ALTERNATIVE TEXTILE FIBER INNOVATION

Achieving Performance, Cost, and Impact Goals

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AGENDA

01 **The state of materials in the textile industry**

02 Overview of alternative textile fiber innovations

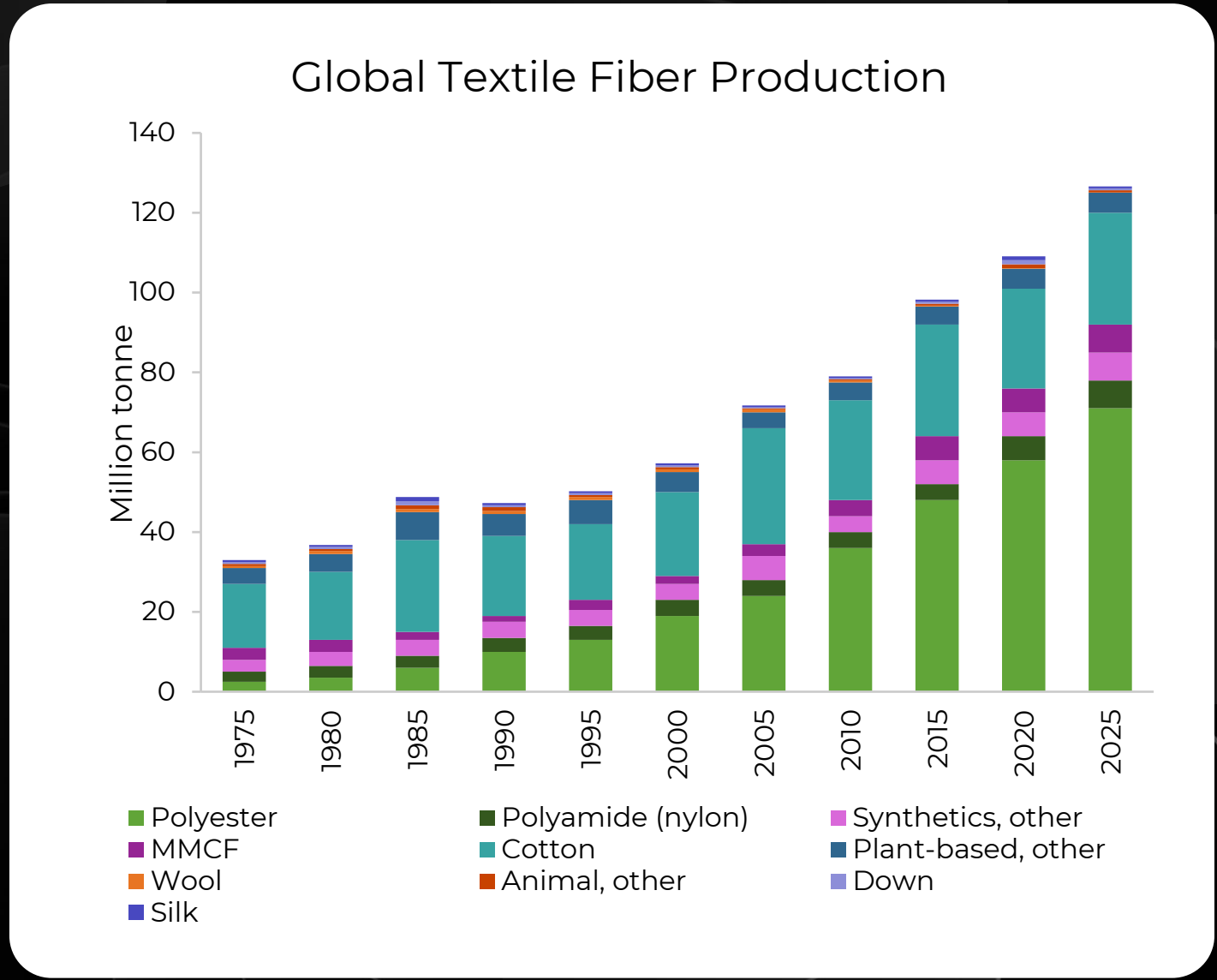
- Alternative synthetic fibers
- Alternative manmade cellulosic fibers (MMCFs)
- Alternative protein fibers

