UV-LED curing in industrial printing

Institute of Print Technology

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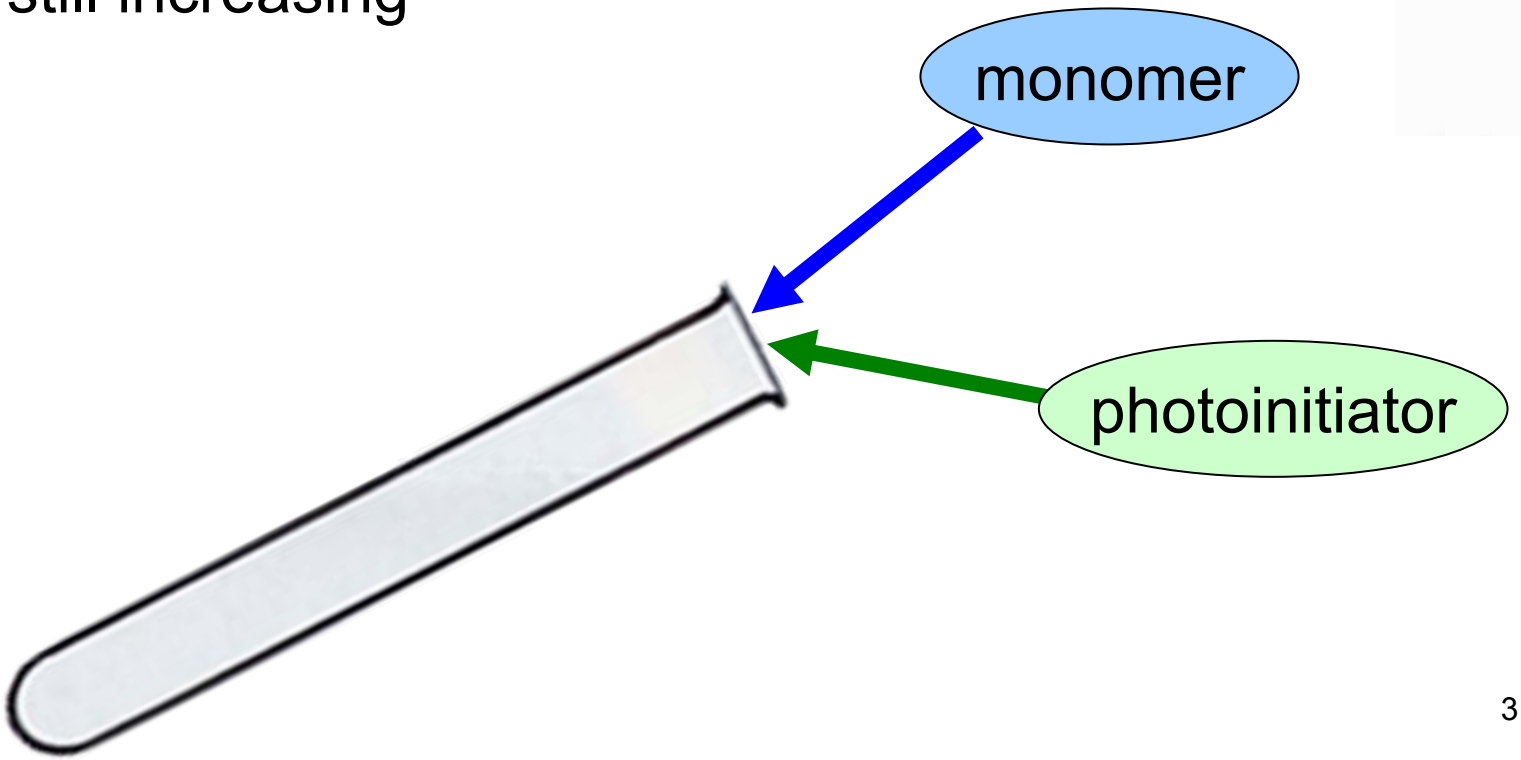
Overview

- Introduction to UV curing
- UV-LED curing
- Actual developments
- Products on the market
- UAS research activities

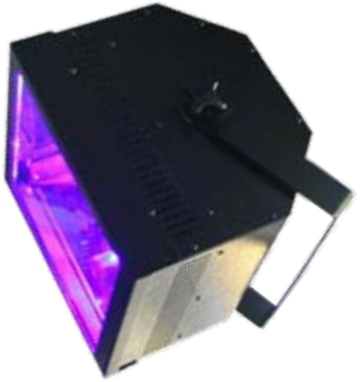
UV curing ink

- widely used in print industry
- for offset, flexo, screen and inkjet printing
- still increasing



