

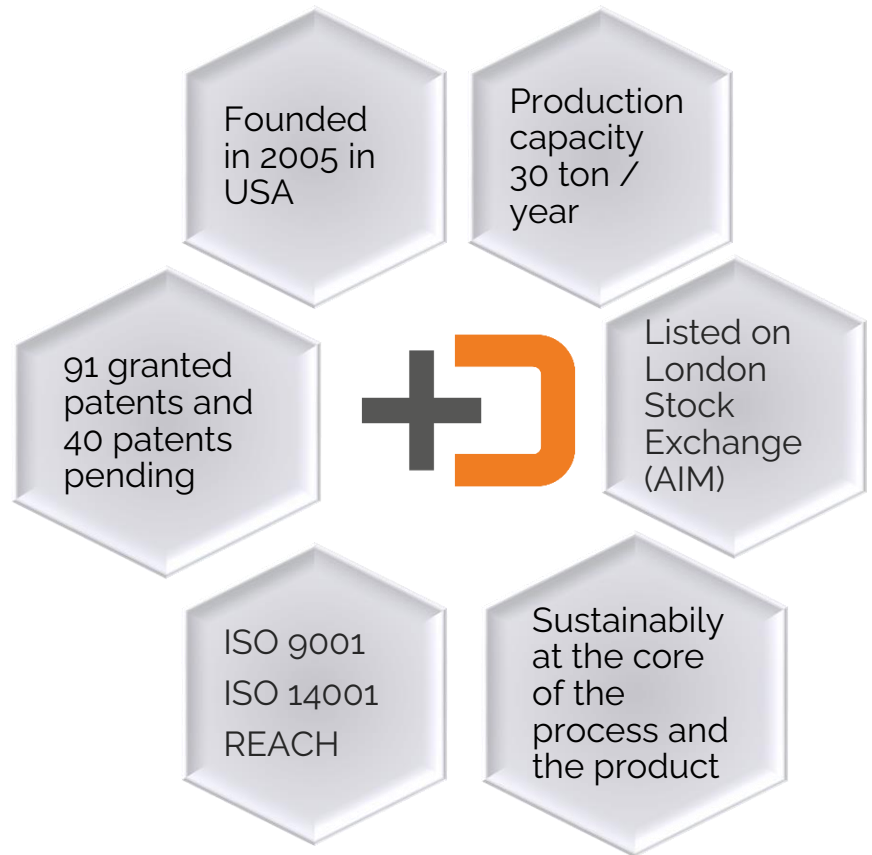


**Graphene Plus
in Textile**

Company overview



Directa Plus is one of the largest producers of **graphene** nanoplatelets-based products for use in **consumer** and **industrial** markets worldwide.



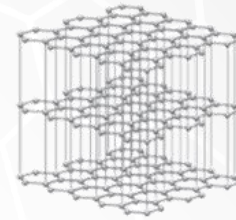
WHAT IS GRAPHENE?

Graphene is the name given to a single **layer of carbon atoms** organized in a honeycomb structure.

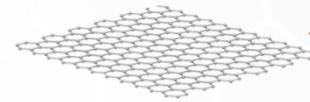
- ❖ Discovered in 1947 by P.R. Wallace
- ❖ Isolated in 2004 by Geim and Novoselov
(Nobel Price in Physics 2010)