03 Key takeaways

THE STATE OF MATERIALS IN THE TEXTILE INDUSTRY

THE SYNTHETIC TEXTILE BOOM

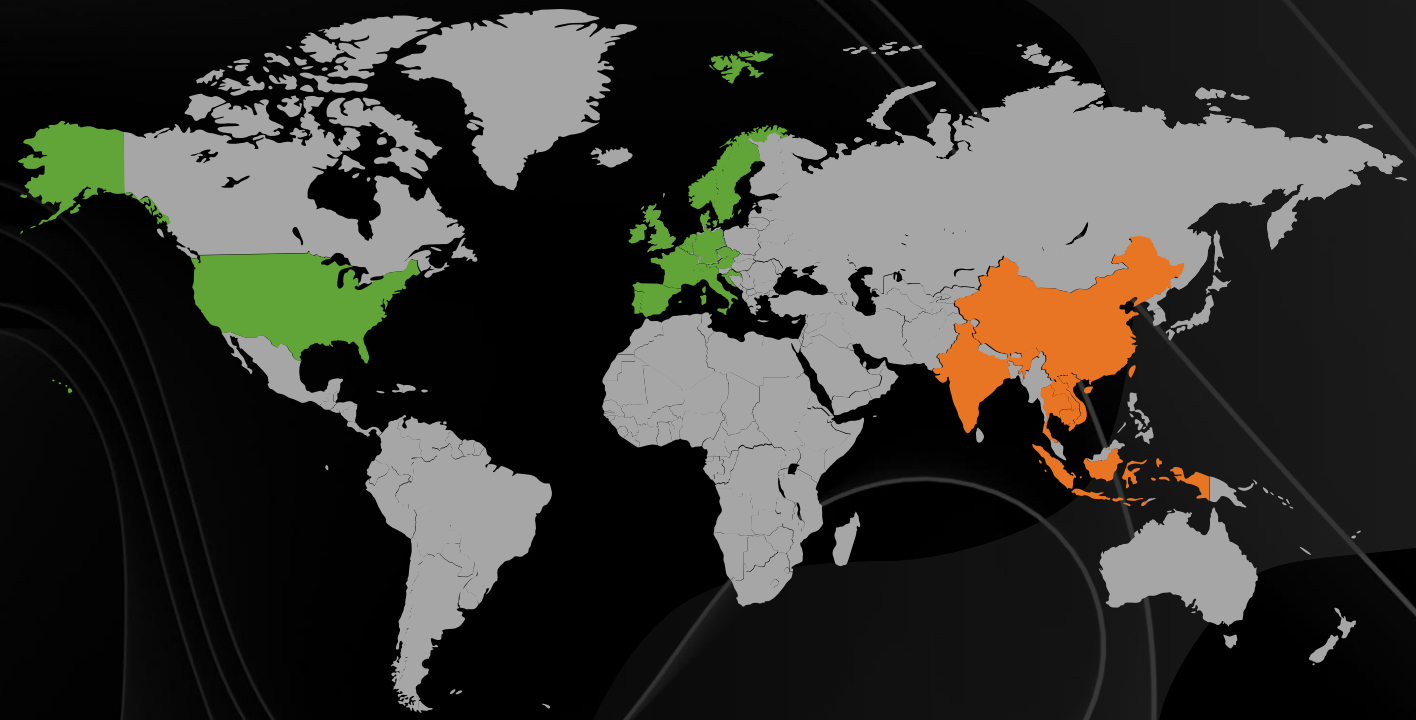
- Global textile fiber production is expected to grow to over 130 million tonne this year.
- The public is recognizing the implications of the materials we wear as concerns arise.
- Regulations and brand commitments are pressuring the textile industry to move toward circular, low-impact fibers.