UV curing process

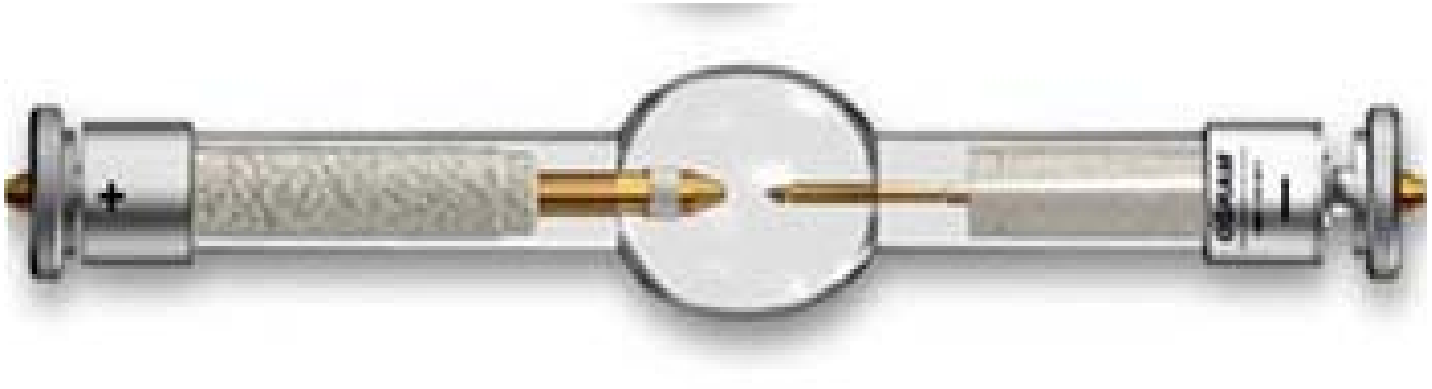
UV light initiates the curing process



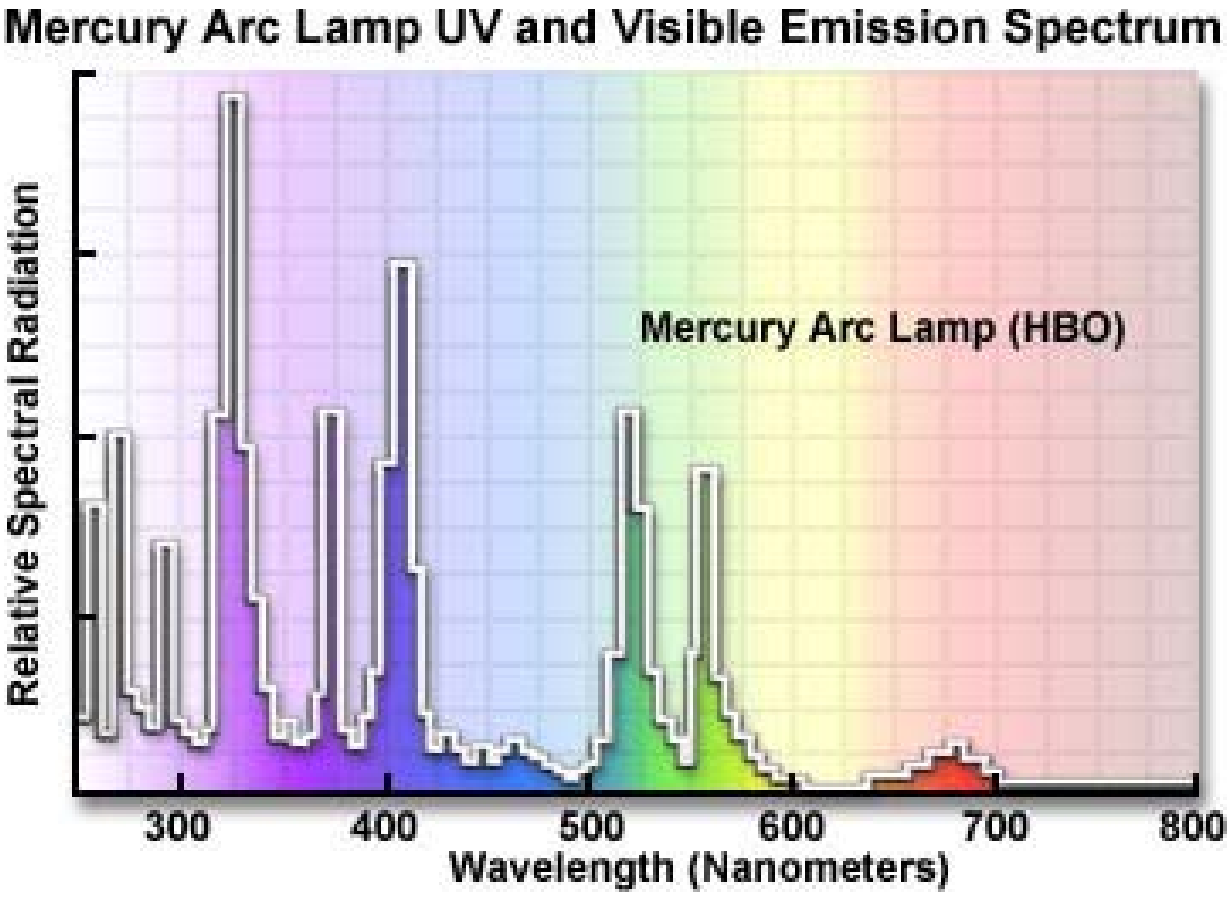
UV energy will cure the ink

Mercury arc lamps as UV source

Mercury arc lamps are the standard curing solution (since 1960 and still today)



