Digital textile printing
Trends & Drivers
Agenda

• About DyStar

• Global textile and textile printing market
  • Textile printing processes
  • Digital textile print machines & print heads
  • Inks for textile printing
  • Summary (advantages of digital printing)

• Outlook
### About DyStar – DyStar Group at a Glance

<table>
<thead>
<tr>
<th>HEADQUARTER</th>
<th>CEO</th>
<th>2015 REVENUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Singapore</td>
<td>Eric Hopmann</td>
<td>898 million USD</td>
</tr>
</tbody>
</table>

#### VISION

“We strive to be the **environmental** and **innovation** global leader in our chosen industries.”

#### SHAREHOLDERS

<table>
<thead>
<tr>
<th>Shareholder</th>
<th>Percentage</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Senda International Capital limited (subsidiary of Lonsen)</td>
<td>(62.45%)</td>
<td></td>
</tr>
<tr>
<td>Kiri Industries Ltd.</td>
<td>(37.55%)</td>
<td></td>
</tr>
</tbody>
</table>

Approximately 2200 Employees

14 Production Facilities in 12 Countries

28% America

45% Asia

27% Europe
To continue our success we will….

- **Grow** our traditional **textile business** and also **venture out into new markets** and industries like paper, plastic and other specialty chemicals

- Use our **expertise** and **creativity** to support the competitiveness and business growth of our customers

- Provide **cost-effective and innovative** new products as well as integrated **technical and environmental solutions** to our customers

- Pursue to invest in our **leadership** to make a difference, by living up to global and **legal** business requirements and **environmental and social responsibilities** and by reducing the ecological impact of both our own and our customers’ operations.

- Help our customers and their supply chain partners to produce low-impact consumer products meeting the highest **environmental and quality standards** in the most cost effective way.
About DyStar – Worldwide Locations

Global Manufacturing Facilities

**ASIA**
- China
- India
- Indonesia
- Japan
- Thailand

**TURKEY/AFRICA/MIDDLE EAST**
- Turkey
- South Africa

**EUROPE**
- Germany
- Portugal

**AMERICA**
- USA
- Mexico
- Brazil

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www.DyStar.com
About DyStar – History

1995 Foundation
Joint Venture of Hoechst and Bayer Textile Dyes, Mitsubishi

2000 Joint Venture with BASF (incl. ICI/ Zeneca dyes) and Mitsui

2002 Acquisition
Color Solutions

2004 – 2006 Acquisition of Yorkshire Americas, Rotta Group and Boehme Group

2004 Launch
econfidence® program

2007 Acquisition of Texanlab

2011 First Sustainability and Carbon Footprint report

2012 Foundation of Sustainable Textile Solutions

2013 Acquisition of the Lenmar Chemicals Coorporation
TWO-FOLD SUSTAINABILITY STRATEGY

1. Reduce Our Own Operational Impact
   - Established sustainability structure
   - Implement emission reduction strategies
   - Commitment to reduce our footprint in water, waste, energy, GHG
   - Sustainability reporting

2. Help Our Customers Reduce Their Impact
   - Foundation of econfidence®
   - Product safety & environmental compliance
   - Sustainable product innovation
   - Sustainable processing – improving resource efficiency
   - Sustainability services

Annual Sustainability Report 2014 in accordance with the Global Reporting Initiative (GRI®)
About DyStar – Sustainability Strategy

Working towards establishing closed loop systems

Sustainable Process Development

Sustainable Consumption and Footprint Reduction

Sustainable Education and Services

Sustainable Product Innovation

Sustainable Product Development

Sustainable Education and Services
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  - Outlook
Global textile and textile printing market

Apparel/Fashion

Home Textiles

Carpet

Flags/Banners
World Textiles and Garment Exports 1990 - 2014

Source: WTO Annual Trade Statistics
Exports of Garment and Textiles by Country – Top 5 in Year 2014

Source: WTO Annual Trade Statistics
Imports of Garment and Textiles by Country – Top 5 in Year 2014