GRAPHITE



GNPs



MONOLAYER

GRAPHENE

G+® production process

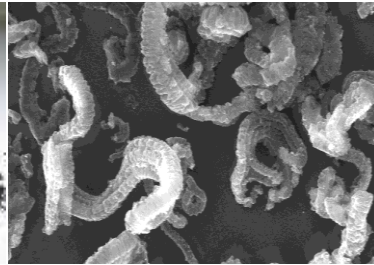
NATURAL
GRAPHITE



FRAGMENTED
GRAPHITE



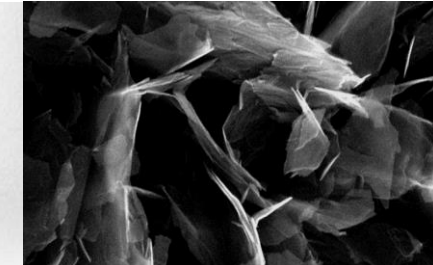
PLASMA
SUPER-EXPANSION



EXFOLIATION AND
CONCENTRATION



PRISTINE GRAPHENE
NANOPLATELETS



G+® products are **Pristine Graphene Nanoplatelets**, obtained through a proprietary and **patented process** based on the physical transformation of natural graphite.





AIR FILTRATION



WORKWEAR
& MILITARY



LUXURY



SPORTSWEAR



SEATS



Certifications and analysis for G+® textile applications

- **Toxicology screening** on G+® textile products – in vivo tests **(7)**
- **ZDHC** and **MRSL** for G+® finishing (GRAFYTEX SPg and GRAFYPAD G+®) **(2)**
- **Absence of nanoparticles release** from G+® printed and dyed fabric, and from Surgical Grey Filter during **abrasion test (3)**
- **Absence of nanoparticles release** from G+® printed fabric and dyed G+® cotton in biological fluids (**sweating test**) **(2)**
- **ECOPASSPORT** by OEKO-TEX Certification of G+® finishing (GRAFYTEX SPg and GRAFYPAD G+®) **(2)**

G+® printed fabrics and G+® membranes are:

- DERMATOLOGICALLY TESTED, after 48 hours of applications
- HYPOALLERGENIC, after three weeks of applications on volunteers with sensitive skin



G+® in textile

G+® Graphene Plus can be incorporated into fabrics through four different technologies.

G+® PLANAR THERMAL CIRCUIT®: a **functional print** that can be applied to any type of fabrics, obtaining a circuit.

The main properties are:

- **Heat dissipation** and **equalization** in a t-shirt
- **Heat retention** and **equalization** in a jacket



G+® MEMBRANES: G+® is incorporated into the polyurethane membrane that can be laminated self-standing or combined with a PTFE membrane directly to a fabric.

The main property is:

- **Heat retention** avoiding the formation of hot spots



G+® DYEING: The fabric is immersed in a water-based bath containing G+®. It provides a completely antimicrobial fabric.

The main properties are:

- **Heat homogenization** and **equalization**, therefore thermal comfort
- **No odor**



G+® COATINGS: Directa Plus has developed a special coating process, based on water, able to obtain high-performance PU, enhanced with G+®.

The main properties are:

- **Antistatic** - **Antimicrobial** - **UV fastness** - **Abrasion resistance**



G+® textiles find application in:

SPORTSWEAR, WORKWEAR, FASHION, FOOTWEAR, AUTOMOTIVE

G+® Planar Thermal Circuit®

Active interaction between the **body** and the **fabric**



The G+® Planar Thermal Circuit® captures body heat thanks to IR adsorption and transports it along the circuit, from the hottest to the coldest points of the body, thanks to the thermal conductivity.

Main effects:

- **Heat dissipation** and **equalization** with breathable and light fabrics (t-shirt).
- **Heat retention** and **equalization** with insulating fabrics (jacket)

