UV Cure Inkjet: Developments and Challenges in a Rapidly Evolving Market

For RadTech with SUNY-ESF Outreach
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Technical consultants for the paper, packaging and printing industries
Digital print a specialty
Devise new product constructions and development
Focus on the whole production process
Raw materials to end use
Solve process, performance and RM problems
Best when complicated
Assemble coating, printing and packaging production systems using most appropriate technology
Procure out-sourced assemblies, manufacturing, raw materials and services
Expert witness services
Network of skilled associates, contactors and vendors
Preview

- UV Inkjet technology
  - Comparison with desk top inkjet
- Production Printing – Machines & Inks
- Applications - example systems
- Market Prognosis
- What can RadTech Community do?
- Questions
Drivers for Digital Print

- Economical short runs
- Print on-demand
- Make the number required
  - Slash inventories
- Total customization
- Errors reduced
- Brand owners now know Digital Print’s value
Market for UV Inkjet

- Growing rapidly
- Graphic arts still high growth
  - No longer displacement but fueled by new business
  - Dominated by digital printer OEMs
- Labels
  - Rapid growth
  - Initiated by digital OEMs
  - Growth in partnership with finishing OEMs
  - Heavy investment by traditional OEMs

- **Industrial** (not packaging)
  - Getting going
  - Incubated (sandbox) by integrators and custom assemblers
  - Heavy investment by some traditional printing OEMs

- **Packaging**
  - Varies from active to inactive
  - UV inkjet is best digital except ...
Desktop Color (Aqueous) Inkjet Printing

- Reciprocating printhead
  - Slow (compare to laser printer)
- Ink
  - Water based, Low viscosity
  - Bleeds on regular paper
  - Runs on plain films
  - Slow to dry
- Substrates
  - Treated/coated to be absorbent
  - Costly to make

- BUT No safety or health concerns
Production Color UV Inkjet Printing

Primary Attraction – the Ink:
Print on non-absorbent materials and dry immediately

• Readily wet out & adhere to surfaces
• Plain papers
• Plain or corona treated films
• UV is rapid cure so instant dry to touch
• Monomer-based
  • Huge range of cured polymers
  • No end to applications
• Moderate viscosity at RT: ~ 30 cP at RT
• 100% solids – no VOC. (Emulsions starting to appear)
• Good carriers for pigments
• Strong colors
• Easy to keep printer clean
Production Color UV Inkjet Printing

UV Ink Issues for Inkjet
(compared to aqueous)

1. Based on monomers and use photo-initiators
   • For industrial or commercial use, not office, not home.
   • Regulated as liquids – shipping ...
   • Regulated for some applications especially near food

2. Obtaining proper jetting viscosity ~ 17 cP
   • Limits selection of components
     • Only a few low viscosity monomers
     • Formulating is a compromise between performance and viscosity

   • So heat ink to 45 - 50°C and get ~ 17 cP
     • Formulate for ~ 30 cP RT
UV Ink Consequences for Hardware
(compared to aqueous)

• Heating the ink
  ◦ Must have same viscosity at all jets
  ◦ Heat the ink in a supply reservoir
  ◦ Circulate hot ink through the printhead rapidly
  ◦ Potential for gelling

• Printheads
  ◦ Hundreds of nozzles
  ◦ Circulation
  ◦ High chemical and heat resistance
  ◦ Costly to manufacture
  ◦ High prices

• UV cure unit on or close to printhead
  ◦ Adds weight and heat

• Printers
  ◦ Stronger and more robust
  ◦ Higher costs
  ◦ Much higher prices
Printheads for Color UV Inkjet

Drop volumes 1.5 to 90 pl

- **Epson:**
  - DX5, 6, 7, TFP, MicroTFP

- **Fujifilm Dimatix:**

- **Konica Minolta:**
  - KM1024, 1024i, 512, 1800i

- **Kyocera:**
  - KJ4A, 4B, 4B-Z

- **Ricoh:**
  - Gen3-E1, Gen3-E3, Gen4, Gen4L, Gen5

- **SII Printek:**
  - EB3, JetT254, 510, 508

- **ToshibaTec:**
  - CA3, 4, 5, CB1, CE2, CF1

- **Xaar:**
  - Electron, Proton, 126, 128, 318, 500, 1001

*Note: Two ink connectors*
KM 1800 Printhead

6 rows at 300 nozzles/inch
Recent Developments: Head Assemblies & Print Bars e.g., Konica Minolta

*Frame for assembly of overlapping print heads especially for wide systems*
Fujifilm Dimatix Merlin 30” Printhead Cluster
Hymmen Modular Head Assemblies

Each module has 4 print heads

16 heads
Hymmen Single Color Printbar

- 2.7 inch per head
- 32 heads per color
- 128 heads for CMYK
Curing – Mercury bulb & UV LED