Mercury arc lamp spectrum



www.olympusmicro.com

Mercury arc lamps

Advantages:

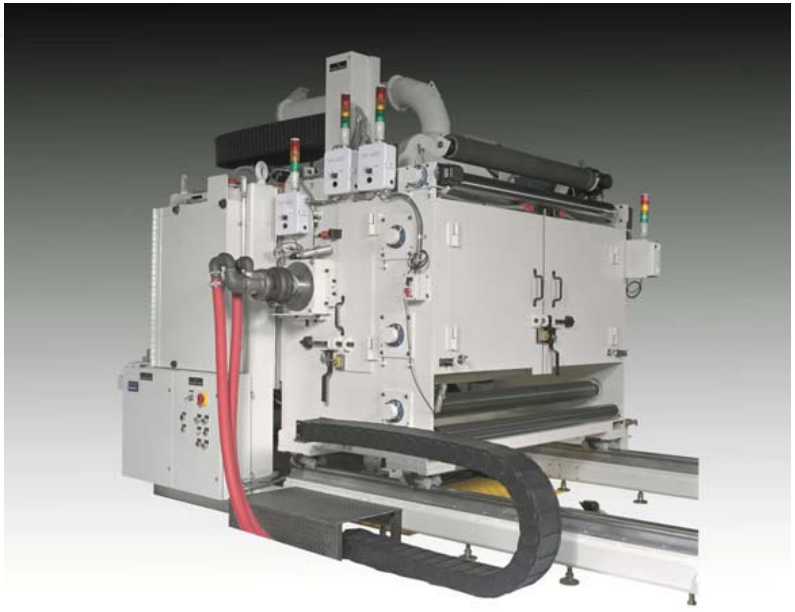
- Produce vast amounts of UV photons
- High speed curing (up to 10 m/s)

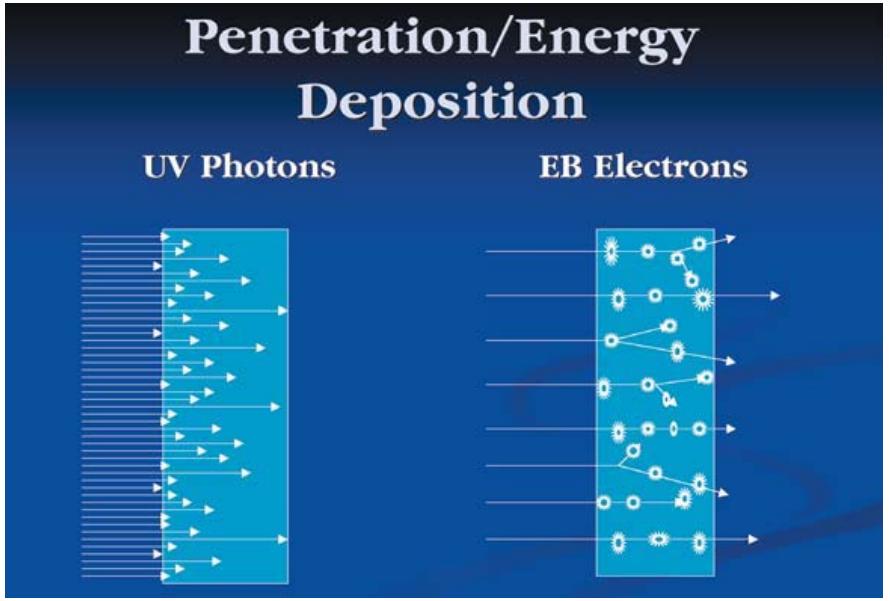
Disadvantages:

- High energy consumption
- No flexible arrangement
- ~60 seconds warm-up period
- Shutters normally required

Electron beam (EB)

- X-ray system (electrons instead of photons)
- Higher energy transport (total energy for curing is comparable)