Source: Textile Exchange *Materials Market Report* 2023

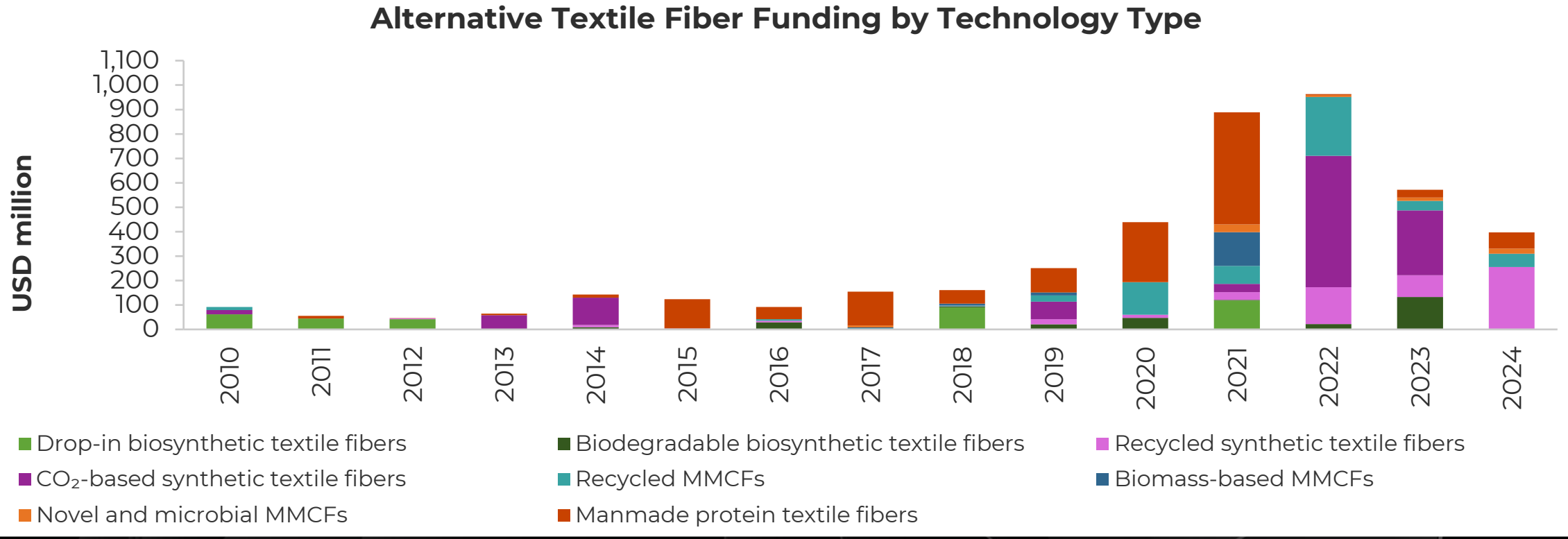
THE FASHION INDUSTRY'S DICHOTOMY

- Since the 1990s, textile production has been centralized in Asia Pacific.
- The largest fashion brands are located in the West.
- Regulations including recycling and extended producer responsibility (EPR) schemes are being introduced in the U.S. and EU.



INVESTMENT TRENDS

Investments in alternative textile fibers spiked in 2021 but are still growing



Source: Patent Trends: Thermal management materials

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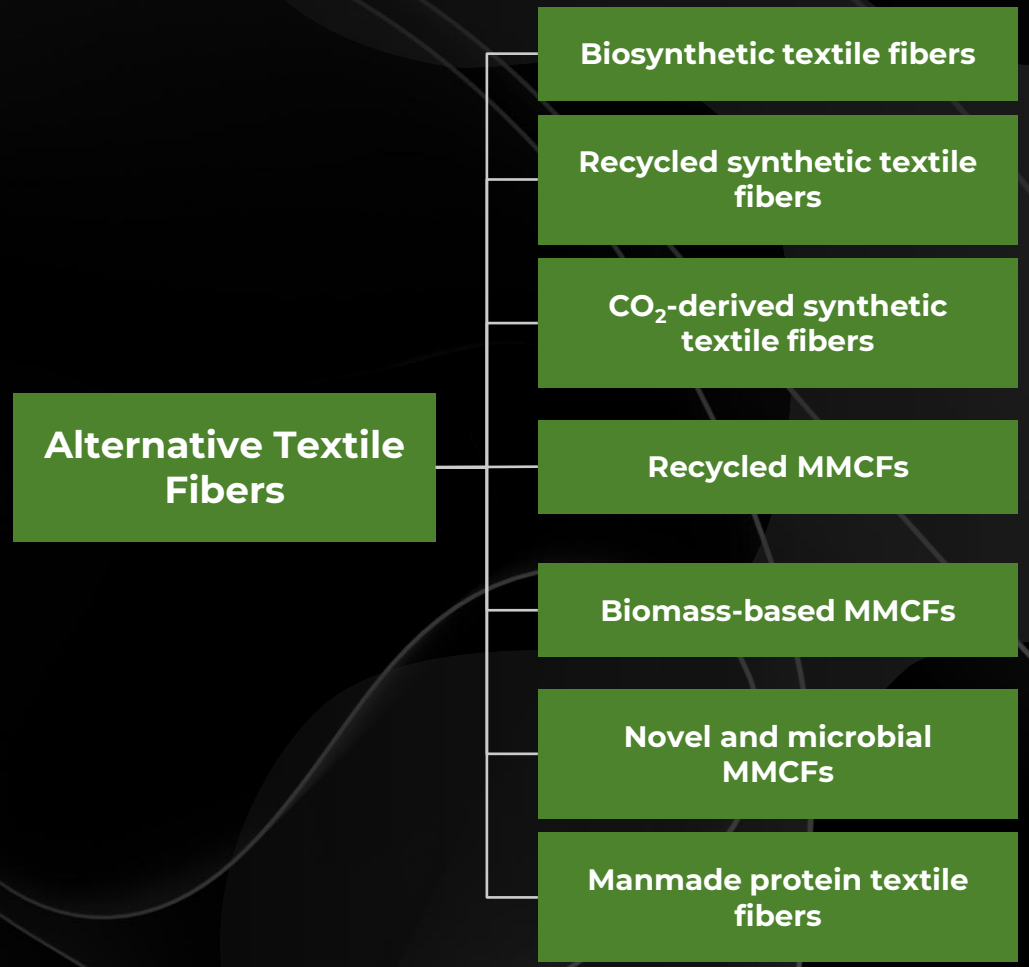
OVERVIEW OF ALTERNATIVE TEXTILE FIBER INNOVATIONS

Innovations that include alternatives to synthetic, cellulosic, and protein-based textile fibers