- Dominantly still mercury bulbs - arc
- LED is much preferred
  - Little heat with the UV so good with temperature sensitive substrates
  - No ozone
  - Long life – at least a year continuous
  - Continuous output until failure.
  - Modular so no length limit
- LED not ideal
  - Lower power so typically slower
  - Oxygen inhibition – inerting common
  - Chemistry more costly
Durst Tau 330 Label and Film Press

Features
• Cure against chill roll
  • Heat sensitive and thinner substrates
• Additional ink channels
  • Optional extended gamut
  • White ink
• In-line converting options
Fujifilm Sheet Fed with Fixed Heads

- Offset OEM press frame and sheet feeding
- Sheet sizes: 750 x 530 mm, 127 – 300 gsm
- Speed: 2800 sh/hr
- Folding carton
- 1.5 pl drop
Stork DSI Label Press

Features
- LED ink pinning
- Modular
  - Additional ink channels
    • Optional extended gamut
    • White ink
- In-line converting options
Mark Andy Digital Label Press

Features

• Same as on a flexo press – but shorter
Cardboard & Panels - Flat Bed Traversing Heads

- For sheet stock/panels up to 8 ft wide & 16 ft long.
- Automatic feeders and stackers
- Productivity: up to 5000 sf/hr.
- Displays, Boxes, Folding Cartons

Agfa / Thieme

:M-Press Leopard
Dubuit Direct to Container UV IJ Printers

Up to 4000 per hour
Till Direct to Container Industrial Printer

Till Gmbh: 600/min or 36,000 per hour
Also lab and batch printers
Industrial Markets

- Auto, white goods, construction, furniture
- Rigid Laminates
  - HPL – phenolic/melamine
  - MPL – MDF, hardboard
- Panels
  - Fiberglass
  - Wood
  - Metal
- Flooring
  - Wood
  - Vinyl
- Wall coverings
- Vinyl laminates
- Glass
Industrial Markets - Analog

Description

- Huge volumes
- Industry unwilling to modify substrates at all
- Ink pricing is cost plus
- Plants have no HVAC & sometimes dusty
- Printer is usually gravure or rotary screen
- Short runs only by changing pattern colors
- Growing demand for digital

Traditional printing OEMs

- Tremendous experience with materials handling
- Strong customer relationships
- Total solution providers – printing is only one step
Industrial Markets - Digital

- Analog system providers have taken the lead
- Seen the profits in other markets
- Assemble own printers with purchased components
  - Print bars
  - Ink management
  - Controller – computer, boards, full image software, …
- Incorporate the printer into the production line
  - Directly or stand beside
  - Same interfaces, same terminology, same logic
- Provide the ink
  - Know what it has to do
  - Experience means few product problems.
Industrial Markets - Gap

- Radiation cure for coatings has been driven more by better product than by process or VOC.

- Digital printing has been driven most by process and VOC.

- Will industrial provide an opportunity for DP products with no just equal, but truly better performance?
Converting - //polytype Pilot Inkjet

For film & paper converting industry
Master rolls supplied to the names you know

Have installed 1.4 m wide lines
Building 2.5 m wide line
Speed is head limited
Hymmen JPT-L Single Pass Panel Printer

- 1.3 – 2.2 m wide and 25 - 50 m/min.
- 2,000 to 8,000 m²/hr
- CMYK
- Ink hog
### Label & Packaging Sectors - Stage of UV IJ

<table>
<thead>
<tr>
<th>Sector</th>
<th>Market Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retail product labels</td>
<td>Moderate – some concerns</td>
</tr>
<tr>
<td>Self Adhesive</td>
<td>Pre-natal</td>
</tr>
<tr>
<td>In-mold</td>
<td>Pre-natal</td>
</tr>
<tr>
<td>Heat transfer</td>
<td>Pre-natal</td>
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<tr>
<td>Shrink wrap</td>
<td></td>
</tr>
<tr>
<td>Folding Carton</td>
<td>Starting</td>
</tr>
<tr>
<td>Corrugated boxes</td>
<td>Moving steadily – but hard sell</td>
</tr>
<tr>
<td>Flexible packaging – films*</td>
<td>Nothing – but Toner has started*</td>
</tr>
<tr>
<td>Flexible packaging - paper</td>
<td>Not common</td>
</tr>
<tr>
<td>Containers and lids</td>
<td>Underway - concerns</td>
</tr>
</tbody>
</table>

* This should belong to Ink Jet
UV Inkjet Concerns for Consumer Packaging

- Heat sensitivity of thin films
  - LED UV “cold” cure
  - Cure against chill roll
- Adhesion to plastics
  - Primers
  - Plasma
- Surface tackiness
  - Formulating, Additives
  - Inert atmosphere cure
- Odors
  - Formulations
  - Inert atmosphere cure
- Chemicals in the contents
  - Offsetting
  - Migration
- Power of Perceptions
EFI Jetrion 4950LX Press

Features
• LED ink cure
  • Heat sensitive and thinner substrates
• Additional ink channels
  • Optional extended gamut
  • White ink
• In-line converting options
• Made in America
Consumer Packaging Holdouts