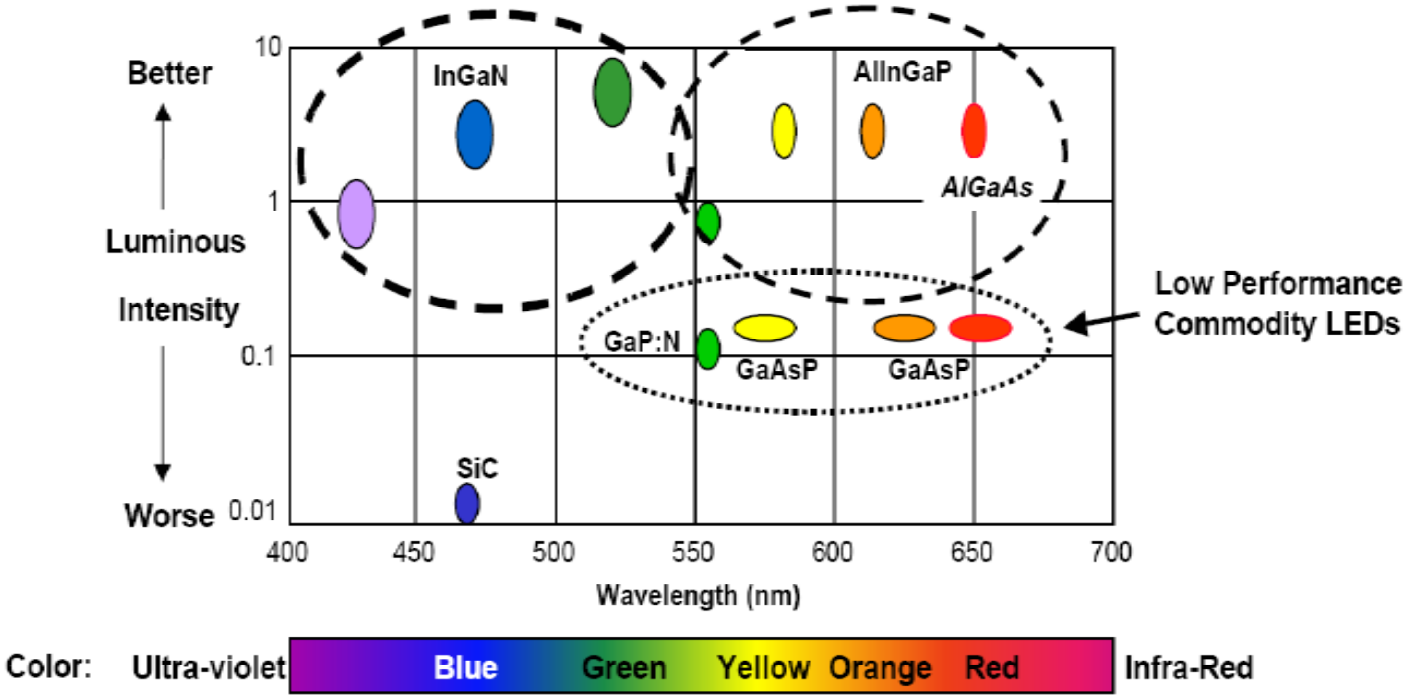


Radtech Report 2008 (September/October)

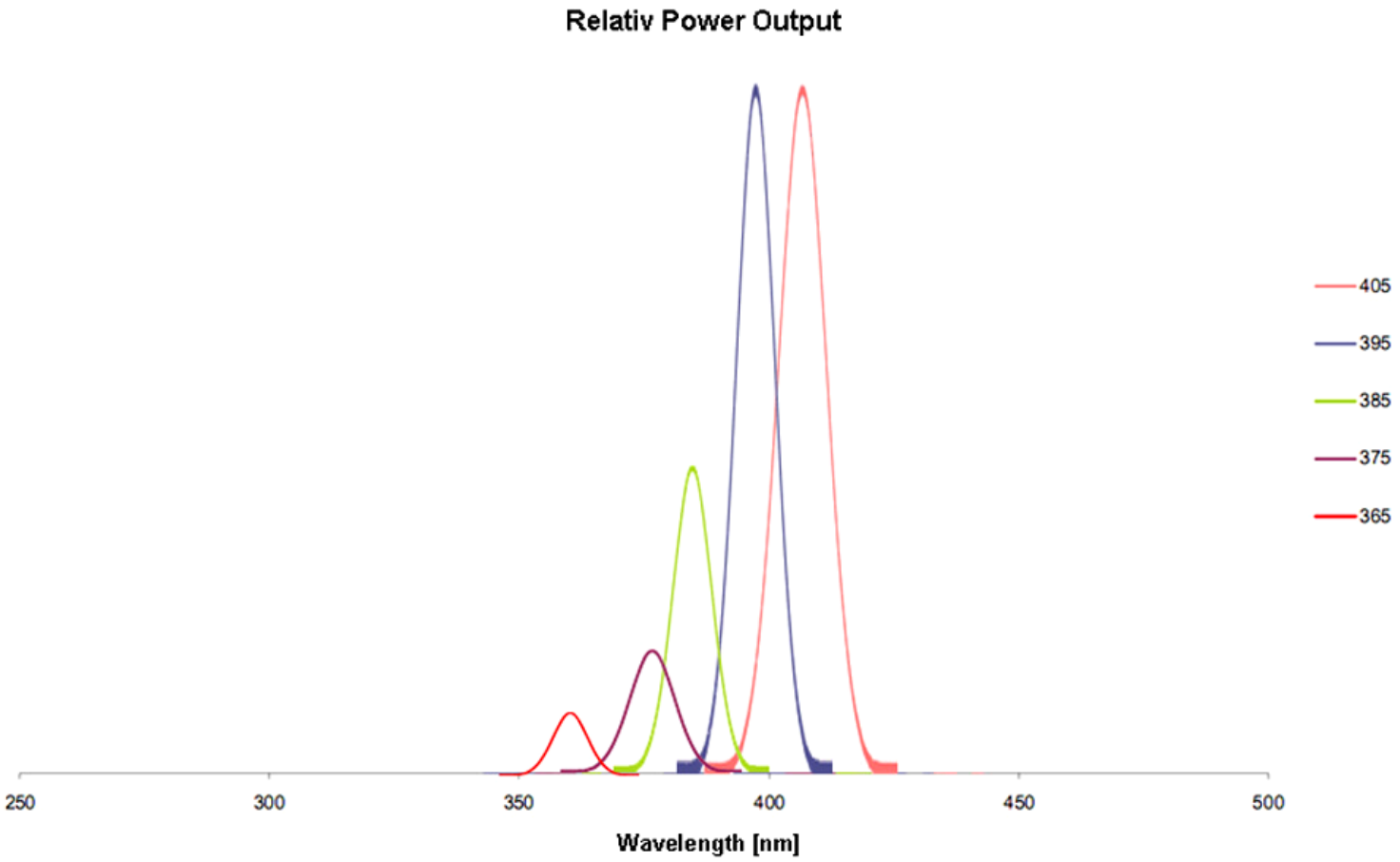
Electron beam (EB)