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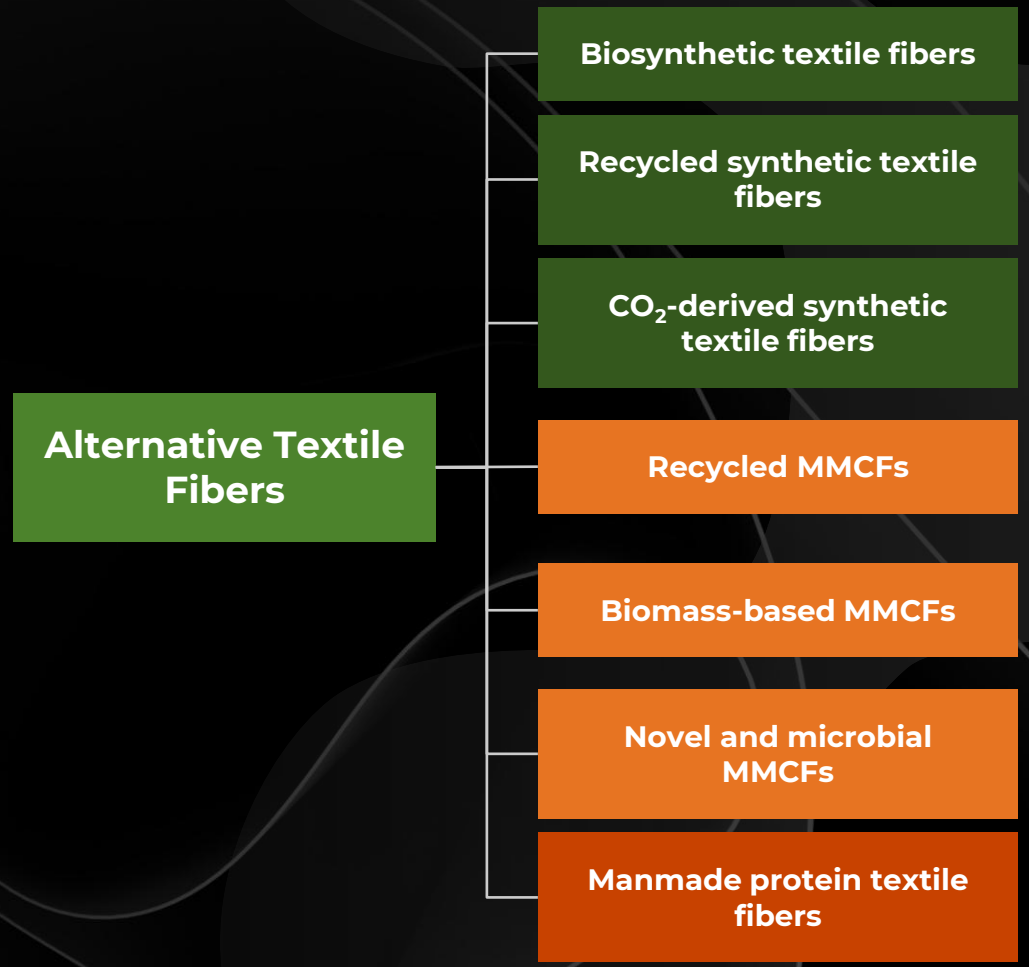
