient for most practical applications.

Conclusion

In some industries and applications, UV LEDs offer a significant heat, instant switching and size advantage. However, the lack of energy at the shorter wavelengths, efficiency and the required use of specialised and 'loaded' coatings, coupled with initial investment costs, will undoubtedly limit their short to medium term potential. It can however be said that in many cases they create new opportunities rather than replace them.

As with all technologies, they are constantly evolving and most market leading UV manufacturers are consistently evaluating and developing new applications and power levels to meet the demands of the growing UV market.