Concerned about **perception** of contamination

- **Beverage cans**
  - Lips touch print

- **Flexible packaging**
  - Zero tolerance for failure
Pouch Construction

Reverse print on PET – possible offsetting

Laminate to PE – possible migration
Current Path for Consumer Packaging

- More reliable production systems
- Low migration chemicals
Uncured ink tastes bad

As an industry we can guarantee:
  The cured ink can meet migration standards
  The printer can operate properly
  The cure system can cure effectively

As an industry we cannot guarantee:
  Cure of all of the ink,
  Cure all of the time

  We aren’t running the press
  We aren’t checking the product
  We aren’t in the factory
Addressing Packaging Concerns - 100% Cure

- **What does this mean?**
  - 100% cure for anything near food
  - 100% cure for anything people touch

- **How is this done?**
  - Chemistry that does it
  - Processes that make it
  - Manufacturing procedures to maintain it
  - Test methods to demonstrate this
  - cGMP!!

- Learn with un-regulated products?

Still dependent on people so failures will happen.
Addressing Packaging Concerns: “Don’t go that way”

• Number 1 Rule for Improving Safety/Addressing Fear
  
  Eliminate the Cause

• Our Cause: Dependence on people and procedures

• Solution: Design out the people – Engineered Solution
Addressing Packaging Concerns: Engineered Solutions

• Chemistry that doesn’t migrate
  ◦ PE, PET and PP are effective barriers
  ◦ Migration barriers on PET and PE
  ◦ Chemistry that fully cures itself

• Chemistry that is not a concern

• Approaches
  ◦ Much higher molecular weights
  ◦ Much higher jetting temperatures
  ◦ Emulsions of high molecular weights?
UV Inkjet Ink Consumption 2014 Estimate

$350 million for ink sales for wide and grand format graphic arts*
$50 million for labels*
Other markets say 50 million or more

* Based on IT Strategies data, 2014 Feb

Half billion dollars
# Ink Consumption by Printer Productivity

<table>
<thead>
<tr>
<th>UV Inkjet Printer Ink Usage (kg/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Productivity</strong></td>
</tr>
<tr>
<td>sm/hr</td>
</tr>
<tr>
<td>10</td>
</tr>
<tr>
<td>30</td>
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<tr>
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<tr>
<td>1,200</td>
</tr>
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<td>3,000</td>
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<td>12,000</td>
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Ink Consumption by Printer Productivity

Ink Consumption by Thickness and Productivity

<table>
<thead>
<tr>
<th>Ink Consumption (kg/hr)</th>
<th>2.5 µm</th>
<th>5 µm</th>
<th>10 µm</th>
<th>15 µm</th>
<th>20 µm</th>
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</thead>
<tbody>
<tr>
<td>Productivity (sm/hr)</td>
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<td>100</td>
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<td>10000</td>
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<td>120</td>
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<td>480</td>
<td>720</td>
<td>960</td>
</tr>
</tbody>
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SPF
Prognosis – Industrial Printing

• Coming in from the cold – rapid placement in some sectors
  ◦ Traditional industry printer OEMs have jumped in
  ◦ Have the materials handling expertise
  ◦ Incorporate into complete production lines
  ◦ Inkjet printing technology comparatively straightforward

• Out of reach for the digital OEMs
  ◦ Lack materials handling
  ◦ Lack access to the users

• New generation of very high productivity machines
  ◦ Many single pass 1.4, 1.6 2, and now 2.5 m machines placed
  ◦ 20, 30 and soon 80 m/min

• Industry OEMs and non-graphics companies producing the ink
  ◦ Specific requirements OEMs understand
  ◦ Ships in drums – perhaps totes

• Opportunities for better product performance?
Prognosis – Labels and Folding Carton

- Continued spectacular growth
- More demand for special effects
  - Metallics, Fluorescents,
- Continued demand for ink sets for additional substrates
  - Less interest in special grades
- More demand to use thin temperature sensitive films
  - Increased use of LED Cure
- Continued market sensitivity
  - Primary use is consumer retail.
  - Always the potential for perception food is being contaminated.
  - No odors, No tackiness, No migration
  - Improved cure – always 100%
Prognosis – Flexible Packaging

Long way from the tipping point

• Out of reach for the IJ OEMs
• Brands are not yet on board.
• Continued market sensitivity
  ◦ Primary use is consumer retail.
  ◦ Always the potential for perception food is being contaminated.
  ◦ No odors, No tackiness, No migration
  ◦ Improved cure – always 100%

Options available

• Continued incremental effort
  ◦ Low migration inks, highly controlled production, printer certifications

• Formulations that avoid the issues
  ◦ Higher molecular weight & much higher temperature
What can the RadTech Community do?

- 100% cure for anything near food
- 100% cure for anything people touch
- Eliminate migration as a concern
- Enable LED to cure faster and faster again
- Support the developing applications
- Get knowledgeable about the applications
- Help solve your customer’s customers problems
Thank You

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