Resource efficient textile processes for functional and smart textiles: digital printing and spray technology

Razieh Hashemi Sanatgar / University of Borås
RESOURCE EFFICIENT TEXTILE PROCESSES FOR FUNCTIONAL AND SMART TEXTILES: DIGITAL PRINTING AND SPRAY TECHNOLOGY

LU3.2
Content

• Digital printing
  • Inkjet printing
    • Application of enzyme
  • Valve jet printing
  • 3D printing on fabric

• Spray technology
Digital printing
Inkjet printing
Inkjet printing: Introduction

- Digital inkjet printing technology offers new horizons to the advanced textile manufacturing sector, as it is a resource-efficient technology that consumes just enough materials and chemicals, with minimum waste production after the process.

- The flexibility it provides to the fashion sector plays a great role in adapting to the fast changing trends of the markets nowadays. High-resolution prints, endless color choices, high-speed production and potential of industrialization with no minimum run length are few of the outstanding characteristics of this technology.

- The designs are created digitally via software that are connected to the print heads, this allows a significant reduction of production time, as well as reduces storage space and costs related to the stamps/stencils used in rotary and screen printing methods.
Inkjet printing: Background

- Conducting printing directly from a digital-based image onto the textile
- The technology ejects tiny drops of ink onto a substrate
- In practice, implementation of the technology is complex
- It is resource-efficient process, uses the least amount of materials, water and energy
- The (CMYK) system of subtractive colors (cyan, magenta, yellow and black) is used in digital inkjet printing
- It has seen commercial success since the 1970s
- The time required in the whole printing process with its preparation is significantly shorter than conventional printing of textiles
Main inkjet printing systems

**Drop-On-Demand (DOD)**

- **Thermal**
  - Use of heat to force ink from the print head.
  - Electrifying resistors behind the print nozzle, creating an intense heat that vaporizes the ink to explode onto the substrate.

**Continuous (CIJ)**

- **Piezoelectric**
  - Piezoelectric elements (crystals or ceramics) are built behind the nozzles.
  - When there is need to print a pixel, an electrical charge is applied, these elements force precise amounts of ink onto the substrate by pressure.
Characteristics and components of DIJ printing on textiles

<table>
<thead>
<tr>
<th>Feature</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable data</td>
<td>Digital</td>
</tr>
<tr>
<td></td>
<td>Unrestricted in size</td>
</tr>
<tr>
<td>Non-contact with substrate</td>
<td>Ink is dropped onto the substrate</td>
</tr>
<tr>
<td></td>
<td>Printing on different surfaces</td>
</tr>
<tr>
<td>Versatile</td>
<td>Compatible inks with different substrates</td>
</tr>
<tr>
<td>Multicolor</td>
<td>Based on CMYK system</td>
</tr>
<tr>
<td>No moving parts</td>
<td>Inherently reliable</td>
</tr>
<tr>
<td>High speed</td>
<td>Depending on resolution</td>
</tr>
</tbody>
</table>
Main components of digital inkjet printing

1. The software (controlling process and input of image)
2. The textile used (material, structure, texture…)
3. The ink used (Chemistry to suit the textile used)
4. The printhead and hardware (compatible with the ink used)

Compatibility in interactions between the components is crucial to obtain good quality prints.

Characteristics and components of DIJ printing on textiles
Inkjet printing of Enzymes
Enzyme Printed Fabrics: Bio-functionalisation of synthetic textiles by digital inkjet printing
Bacterial growth on lysozyme and tyrosinase printed PA6,6 fabric

<table>
<thead>
<tr>
<th>Blank</th>
<th>Tyrosinase and lysozyme printed (pTL)</th>
</tr>
</thead>
</table>

A red dot in the figure shows the growth of one gram-positive bacterial colony
Valve jet printing
Valve jet printing system

Drop-on-Demand (DOD) — Electromagnetic

(Valve jetting)

An electromagnet activates a plunger which is opening and closing a nozzle.
3D printing on textiles
3D printing

A

Material

Subtractive Manufacturing

3D object + Waste

B

Material

Additive Manufacturing

3D object + Waste

LU3.2 Resource efficient textile processes for functional and smart textiles
It is believed 3D printing on textiles can be one of the solutions to open up opportunities and fulfill the requirements of functional and smart textiles such as cost and flexibility as a more flexible technique.

The workflow of the method begins with a CAD modeling and then the design is given to a 3D printer and as you can see in the figure you can have polymeric patterns on certain places of fabrics for example to integrate printed sensors and interconnections.
Potential Benefits of 3D Printing on Textile

• The technology can be applied where patterned and water and solvent-free functionalization is needed.

• The technology enables to improve the ecological footprint by minimization of textile waste as well as reduced consumption of energy, water and chemicals.

• The technology is high productive, flexible and cost effective

• It has short time to market for textile innovations.

• It is adaptable to quick changes of customer demands.

• It is possible to develop innovative products for functional and smart textiles

Main challenges of 3D Printed Textiles

• Durability,

• Flexibility

• Comfort

Affecting factors on 3D printed textile properties

• Adhesion

• Tensile properties

• Bending and drape properties

• Washability

• Abrasion
Spray Technology
Spray technology

The combination of high-speed spray application with the special imogo autoclave fixation step enables high output.

(Flex Dyer® process)

- Most types of traditional dye classes
- High range of fibre types
Summary

• Digital printing and spray technology are resource-efficient technologies for textile printing and functionalization with minimum consumption of water and chemicals, and minimum waste production.

• These technologies overcome many disadvantages of the conventional methods of textile dyeing, printing and functionalization with reduction of time and endless flexibility of designs to adopt to the changing fashion trends, and developing innovative smart and functional textiles.

• The elimination of metallic stencils used in conventional printing process reduces cost, time and storage needed in the digital printing process.

• The interest in these technologies is rapidly increasing due to their great potential in advanced textile manufacturing, and their capacity of overcoming many disadvantages of conventional printing and functionalization techniques.
Partners:

Project:
Innovative smart textiles & entrepreneurship
2021-1-RO01-KA220-HED-000027527

Financial support:

Co-funded by the European Union
The European Commission’s support for the production of this publication does not constitute an endorsement of the contents, which reflect the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.
Innovative smart textiles & entrepreneurship
Project 2021-1-RO01-KA220-HED-000027527