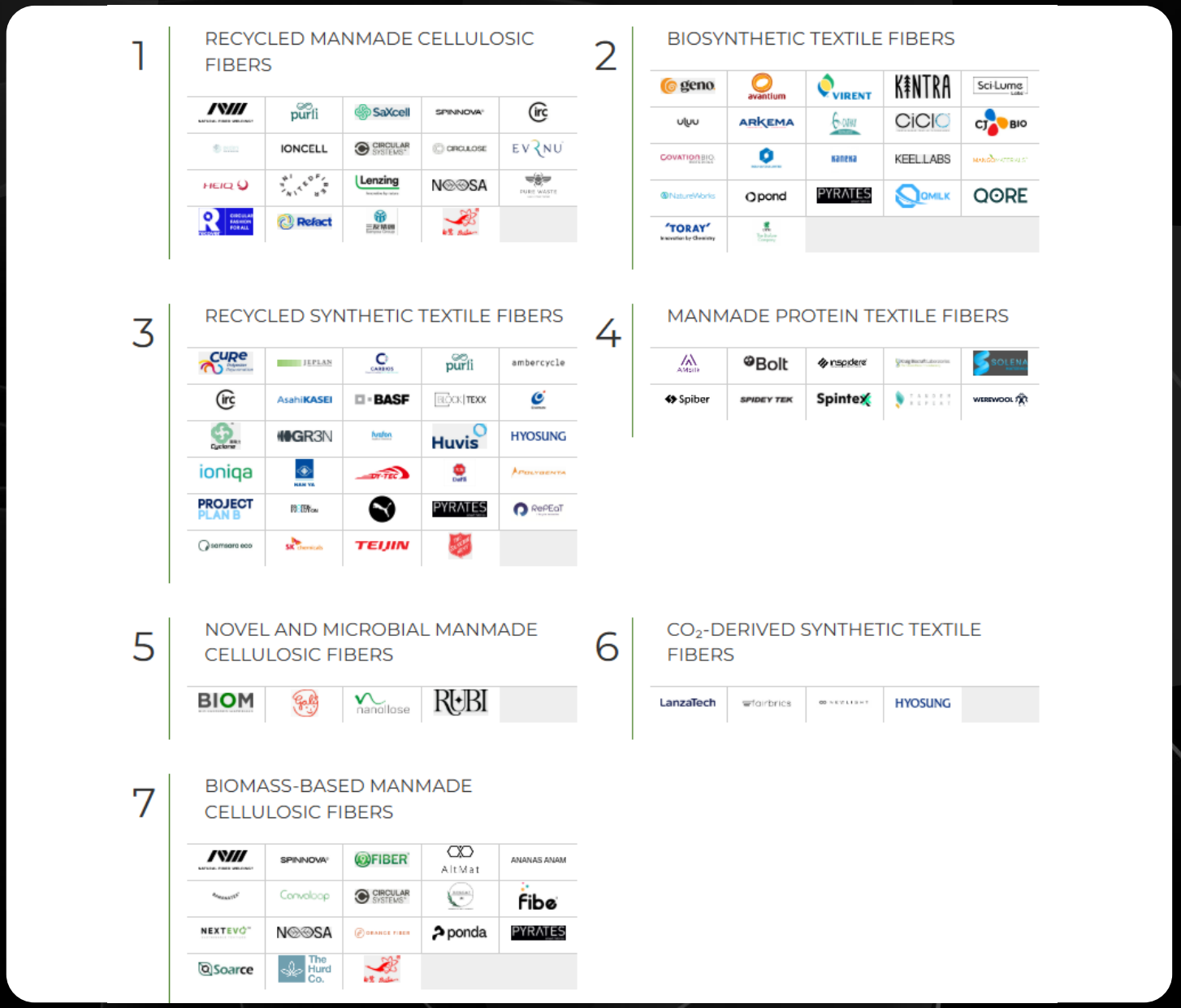
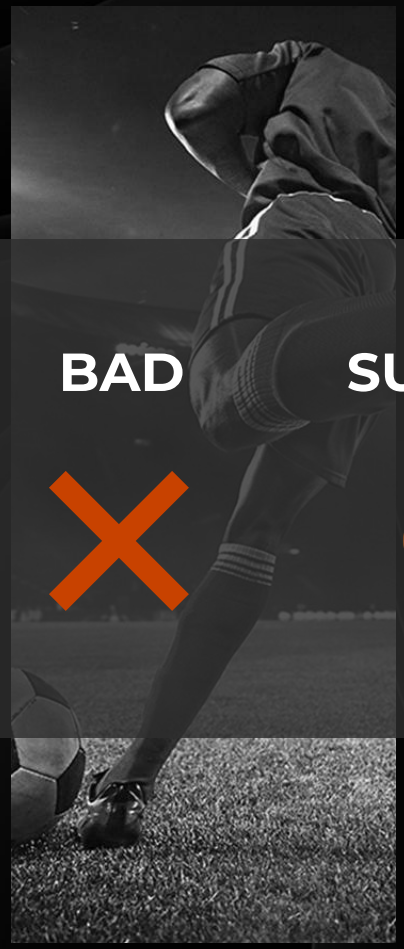