- Electrons can break the chemical bonds (ionizing radiation) → no photoinitiators are needed
- EB is not much affected by pigments
- Careful use because of substrate damage
- Higher security requirements (X-rays)
- Normally at the end of a printline because of size (no interstation curing → offset printing)
- Used instead of multilamp UV installations
- Minimum Price 500’000 €

LED Overview



UV-LED spectra



UV-LED advantages

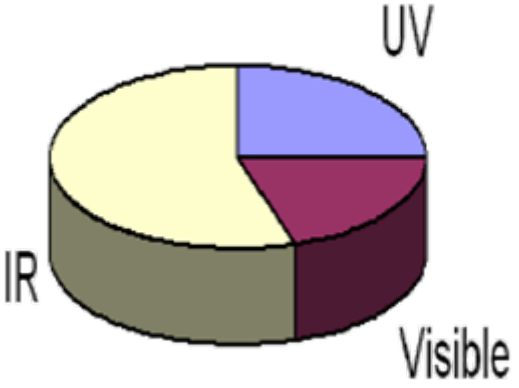
- No IR radiation and minimal heat transfer to the substrate
- LED's are more compact
- LED's operate on low voltages making them electrically simpler and safer
- No shutters – instant on /off
- Matrix design enables easy application configuration
- Consistent UV output over the operating life
- UV-LED's offer uniform radiation across the exposure width

UV-LED advantages

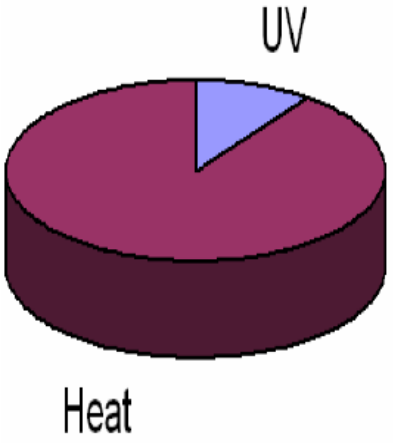
- UV-LED‘s emit no harmful UVC and no ozone extraction
- UV LED sources do not contain toxic heavy metals (mercury)
- Longer life expectancy (10-40K compared to 1-2K hours)
- LED light is more directional and will not lead to curing inks on the nozzle plate
- Less expensive

Energy consumption

- Mercury arc lamp
  25% UV
  20% visible light
  55% IR *(dichroic reflectors required)*



- UV-LED's
  5 to 15% UV
  (depending on wavelength)
  85 to 95% heat



Manufacturing of UV-LED chips

- 5-6 semiconductor manufacturers producing UV-LED chips (Nichia, Cree, Nitride, …)
- All small scale beta sample production - primarily aimed at visible lighting development
- Insufficient market volumes / demand to change this situation
- Uncertainty over long term supply