* Europe figures not available in 1990

Source: WTO Annual Trade Statistics
Textile Industry moving out to Asia
Garment first because of cost pressure from retailers,
then textiles and last also the chemical industry
Impact on Environment in China / India
Impact on Environment in China / India
Own collection - Pakistan 2016

Watch out...
Possible Scenarios

- Vietnam
- Cambodia
- Laos
- Myanmar
- Turkey
- Africa
- Bangladesh
- Pakistan
- India
- Mexico
- Central America
- Vietnam, Cambodia, Laos, Myanmar
- Turkey, Africa

2016 - 2040
Global textile printing market

China 26%
India 18%
Other Asia 15%
Americas 12%
Europe/Turkey 14%
Africa/Middle East 15%

DyStar internal market study
Importance of textile printing technologies

- Rotary Screen: 78%
- Flat Screen: 13%
- Transfer Printing
- Hand Printing
- Digital Printing

DyStar internal market study
Article segment importance by application technology

**Conventional printing**

- **Fashion**: 51%
- **Home Textiles**: 23%
- **Bed Sheets**: 17%
- **Garment**: 11%
- **Others**: 10%

65% CO, CV, fibre blends
45% Pigment
27% Reactive

**Digital printing**

- **Fashion**: 41%
- **Signage / Advertising / Graphic**: 51%
- **Garment**: 8%

65% PES
59% Dispersion (Subli + Direct)
36% Reactive

DyStar internal market study
Ink class importance by application technology

Conventional textile printing
~32 Billion m²

- Acid [PROZENTSATZ]
- Disperse [PROZENTSATZ]
- Reactive [PROZENTSATZ]
- Others [PROZENTSATZ]
- Vat 3%
- Sublimation [PROZENTSATZ]

Digital textile printing
~1 Billion m²

- Disperse [PROZENTSATZ]
- Reactive [PROZENTSATZ]
- Acid [PROZENTSATZ]
- Pigment [PROZENTSATZ]
- Sublimation [PROZENTSATZ]

Average growth continues at about 30% per annum
Market development and challenges

- Printing machine: ✔
- Software: ✔
- Computing power: ✔
- Printhead: (✔)
- Inks: !

Market share:

- 2016: 32 Bil. m², 97%
- 2017: 34 Bil. m², 94%
- 2018: 34 Bil. m², 94%
- 2019: 34 Bil. m², 94%

CAGR:

- 2016: 1 Bil. m², 25%
- 2017: 2 Bil. m², 6%
- 2018: 2 Bil. m², 6%
- 2019: 2 Bil. m², 6%
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Digital printing vs. conventional printing

**Pre-treatment**
- Mechanical
- Setting
- Calendering
- ...
- Chemical
- Desizing
- Bleaching
- ...

**Digital printing process**
- Substrate preparation
  - Thickener
  - Diff. chemical additive
- Design layout
- Printing

**Conventional printing process**
- Design layout and management
- Screen production
- Print paste production
- Printing

**Post-treatment**
- Fixation
- Wash off
- Finishing
- ...

- Time to market
- Flexibility
- Reduced water consumption
- Energy saving
- Almost unlimited creativity
### Process steps of different ink classes

All substrates printed digitally have to be pre-treated and a preparation is applied!

<table>
<thead>
<tr>
<th>Ink Class</th>
<th>Process Steps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reactive</td>
<td>Steaming → Rinse → Wash off → Final rinse → Dry</td>
</tr>
<tr>
<td>Vat</td>
<td>Steaming → Rinse → Oxidation → Soaping → Dry</td>
</tr>
<tr>
<td>Disperse</td>
<td>HT Steaming → Rinse → Red. Clean → Wash off → Rinse → Dry</td>
</tr>
<tr>
<td>Sublimation</td>
<td>Heat Fixation</td>
</tr>
<tr>
<td>Acid</td>
<td>Steaming → Rinse → Wash off → Final rinse → Dry</td>
</tr>
<tr>
<td>Pigment</td>
<td>Heat Fixation → Wash off → Final rinse → Dry</td>
</tr>
</tbody>
</table>

- This is a universal ink, which is independent from fabric
- Fixation is performed ideally only using heat fixation