TECHNOLOGY LANDSCAPE OF ALTERNATIVE TEXTILE FIBERS



Source: Technology Hub: Alternative Textile Fibers

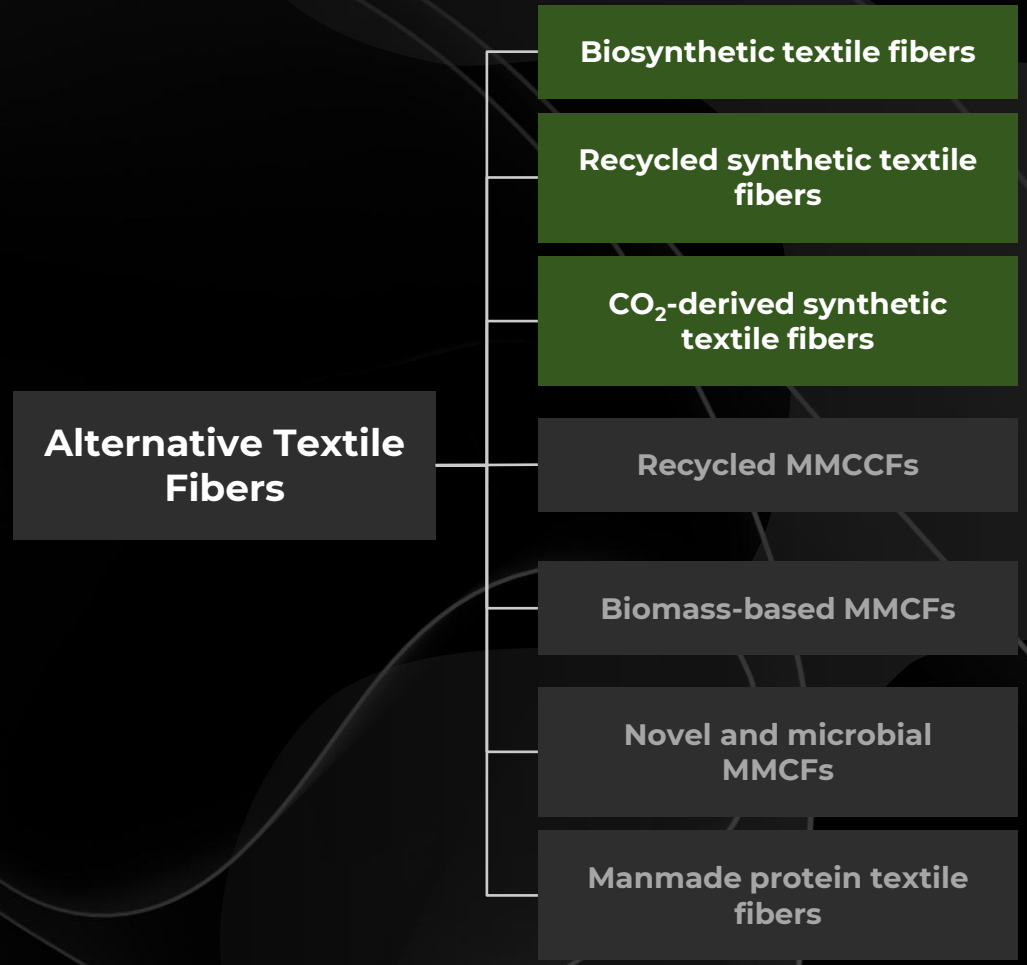
	PERFORMANCE	COST	IMPACT
ALTERNATIVE SYNTHETIC FIBERS			
ALTERNATIVE MMCFS			
ALTERNATIVE PROTEIN FIBERS			

	PERFORMANCE	COST	IMPACT
ALTERNATIVE SYNTHETIC FIBERS			
ALTERNATIVE MMCFS			
ALTERNATIVE PROTEIN FIBERS			

BAD ✕ SUFFICIENT ○ GOOD ✓

ALTERNATIVE SYNTHETIC FIBERS

Biobased, recycled, CO_2-derived equivalents to PET, PA, or novel biopolymers



STATE OF THE ART: ALT. SYNTHETICS

	Biosynthetic Textile Fibers Synthetic fibers via biobased sources	**Recycled Synthetic Textile Fibers** Synthetic fibers via recycled plastics	**CO_2-Derived Synthetic Textile Fibers** Synthetic fibers via chemicals from CO_2
Stage of development	**Introduction**	**Scale**	**Development**
Tenacity	**4–85 cN/tex**	**66–80 cN/tex**	**35–78 cN/tex**
Elasticity (elongation)	**5%–500%**	**13%–500%**	**16%**
Moisture absorption	**0.4%–5%**	**0.4%–5%**	**0.4%–0.8%**
Temperature resistance	**50 °C–270 °C**	**160 °C–270 °C**	**160 °C–260 °C**
Biodegradability	**Nonbiodegradable**	**Nonbiodegradable**	**Nonbiodegradable**
Carbon footprint	**1.5–4 kg CO_2 eq**	**0.3–11.5 kg CO_2 eq**	**0.9–1.7 kg CO_2 eq**
Lux Recommendation	**Engage**	**Engage**	**Ignore**

LYCRA GOES BIOBASED

Upcoming influx of bio-spandex in 2025

Qore, a JV between Cargill and Helm, is scaling up Qira, a bio-based 1,4-butanediol (BDO).

- Partnered with Lycra for spandex using QIRA BDO
- 44% CO_2 reduction over incumbent fossil-based spandex
- Biobased Lycra available on the market in early 2025

LUX TAKE

This influx of biobased spandex to the market should be closely monitored as there will be critical insights into how a biobased premium impacts consumer appetite and market demand for these materials.