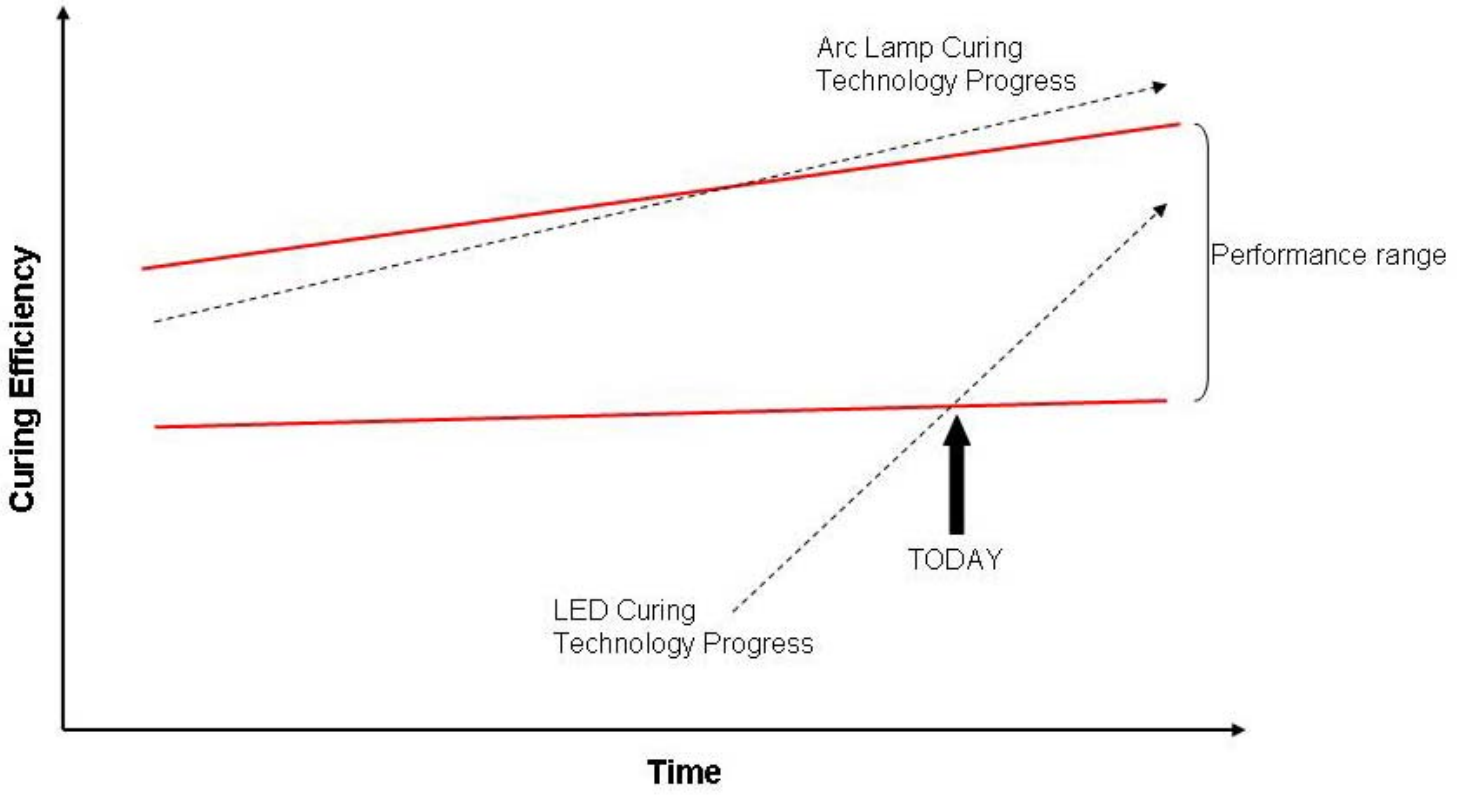
UV-LED development

With such a convincing case for using UV-LED's why has the technology not been more widely adopted?

- Non availability of dies (semi conductors)
- Offering sufficient light output at suitable wavelengths
- Lack of shortwave radiation (below 350nm)
- Lack of suitable inks formulated to react to the outputs from UV LED light sources

But this is all starting to change……

UV-LED development



LED development

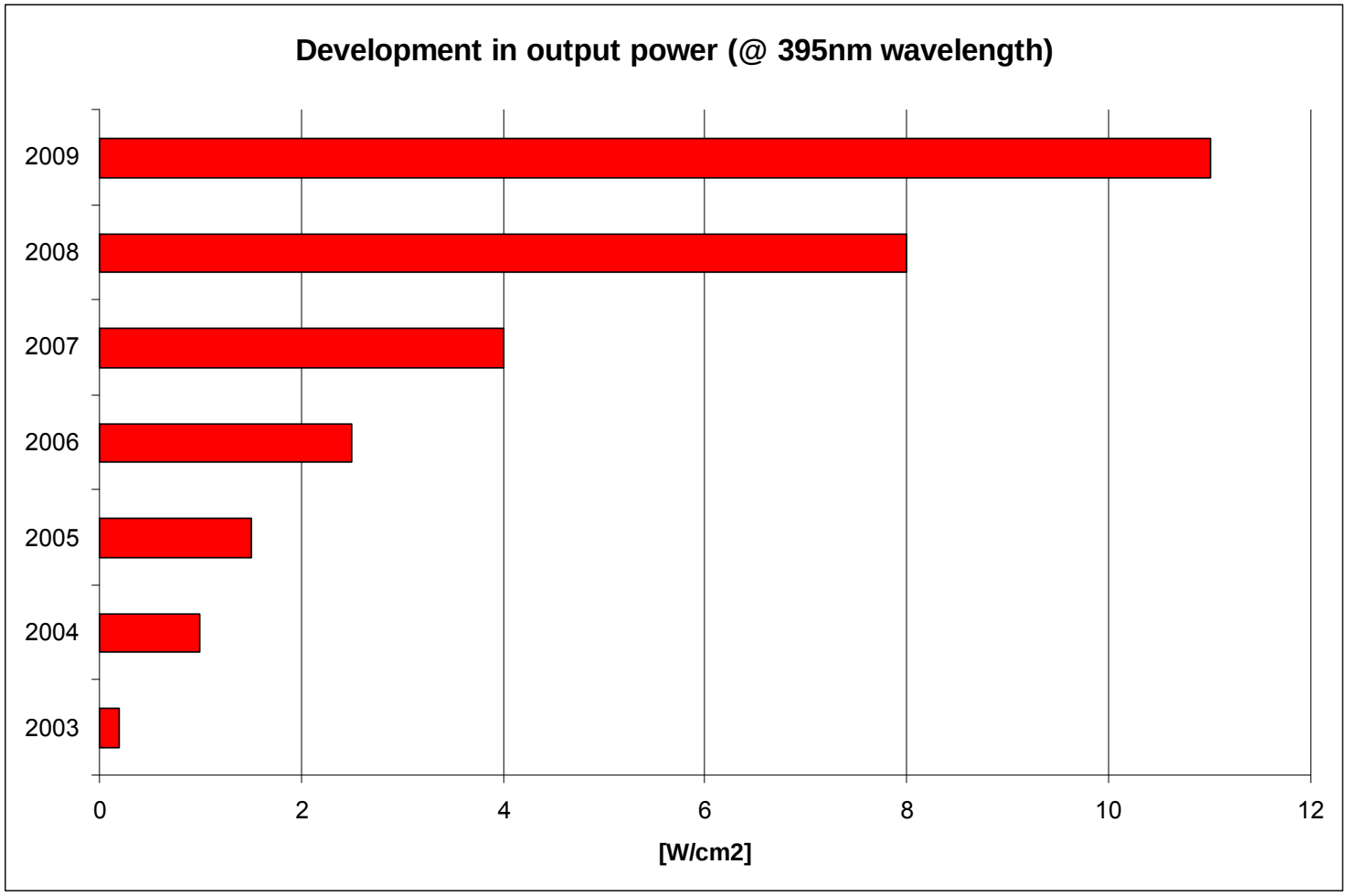
Advances in LED technology over the past 10 years (1999 - 2009):

