

HACKTEX VIRTUAL TRAINING MATERIALS

ADVANCED TEXTILES MANUFACTURING INDUSTRY

Learning unit 3 Technologies for functional and smart textiles

Lesson 3

Joining and other integration technologies for production of 2D and 3D smart textiles

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JOINING AND OTHER INTEGRATION TECHNOLOGIES FOR PRODUCTION OF 2D AND 3D SMART TEXTILES

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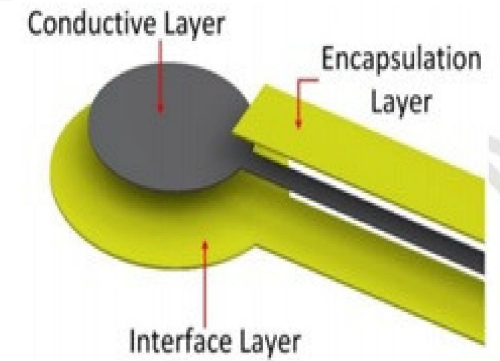
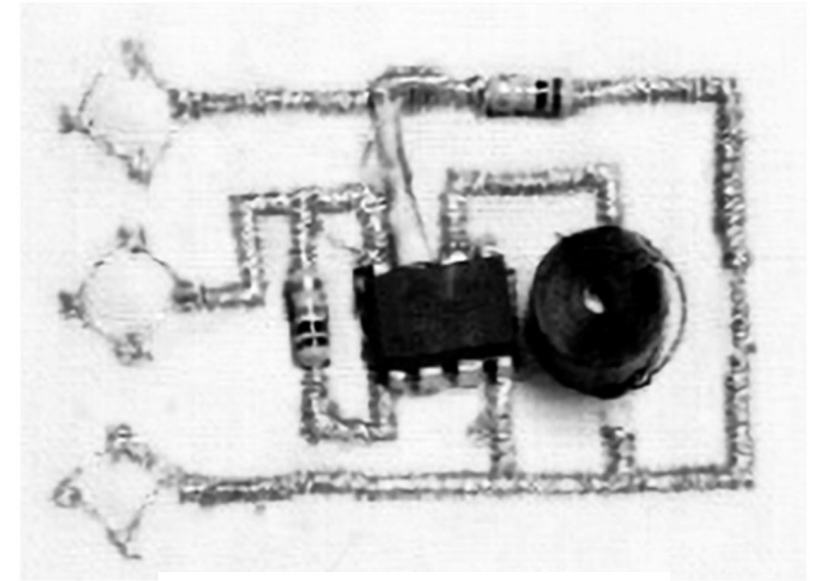
Contents

- Overview of joining techniques of smart textiles.
- Common smart textiles fabrication methods.
- Summary

OVERVIEW OF JOINING TECHNIQUES OF SMART TEXTILES

Overview

- Joining and integration techniques for development of smart textiles includes, **but are not limited to, physical, mechanical, and chemical approaches.**
- Joining techniques must satisfy being **flexible, lightweight, breathabale, stretchable, and washable to offer a superior usability, comfortability, and non-intrusiveness of the resultant Smart textile.**
- **Fixed and attachabale** Integration and joining technique for Smart textiles.