Image source: Lycra

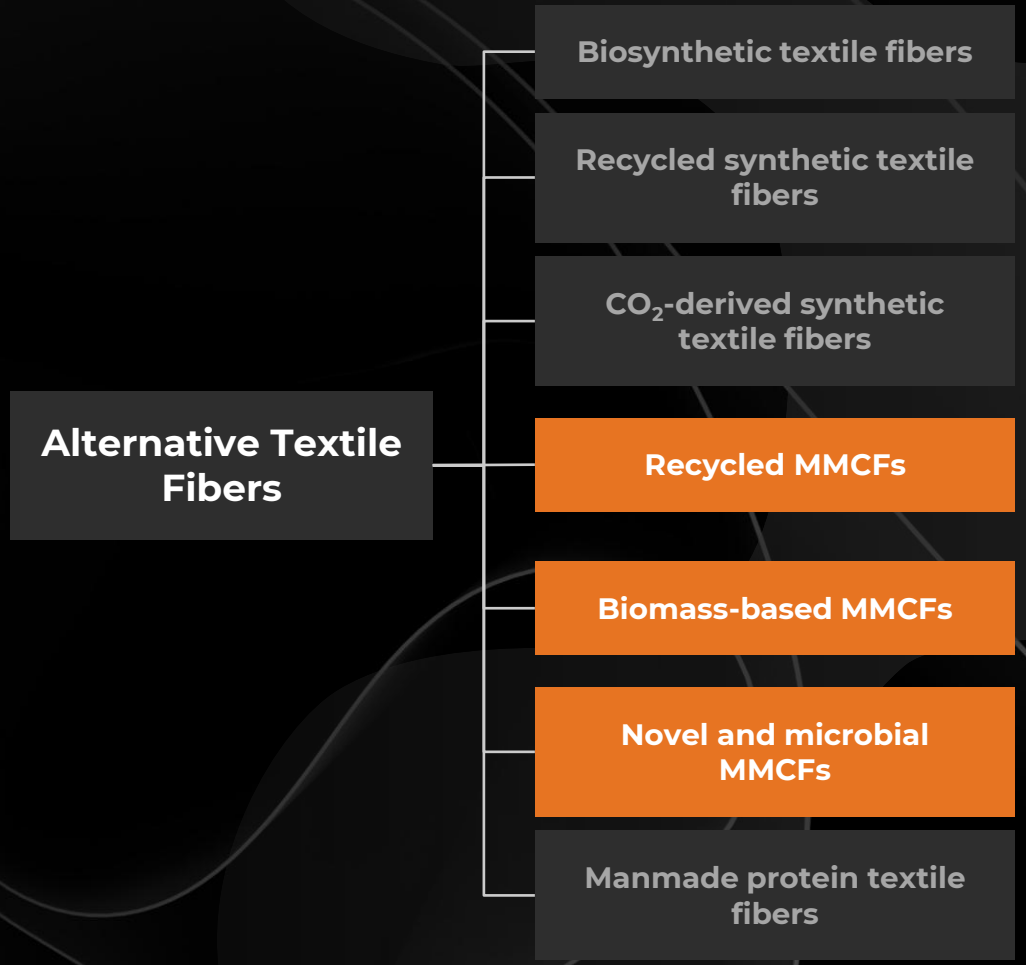
We won't consider new textile fibers or materials unless there are at least more than two suppliers producing the material.

– Global sports apparel brand

	PERFORMANCE	COST	IMPACT
ALTERNATIVE SYNTHETIC FIBERS	✓	○	○
ALTERNATIVE MMCFS			
ALTERNATIVE PROTEIN FIBERS			

ALTERNATIVE MMCFS

Recycled, biomass-based, and novel and microbial MMCFs that serve to replace cotton and conventional viscose



STATE OF THE ART: ALT. MMCFS

	Recycled MMCFs MMCF via recycled cellulosic textiles	Biomass-Based MMCFs MMCF via biomass/agricultural waste	Novel and Microbial MMCFs MMCF via artificial cellulose production
Stage of development	**Introduction**	**Development**	**Lab**
Tenacity	24–60 cN/tex	23–60 cN/tex	40–57 cN/tex
Elasticity (elongation)	10%–17%	13%–23%	5.5%–10%
Moisture absorption	10%–13%	10%–13%	10%–13%
Temperature resistance	120 °C–160 °C	120 °C–160 °C	120 °C–160 °C
Biodegradability	<6 months	1 year	1–2 years
Carbon footprint	–2 to 6 kg CO_2 eq	1.5–4.4 kg CO_2 eq	34–296 kg/CO_2 eq
Lux Recommendation	**Monitor**	**Monitor**	**Ignore**

ORANGE FIBER IN LUXURY

Lyocell textile fibers from citrus fruit biomass

Orange Fiber is an Italian startup founded in 2012.

- Partnered with Italian textile mill Tessuti di Sondrio and Lenzing as well as Salvatore Ferragamo and H&M for limited collections
- The fiber's novelty and regional ties in Italy support the company's growth

LUX TAKE

Orange Fiber's partnership with a renowned Italian textile mill is a major factor in succeeding in small luxury markets. The textile craftsmanship imparts performance and grants the yarns recognition as luxury materials.