Applications -> next to skin / towards the body

- Sportswear, casual, fashion clothing
- Technical textiles
- Automotive



thermal
comfort



antistatic



antibacterial



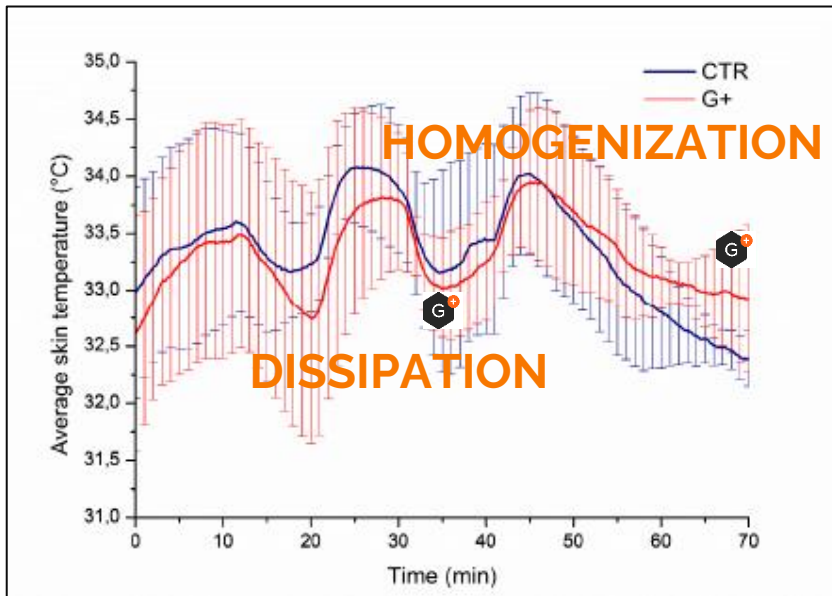
antiviral



In-vivo test in a climatic chamber of a G+® t-shirt

Comparing a G+® t-shirt and a standard one with the same climatic conditions and tester activity, it comes out that

Graphene Plus is able to provide **HEAT DISSIPATION** and **HOMOGENIZATION**

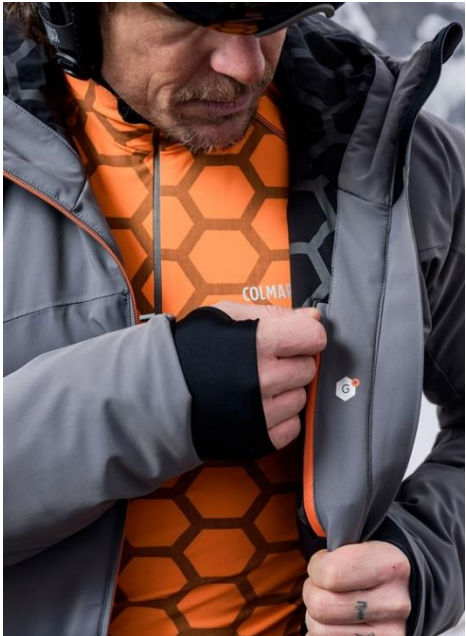
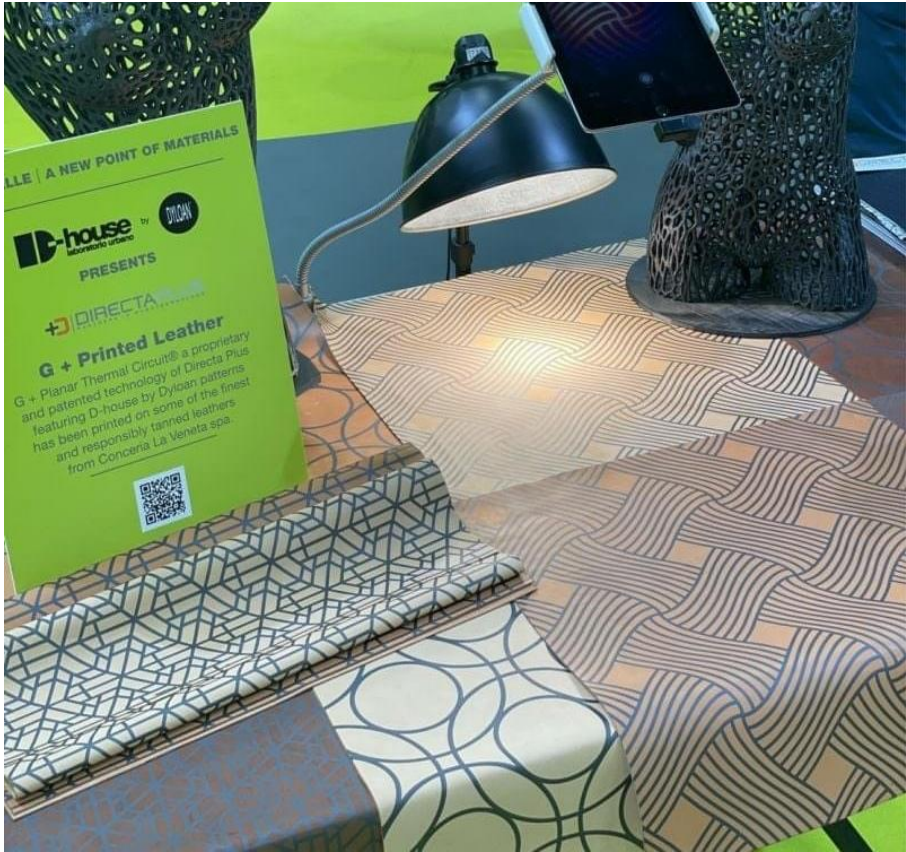


