



INTESA SANPAOLO
INNOVATION CENTER

INDUSTRY TRENDS REPORT **SMART TEXTILES:**

*EMERGING STRATEGIES FOR
HUMAN PROTECTION AND
COMFORT*



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EXECUTIVE SUMMARY

The textile sector is undergoing a structural technological transformation, progressively moving away from materials conceived for passive protection and comfort toward advanced systems capable of integrating sensing, adaptive response, and energy-related functionalities. Smart textiles have emerged as one of the most dynamic frontiers in advanced materials innovation, driven by the convergence of materials science, flexible electronics, nanotechnology, and digital technologies. These systems go beyond the simple embedding of electronic components into fabric structures: they represent a broader class of functional platforms capable of sensing, processing, and responding to environmental or physiological stimuli.

This report provides a structured analysis of the current state of the art and the main technological development trajectories of smart and multifunctional textiles.

The report opens by establishing the technological framework of the sector, tracing the evolution of textile materials from natural fibers to high-performance synthetics, hybrid composites, and intelligent systems, and introducing the defining properties of smart textiles, physical, chemical, and sensing, that enable their active role in protection, comfort, and human–environment interaction. Global market dynamics and innovation drivers are examined in parallel, including the growing integration of wearable technologies, advanced sensing systems, and digital connectivity. Particular attention is given to the European innovation ecosystem, which has positioned itself as a leading hub for research and development through coordinated policy frameworks, Horizon Europe funding programs, and specialized regional clusters.

The analysis then moves to the industrial applications of smart textiles across five strategic sectors: aerospace, defense and security, biomedical and healthcare, sports and wearable technology, and environment, construction and infrastructure. This section opens with an investor-oriented framing of the role of advanced materials as primary technological enablers, establishing miniaturization, durability, and conductivity as the three core value drivers, supported by a comparative overview of the principal material classes by functional category, technology maturity level, and target market. The cross-sectoral analysis that follows demonstrates how smart textiles are evolving into multifunctional technological platforms with significant potential across advanced monitoring systems, protective equipment, and human–environment interaction technologies and highlights the cross-sector synergies emerging from the convergence of these application domains.

The report subsequently maps the global industrial landscape, profiling key companies and startups at the global, European, and Italian level, with a value chain analysis of the sector and a curated directory of relevant startups with links to detailed company profiles.

The main technological and industrial challenges limiting large-scale adoption are then addressed, including the reliable integration of electronic components within textile structures, the need to balance technical performance with user comfort and environmental sustainability, and the development of regulatory frameworks and certification standards tailored to emerging functionalities, alongside future development trajectories encompassing autonomous and adaptive systems, the role of artificial intelligence in textile design and management, and the importance of public-private collaboration in accelerating sector growth.

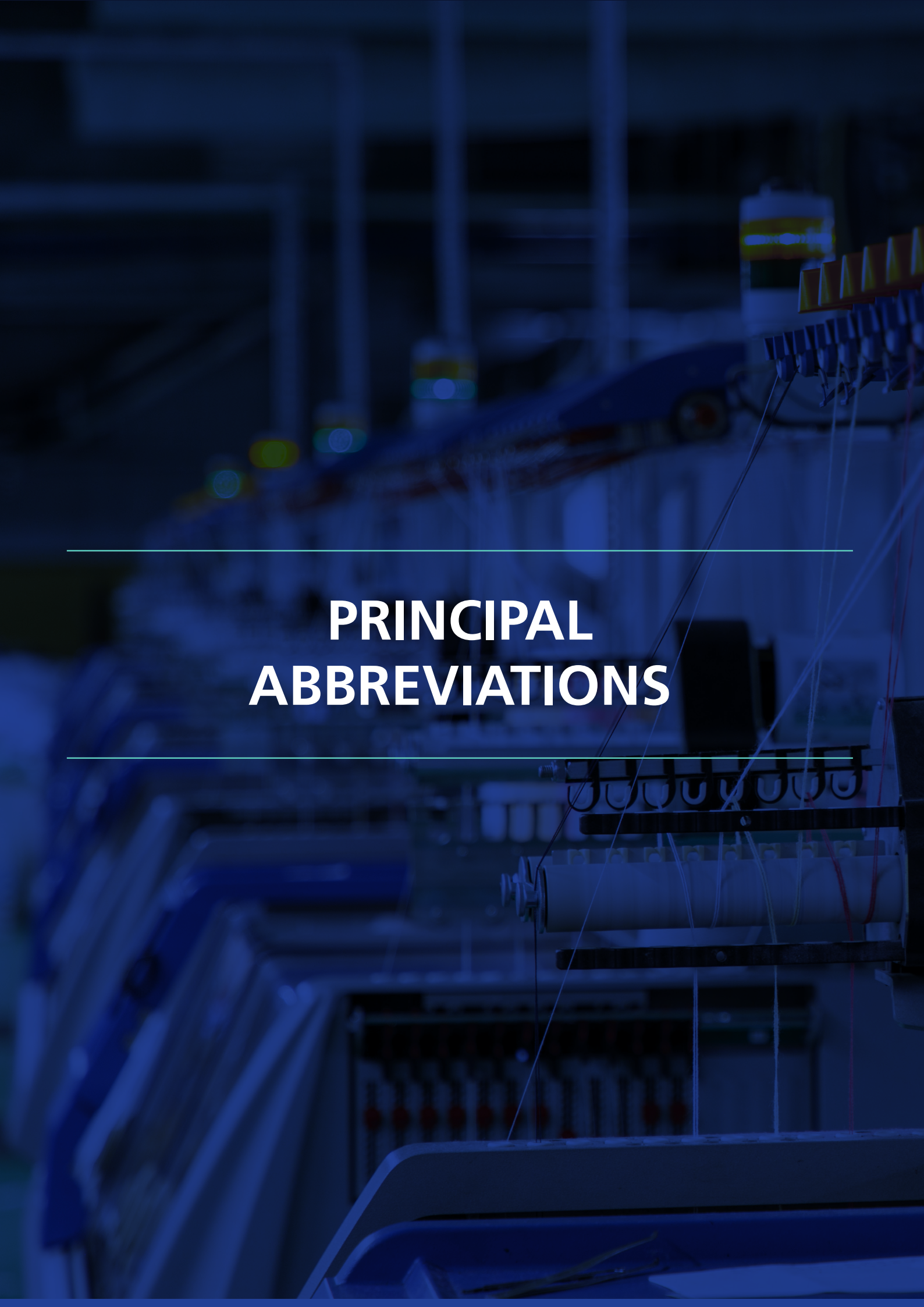
The report concludes by synthesizing the key technological and industrial trends identified across the analysis and outlining future perspectives, with particular focus on the emergence of bio-hybrid textile systems, structures combining advanced synthetic materials with biological components, as a defining frontier for the next generation of intelligent textile platforms.