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**Cellulosic fiber**

- Polyester fiber
- Wool, Polyamide
Functional finishing

- Hydrophobic
- Dirt repellant
- Self-cleaning
- Anti-insect
- Antimicrobial
- Anti-fungal
- Flame retardant
- IR blocking
- UV blocking
- Anti-sunburn
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Perfect combination for digital printing
Historical development of DTP-Machines

- **1995**: Stork Printer, DyStar ink base

- **1999**: Ichinose printer, DyStar ink

- **2003**: DuPont 2020

- **2007**: Mod. Mimaki (JV5)

- **2009**: Zimmer (Colaris)

- **2010**: MS (JP6)

- **2011**: Durst (Kappa 180)

**Roll to Roll Printer**

- **1 m²/h**: Mimaki (TX-2)

- **1 - 4 m²/h**: Robustelli (Monna Lisa)

- **15 - 150 m²/h**: Reggiani (DReAM)

- **40 - 300 m²/h**: Zimmer (Colaris)

*) The only printer equipped with bubble jet print head

Konica Minolta (Nassenger Pro 1000)

Robustelli (Monna Lisa Evo)

Zimmer (Colaris 2)
Further development of scanning printers

- **Mimaki (TX300P-1800)**
  - Speed: 68 m²/h

- **Reggani DReAM**
  - Speed: 200-300 m²/h

- **Konica Minolta (Nassenger 10)**
  - Speed: 580 m²/h

- **Zimmer (Colaris³)**
  - Speed: 1670 m²/h

- **LüscherTschudi (T-Rex)**
  - MS (JPK)

- **SPG (JAVELIN)**

- **Zimmer (Infiniti)**
Duplex textile printer

Color Booster DS:
The first textile printer to include two print engines and a fixation unit, enabling industrial level printing onto textiles on both sides of the media simultaneously.

- It is possible to print the same pictures
- Or different pictures on both sides
Single pass machines

**MS LaRio**, equipped with Kyocera Printheads

- Production speed up to 8 colors: 35 lm/min (realistic 45 lm/min; max. 100 lm/min)
- Production speed CMYK: 75 lm/min
- Dpi resolution: 600 x 600 dpi
- Gray levels: 16
- Drop size: 4 to 72pl
- Printing width: Up to 320 cm
Single pass machines

SPG Prints (PIKE), equipped with Fujifilm Dimatix SAMBA printheads

- Production speed of 6x color machine: 20 lm/min (realistic 40 lm/min; max. 75 lm/min)
- 43 printheads pro color giving a printing width of 1850 millimeters
- Native resolution of 1200 x 1200 dpi
- Variable drop sizes from 2 to 10 pl
- Jetting frequency of 32 kHz
- The modular construction will allow models with up to 9 colors.
Single pass machines

Konica Minolta (Nassenger SP-1), equipped with own KM water based inkjet printhead

- Printhead optimized for single pass machine
- Printing resolution of 720x720 dpi/standard mode
- Flexible ink adjustments for small, medium, or large drop sizes
- 25 linear m/min (max. 100 m/min)

 Rotary Screen Speeds
Development of print heads

Dr. Veena Sarojiniamma, Direct product decoration by inkjet, the Inkjet conference, Germany, 2015
Dominating print heads in textile applications

**Kyocera KJ4B-QA**
- Print width: 108 mm
- Resolution: 600 dpi
- Drop size: 5-18 pl

**Kyocera KJ4B-0300**
- Print width: 112 mm
- Resolution: 300 dpi
- Drop size: 5-18 pl

**Fuji Dimatix Starfire SG-1024**
- Print width: 65 mm
- Resolution: 400 dpi
- Drop size: SA 7-30 pl, MA 30-70 pl, LA 70-150 pl

**Fuji Dimatix Samba**
- Print width: 43 mm
- Resolution: 1200 dpi
- Drop size: 2-13 pl
Other print heads for textile applications