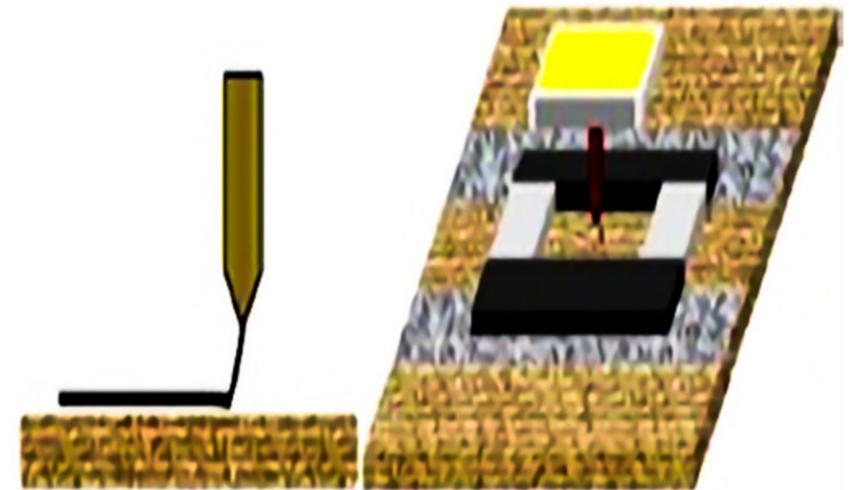
<https://doi.org/10.3390/ma14175113>

COMMON SMART TEXTILES FABRICATION METHODS

Smart Textile Fabrication

Smart textiles can be fabricated using_

- Textile fibers that **have additional functions** (e.g., electrical or optical conductivity).
- Attachment of commercial off-the-shelf components such as **integrated circuits or light emitting diodes (LEDs)** to the textile after fabrication.
- **Hybrid approaches** combining both commercial and textile functionalities.



<https://doi.org/10.3390/ma14175113>

Joining and Integration Methods : Different connection approaches

Mechanical
Connectors

Soldering

Sewing and
Embroidering

Hybrid Solder
and Sewing
Integration

Electrical
conductive
adhesive

Ink-jet and 2D
Screen
printing

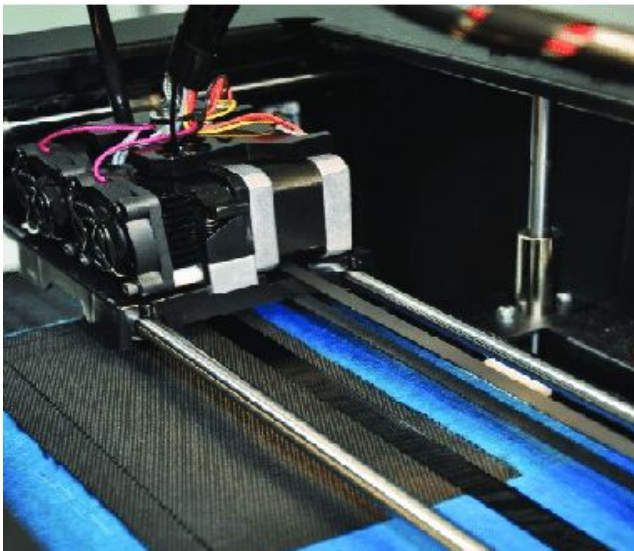
Three-dimensi
onal (3D)
printing

Stretchable
electronics

E-Threads

Joining and Integration Methods : Technology perspective

**Surface technology
(Printing, Laminating)**



[10.1088/1757-899X/254/7/072011](https://doi.org/10.1088/1757-899X/254/7/072011)