Cost	$ 160/W → $ 6/W
Irradiances	1 W/cm2 → >10 W/cm2
Active Areas	100 X 100 µm2 → >1000X1000 µm2
Efficiencies	<10% → >50%

LED research is being driven by the multi-billion dollar general lighting industry.

18th Annual IMI Inkjet Printing Conference (EXFO LSI)

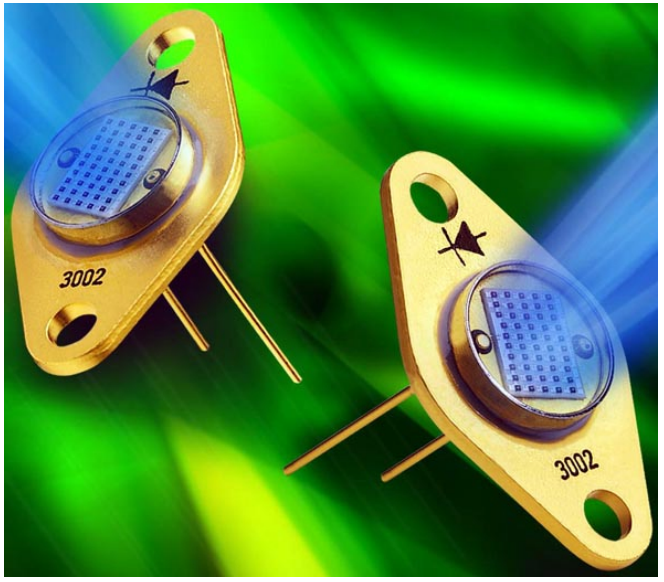
UV-LED development



UV-LED development

Increasing Power / Reducing Footprint

- Denser chip packing
- Driving LED's harder
- More cooling (water cooling for high speed printing)



http://news.thomasnet.com/fullstory/486539

UV-LED development

- Current UV inks for LED curing are being formulated around either 395nm or 365nm
- 365nm offers better flexibility in formulation but the available LED dose is much lower
- 395nm LED‘s offer higher peak irradiance
- The longer wavelength has more penetration into the ink which is better for heavily pigmented inks or thick layers

Remaining barriers

- Availability of appropriate commercial LED systems
- Configuration
- System cost
- Continued performance enhancements
- Wider range of optimized LED inks
- Wider range of application data
- Commitment of R&D resources to convert to UV-LED solutions

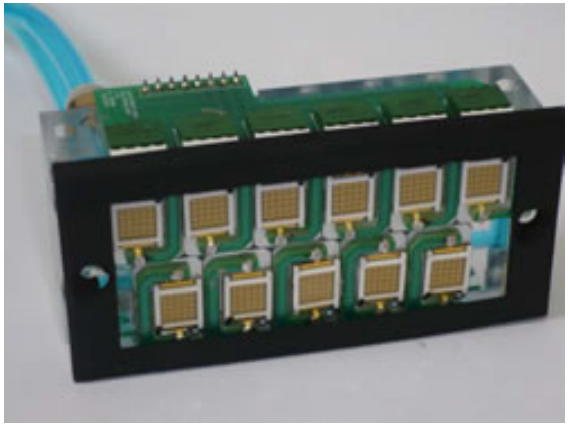
What does the market want?

- Comparable costs to traditional UV light sources → *Not yet, but the gap is closing*
- Equivalent cure speeds to traditional UV technology → *Possible with specially adapted inks or the more sensitive standard inks*
- Smaller and lighter arrays → *Yes*
- Air cooling → *No*
- Increased power and reduced footprint → *Yes*

Products on the market:

EXFO

Phoseon



Integration Technology

UAS research activities

The research institute developed a method to print Braille with drop-on-demand ink jet technology.