The **skin temperature** of the tester wearing the G+® t-shirt is **lower** during all the exercise phases of the test. In the recovery phase, the G+® Planar Thermal Circuit® stabilizes the skin temperature avoiding a fast decrease of the temperature (**post-exercise chill-out**).



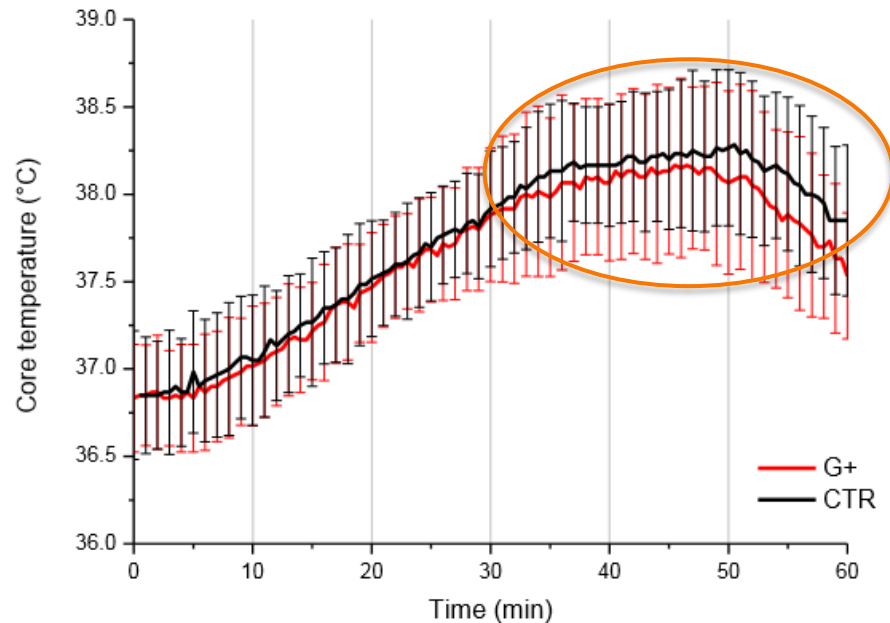
The test is performed during physical activity on treadmills, in a climatic chamber at a controlled temperature (32 C°) and relative humidity (70%).
Source: Tessile & Salute and Politecnico di Torino

G+® printing references (1/2)



In-vivo test in a climatic chamber of a G+® cycling suit

The G+® cycling suit is able to **reduce the core temperature** of the athlete helping him to preserve more energy for the race.



G+® technology has effect not only on the skin temperature, but on the **CORE temperature** of the athlete.

Not only perception, but also functionality



The core temperature of the testers was measured by means of a swallowable pill. The core temperature data was acquired every 30 seconds and transmitted to the data logger via a radio frequency system.