**Ricoh MH5420 (Gen 5)**
- Print width: 54 mm
- Resolution: 600 dpi
- Drop size: 7-35 pl

**Xaar 5601 GS3p0**
- Print width: 115 mm
- Resolution: 1200 dpi
- Drop size: 3-21 pl

**Epson 5113**
- Print width: 34 mm
- Resolution: 600 dpi
- Drop size: 2,5-21 pl

**Panasonic UH-HA810**
- Print width: 34 mm
- Resolution: 600 dpi
- Drop size: 3-21 pl
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# Inks for textile printing

<table>
<thead>
<tr>
<th>Ink</th>
<th>Textile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reactive ink</td>
<td>Cotton, viscose, linen, polyamide, silk</td>
</tr>
<tr>
<td>Acid ink</td>
<td>Polyamide, silk, wool</td>
</tr>
<tr>
<td>Disperse ink</td>
<td>Direct printing on polyester</td>
</tr>
<tr>
<td>Sublimation ink</td>
<td>Indirect printing on polyester</td>
</tr>
<tr>
<td>Pigment ink</td>
<td>Universal</td>
</tr>
</tbody>
</table>

## Vat ink
A new ink for textile printing, developed by DyStar & Zimmer, presented at ITMA 2015

## Cellulosic fibers
High end article segment hometextiles

Any industrial digital printing answer to highest requirements?

Curtains

- Fastness to light >6
- Fastness to chlorine >4
- Multiple washing >4
- Fastness to rubbing >3
- Soft handle and „textile“ drape

Towels

Table cloth

Furniture

Towels

Table cloth

Outdoor
Vat inks for digital printing of cellulosic substrate

- Jettex V is an ink range for high fastness requirements.

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Reactive</th>
<th>Pigment</th>
<th>Vat</th>
</tr>
</thead>
<tbody>
<tr>
<td>High color strength</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light fastness &gt;6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rubbing fastness 3-4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Creases resistance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Handle</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chlorinated water</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dry cleaning</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- bad | good | excellent

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High end article segment hometextiles

Any industrial digital printing answer to highest requirements?

- Jettex Vat CMYK + Orange + Green
  6 inks bulk proof tested – Strength, Fastness, Runability
- Printed with Zimmer Colaris³
  equiped with FUJI Dimatix Starfire printheads
Fixation of vat inks

Two phase fixation process & wash off

25 °C Rinse

40 °C Oxidation
3 ml/l H₂O₂
2 ml/l Acetic acid 60%

95 - 98 °C Soaping
2 g/l Sera® Sperse M-DEW

50 °C Rinse

Cold neutralization
pH 5.5
Article segment importance by application technology

Conventional printing

- Fashion 51%
- Hometextile 23%
- Bed Sheets 17%
- Garment 11%
- Others 10%

33 Bil. m²

65% CO, CV, fibre blends
45% Pigment
27% Reactive

Digital printing

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1 Bil. m²

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36% Reactive
Ink for outdoor applications (Jettex AM)
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Advantages of digital textile printing

- **Printing Process**
  - Number of colors per design are unlimited
  - Design flexibility
  - Customization – higher personalization
  - High resolution up to 1200x1200 dpi
  - High printing speed (even higher compared to rotary screen printing possible)
  - Quick realization of printing job – Highest speed to market

- **Short runs can be printed at reasonable cost level**

- **Sampling and production can be performed on the same machine at equal cost**

- **Environmental friendly process**
  - Reduced chemical waste
  - Less water and energy consumption

- **Meeting Brands & Retailer speed requirements** –
  e.g. Inditex/Zara changing the offer in their shops almost every two weeks
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Functional finishing

- Hydrophobic
- Dirt repellent
- Self-cleaning
- Anti-insect
- Antimicrobial
- Anti-fungal
- Flame retardant
- IR blocking
- UV blocking
- Anti-sunburn

Dr Alan Hudd, Revolutionising Functional Textile Printing Using Inkjet Technology, Xennia Technology Ltd, Digital Textile Conference, Germany, 2011
Technical textiles

https://textinfo.files.wordpress.com
Technical textile

- Specialty fibers
  - Aramide
  - Glass
  - PBI...
- Thermosensitive fibers
  - HT-PE
  - PP
  - PVC
- Coated fabrics
  - PVC
  - PUR
  - …
Possible adaption ranges
Thank you very much for your attention!

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