Prototype of home printer with blue light LED curing system

Industry-version of Braille printer with UV curing system

Involved Research teams

Research team Inkjet Printing

- Industrial inkjet printing
- Digital printing
- UV- and visible light curing

Research team UV-curing coatings and inks

- UV-curing inks for inkjet printing
- UV-curing coatings for self cleaning textiles and wood surfaces

Main industry partner

Polytype SA
Fribourg, Switzerland

- 289 employees
- 78 apprentices
- CHF 55 Mio (O) turnover

Decorating division

- Printing machines for tubes, sleeves, cups and lids made of plastic

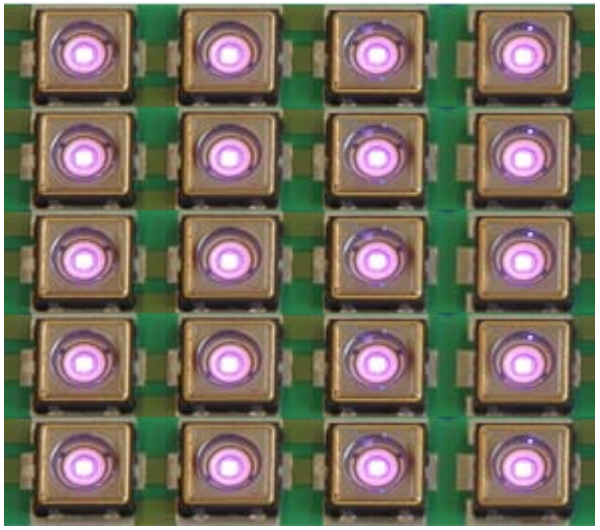
Manufacturing division

- Production for WIFAG, Polytype Converting AG, Polytype Decorating Division and third party customers

Own product proposal

Set of inks

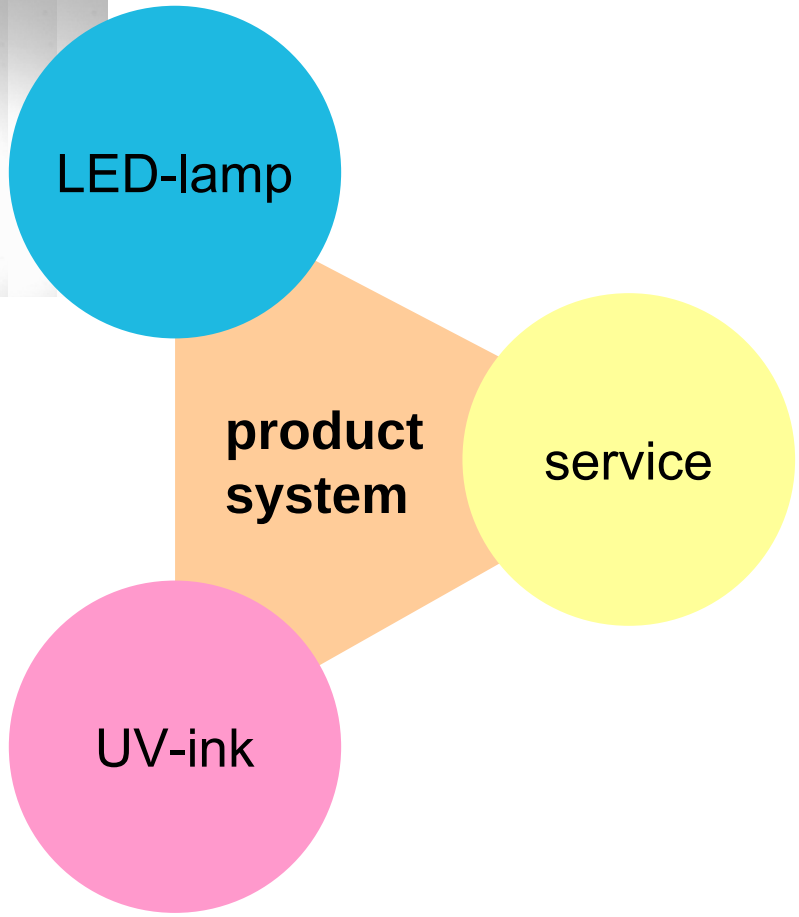
- set of CMYK inks for screen printing, inkjet, flexo and offset
- suitable for food packaging
- spectral matching with UV-LED



UV-lamp

- modularized UV-LED lamp
- bus programmable power supply unit for up to 2 kW output power
- fulfills industrial needs and has for safety reasons no watercooling

Own product proposal



Commercial proposal

- Polytype develops and distributes a product system consisting of LED-lamp, UV-ink and service under the Polytype brand
- customers don't have to care about spectral matching of lamp and ink
- customers have to contact only one company to address their ink curing issues

A brighter future lies ahead

- UV-LED cured applications are now technically feasible but they are still a complement to traditional arc technology.
- Technology convergence will continue over the next five years.
- UV-LED's are adressing a wider range of existing niche applications as imaging onto very heat sensitive media, particularly where performance justifies the added value.
- Mainstream graphics – eventually…