**Hybrid and Embedding
(Embroidery, Cut & Sew)**



Hindrik Johannes de Groot/Shutterstock.com

**Fiber and Yarn (Weaving
and Knitting)**

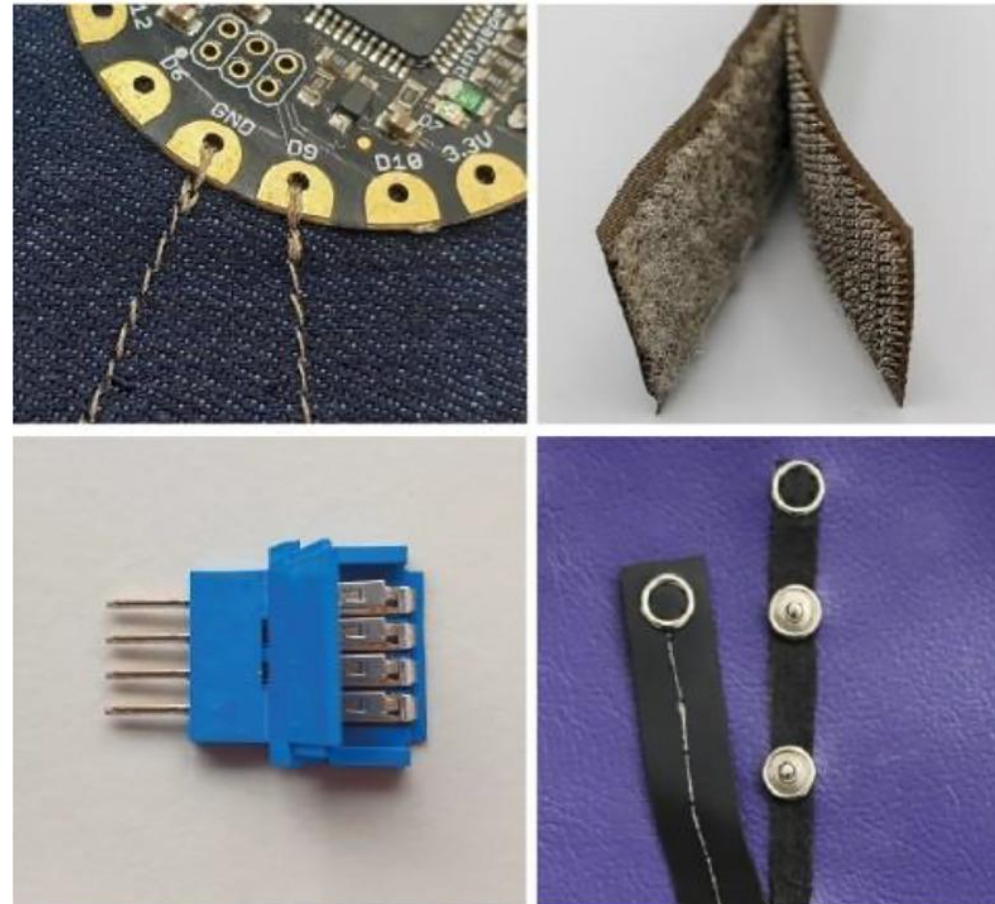


<https://www.digitaltrends.com>

Mechanical Connector

Physical attachments of textile fibers that have additional functions, or integrated circuits or light emitting diodes (LEDs) to the textile **after fabrication and wire with a textile** by using different methods such as _

- **Snap buttons**
- **Socket buttons**
- **Bolt connection**
- **Ribbon cable connector. Etc.**



<https://doi.org/10.1002/eng2.12491>

Soldering

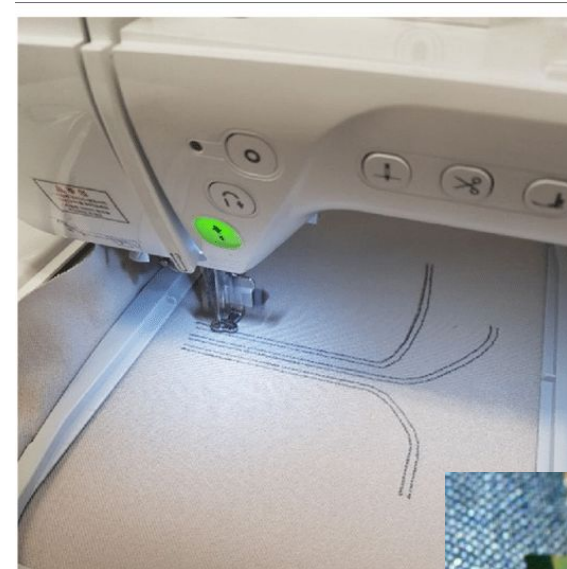
- Interconnections between **conductive textile material and microelectronics** by melting a filler metal or solder and putting it into the joint.
- Mounting the components **directly onto the textiles surface**.
- Soldering process transfers **heat either by conduction, convection, or radiation**.
- Solders are generally **soft alloys** of lead (Pb), tin(Sn), or silver (Ag) etc.
- Achieves **good electrical contact**.
- **Types:** Frictional soldering, Hot air or thermal soldering, Ultrasonic soldering, laser soldering, infrared soldering.