ORANGE FIBER

TESSUTI DI SONDRIO

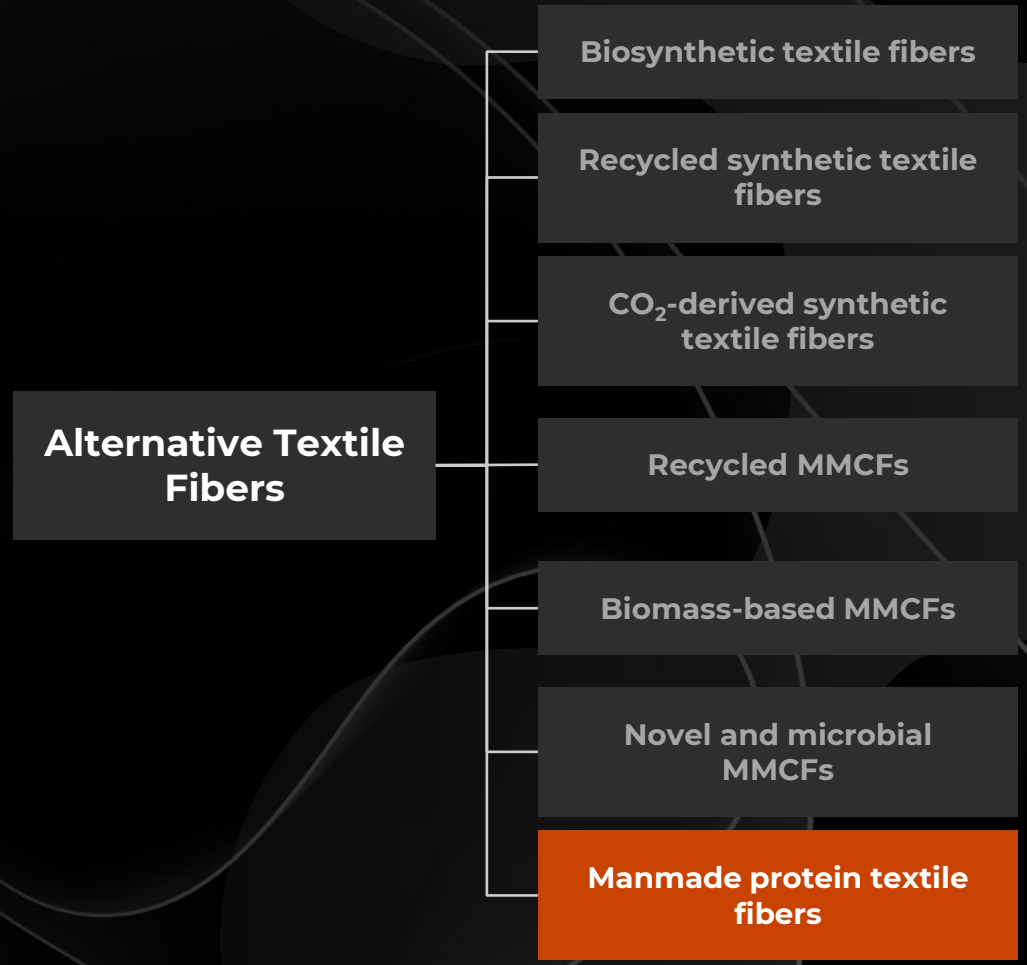
If we're paying that level of premium … every customer would probably need to as well. Then we would need to be telling a really good story that can justify the premium down to the consumer.

– Global performance apparel company

	PERFORMANCE	COST	IMPACT
ALTERNATIVE SYNTHETIC FIBERS			
ALTERNATIVE MMCFS			
ALTERNATIVE PROTEIN FIBERS			

ALTERNATIVE PROTEIN FIBERS

Manmade protein fibers that replace animal-based fibers like wool and silk



STATE OF THE ART: ALT. PROTEIN FIBERS

	Manmade Protein Textile Fibers Protein fibers via manmade processes
Stage of development	**Development**
Tenacity	**8.7–35 cN/tex**
Elasticity (elongation)	**27%–270%**
Moisture absorption	**10%–30%**
Temperature resistance	**200 °C–230 °C**
Biodegradability	**1–2 years**
Carbon footprint	**10–37 kg CO_2 eq**
Lux Recommendation	**Ignore**

BREWED PROTEIN FIBERS

Small-scale jackets

Spiber ferments sugars to produce structural proteins, under the brand name “Brewed Protein.”

- Japan-based Spiber has raised over USD 800 million
- Significant premium (USD 10–USD 100/kg)
- Textile composition ranging from 12% to 60% protein fibers, mixed with cotton or synthetics

LUX TAKE

Spiber and partners sell premium garments with small amounts of protein fibers, leaning heavily on novelty. To move beyond limited collections and succeed long term, Spiber must overcome performance and scaling challenges.

Spiber

I don’t know whether any premium is acceptable at all. The goal should be to close the gap.

– Global sports and apparel manufacturer

	PERFORMANCE	COST	IMPACT
ALTERNATIVE SYNTHETIC FIBERS			
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KEY TAKEAWAYS

1

No solution checks all the boxes, but alt. synthetics wins out.

With performance matching existing solutions, alternative synthetics have the best potential to expand.

Furthermore, EPR and recycling schemes favor recycled or recyclable options where synthetics can further benefit.

2

For other categories, opportunity is restricted to luxury segments.

Luxury and niche brands can handle the higher costs of alternative textile fibers while appreciating their novelty and impact. Mass adoption depends on cost parity and supply chain readiness that the technology lacks.

3

R&D may unlock additional opportunities but at a large cost.

Alternative MMCFs and protein fibers require more upstream investments to improve fiber performance and efficient production.

Innovations to address waste and microplastics remain unclear as today's recycling and compost systems are lacking.

THANK YOU

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