The Technical Annex provides a detailed functional and performance-based classification of the advanced material classes underpinning smart textile innovation, organized across seven categories: physical and mechanical protection, thermal protection and heat management, radiation shielding, antimicrobial and bioactive functionalities, filtration and purification, sensing and interactive systems, and sustainable and bio-based materials. For each category, the Annex covers material composition, structural characteristics, key performance features, and references to laboratory test protocols and applicable certifications.

Overall, the report highlights that smart textiles represent a rapidly evolving field of innovation, with future developments expected to produce increasingly autonomous, adaptive, and bio-hybrid systems capable of dynamically interacting with both the environment and the human body, progressively redefining the boundaries between functional materials, technological devices, and biological systems.



1. INTRODUCTION



PRINCIPAL ABBREVIATIONS

AI	<i>Artificial Intelligence</i>	ISO	<i>International Organization for Standardization</i>
AR	<i>Augmented Reality</i>	LCA	<i>Life Cycle Assessment</i>
BLE	<i>Bluetooth Low Energy</i>	MEMS	<i>Micro-Electro-Mechanical Systems</i>
CAGR	<i>Compound annual growth rate</i>	MOF	<i>Metal–Organic Framework</i>
CNT	<i>Carbon Nanotubes</i>	Mxene	<i>Two-dimensional transition metal carbide/nitride materials</i>
DIH	<i>Digital Innovation Hub</i>	OEKO-TEX®	<i>International certification system for textile safety</i>
ECG	<i>Electrocardiogram</i>	PCM	<i>Phase Change Materials</i>
EMI	<i>Electromagnetic Interference</i>	PPE	<i>Personal Protective Equipment</i>
EVA	<i>Extravehicular Activity</i>	PNRR	<i>National Recovery and Resilience Plan (Italy)</i>
FAN	<i>Fabric Area Network</i>	S3	<i>Smart Specialisation Strategies</i>
FBG	<i>Fiber Bragg Grating</i>	SpO₂	<i>Peripheral Capillary Oxygen Saturation</i>
GOTS	<i>Global Organic Textile Standard</i>	TRL	<i>Technology Readiness Level</i>
IMU	<i>Inertial Measurement Unit</i>	UHMWPE	<i>Ultra-High Molecular Weight Polyethylene</i>
IoT	<i>Internet of Things</i>	UV	<i>Ultraviolet</i>

ABOUT INTESA SANPAOLO INNOVATION CENTER:

Intesa Sanpaolo Innovation Center is the company of Intesa Sanpaolo Group dedicated to innovation: it explores and learns new business and research models and acts as a stimulus and engine for the new economy in Italy. The company invests in applied research projects and high potential start-ups, to foster the competitiveness of the Group and its customers and accelerate the development of the circular economy in Italy.

Based in the Turin skyscraper designed by Renzo Piano, with its national and international network of hubs and laboratories, the Innovation Center is an enabler of relations with other stakeholders of the innovation ecosystem - such as tech companies, start-ups, incubators, research centres and universities - and a promoter of new forms of entrepreneurship in accessing venture capital. Intesa Sanpaolo Innovation Center focuses mainly on circular economy, development of the most promising start-ups, venture capital investments of the management company Neva SGR and applied research

For further detail on Intesa Sanpaolo Innovation Center products and services, please contact businessdevelopment@intesasanolinnovationcenter.com

ABOUT MATERIAS

Materias is an innovative SME aiming to create new businesses, supporting the development of innovative solutions in the advanced materials sector and accelerating their market entry. Materias invests in sciencebased new ventures supporting the most promising technologies to overcome the "Death Valley", through the connection of the research world with industrial companies.

The company operates on scientific knowledge-based technologies, which require more costs and risks than digital innovations. The work carried out by Materias has allowed the scouting of over 1.100 ideas in the advanced materials sector, going from life science, civil engineering, food-tech to industrial engineering.

The development of applied research projects and the management of intellectual property has allowed the company to increase its value and strengthen its intangible assets by feeding the technology database and the patent portfolio. Materias has created an innovation ecosystem that has allowed the company to come into contact with excellent public and private research Centers of international relevance.

The ecosystem has generated a valuable contribution in terms of technology transfer and first industrialization in partnership with universities and Public Research Centers. For further details on Frost & Sullivan's coverage and services, please contact

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