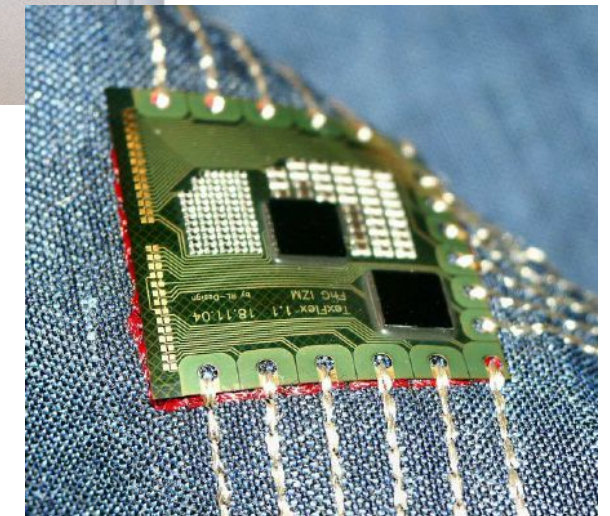
<https://www.ifixit.com/Wiki/Soldering>

Sewing and Embroidering

- Conventional sewing and embroidery technique.
- Interconnection by **attaching functional material on top of a textile fabric** with yarn or making circuit using conductive yarn.
- Advanced embroidery machines to **integrate electronics into the textile substrate**.
- **Special yarn, and needles**, must be used, which allow embroidering without yarn breakage.
- **High resolution circuit** and have **high resistance to washing cycle**.



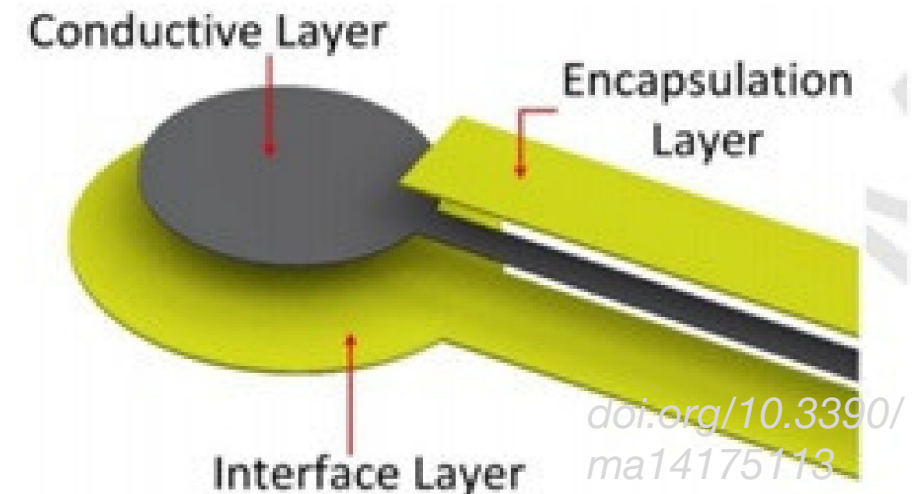
[10.1186/s40691-020-00234-5](#)



[10.1109/ISW C.2005.19](#)

Inkjet and 2D Screen-Printing

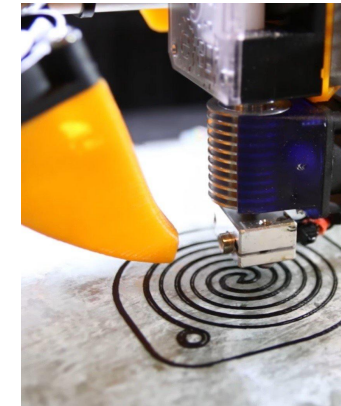
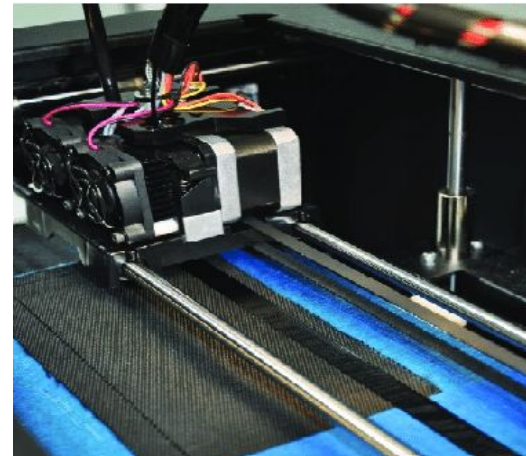
- Performed by **primary printing techniques**, such as screen printing or inkjet printing.
- **Printing of functional materials** or microelectronics on textile Surface.
- **Electro active functional inks** allow the manufacturing of textile based electronic devices.
- Often **rigid and inflexible technologies** that offer **limited skin-compatibility** and are damaged under washing.
- Often **uncomfortable and less breathable**.



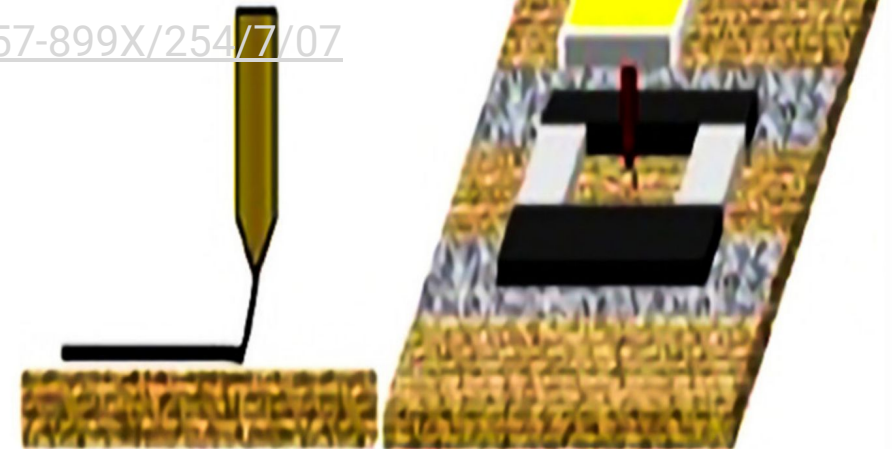
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Three-Dimensional (3D) Printing

- Functional materials are captured on a **Computer Aided Design (CAD)** model and then subsequently fabricated in a **layer-by-layer manner on textiles**.
- Works with the **principle of the fused deposition method (FDM)** technology.
- Sensitive to **mechanical abrasión**.
- Integration of functional materials on textiles with **high precisión, performance and connections**.
- Printability of **multiple layers**.

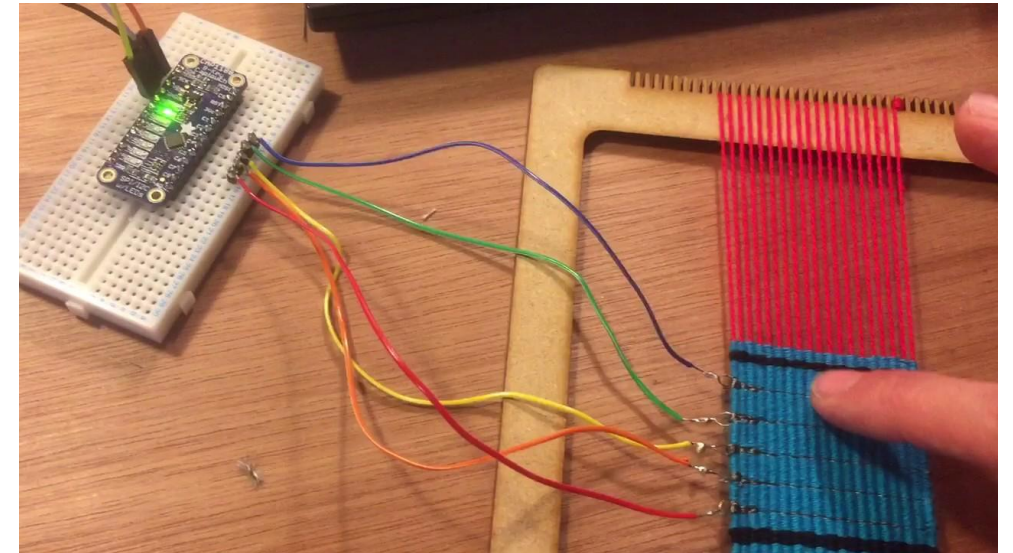
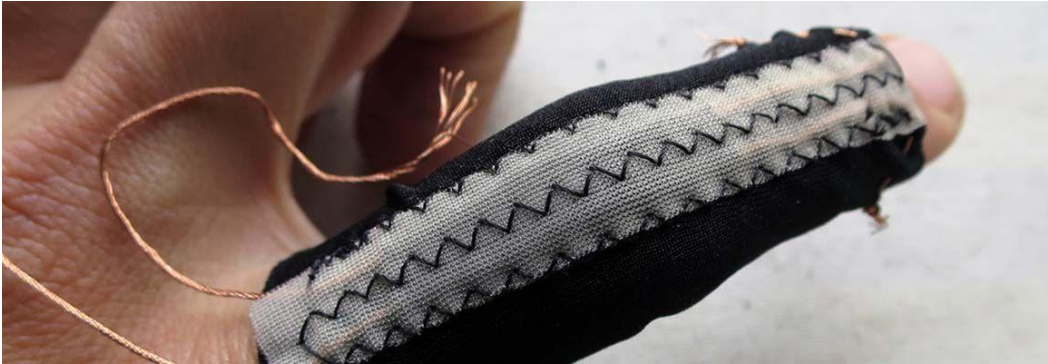


[10.1088/1757-899X/254/7/07](https://doi.org/10.1088/1757-899X/254/7/07)
[2011](https://doi.org/10.1088/1757-899X/254/7/07)



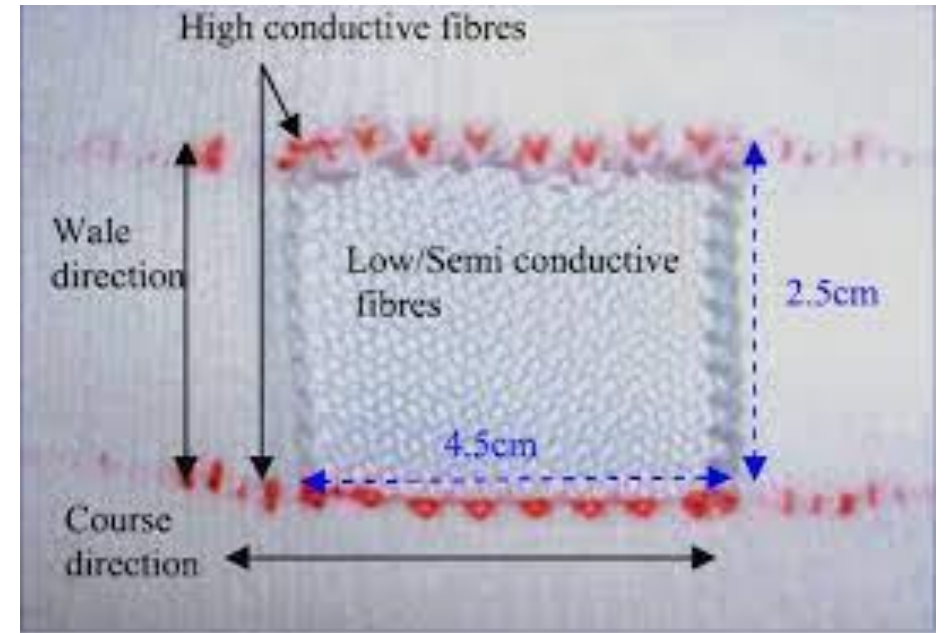
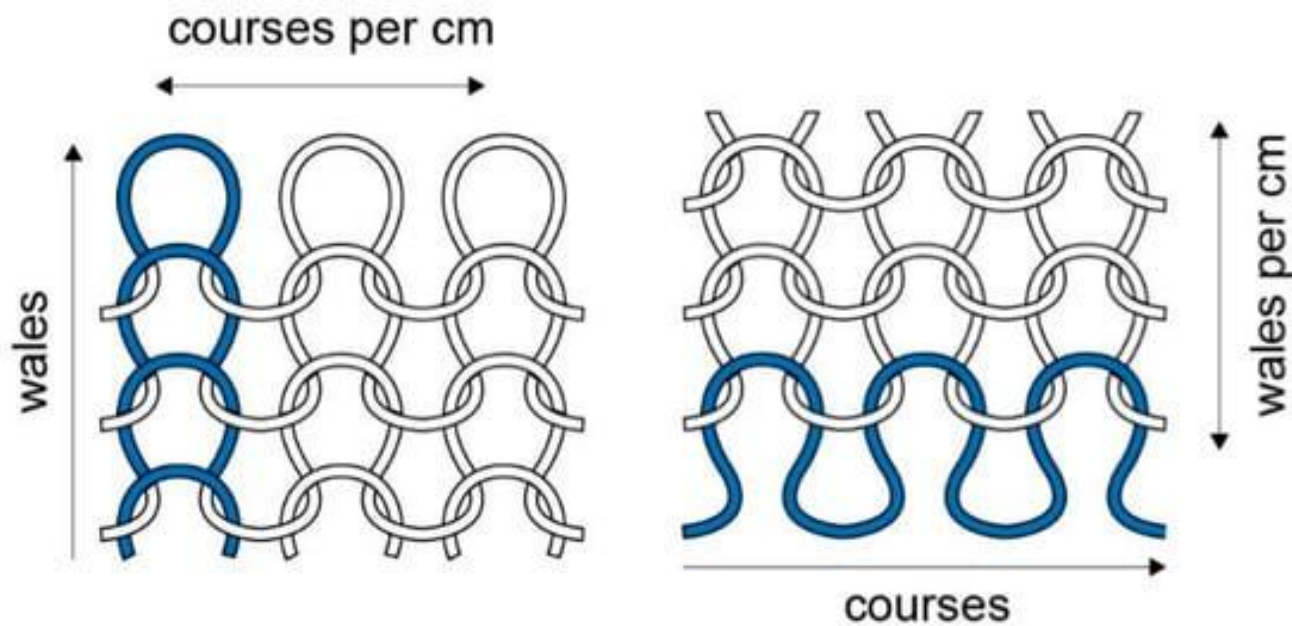
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Weaving



- Traditional **weaving technique**.
- Able to generate **large area textile Surface**.
- Possible to **weave both 2D and 3D Smart textiles**.
- Optical fibers can be **spirally woven into the garment for uncut garment manufacturing**.
- Durable and better resistant to washing cycle.

Knitting



- Durable and **better resistant to washing cycle.**
- Integration of **functional threads of yarn into textiles through traditional knitting technique.**
- Modern machines are capable of knitting complex **2D and 3D structures.**

doi.org/10.3390/s20247236

Summary

- Choice of Joining and integration techniques for development of 2D and 3D Smart textiles depends on the application of the end product.
- Over the years several joining and integration techniques has been introduced from basic weaving-knitting, coating, sewing to three dimensional printing.
- Joining techniques often influence the performance of Smart textiles in terms of durability, comfort and accuracy of the functions.
- Integration of functional materials into textile for the development of Smart textiles shall be done without affecting or influencing the final design and characteristics of the textile substrate.

Project

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