The following warm and humid condition was chosen to stress the athlete's thermoregulation system: air temperature 32°C and air relative humidity 70%. Wind speed was variable during the test to simulate uphill and downhill conditions.

G+® printing references (2/2)



Tokyo 2020 Olympics - Cycling
Road - Women's Road Race



Competition suit with G+®
for Jan Frodeno, world
champion at Ironman
Hawaii 2019



The main property translates into a unique thermal comfort, while ensuring excellent heat retention and the creation of an indoor microclimate that avoids the formation of hot spots.

The main properties are:

- IR adsorption
- Thermal conductivity
- Antistatic
- Antibacterial
- Waterproof and windproof
- Breathability

translated into:

- **Heat retention** and **equalization**, avoiding hot- spots

Applications

- Technical, casual, fashion clothing
- Footwear
- Technical textiles
- Automotive



thermal
comfort



antistatic



antibacterial



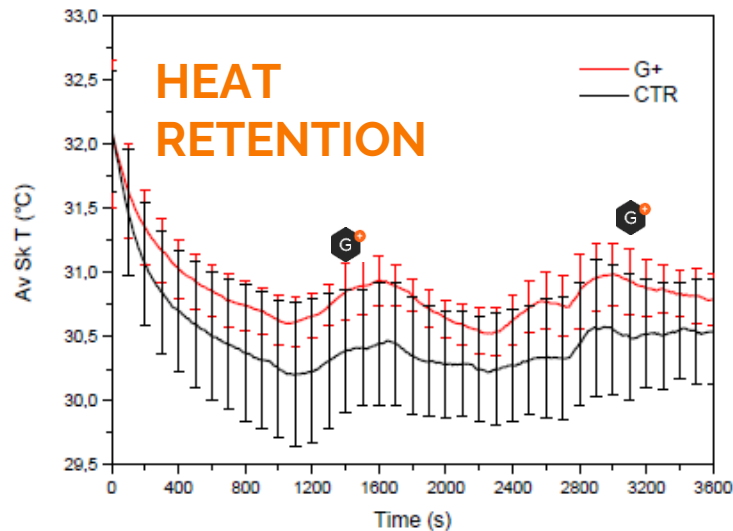
waterproof &
windproof



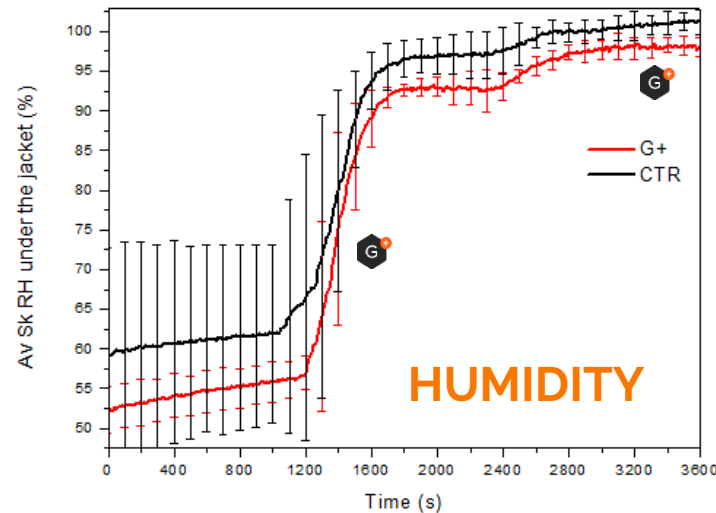
In-vivo test in a climatic chamber of a G+® softshell

Comparing a G+® softshell and a standard one with the same climatic conditions and tester activity, it comes out that

Graphene Plus is able to provide **HEAT RETENTION** and **HOMOGENIZATION**, even though maintaining the relative humidity lower.



The temperature under the skin is **2° higher** with G+® during all the test phases.

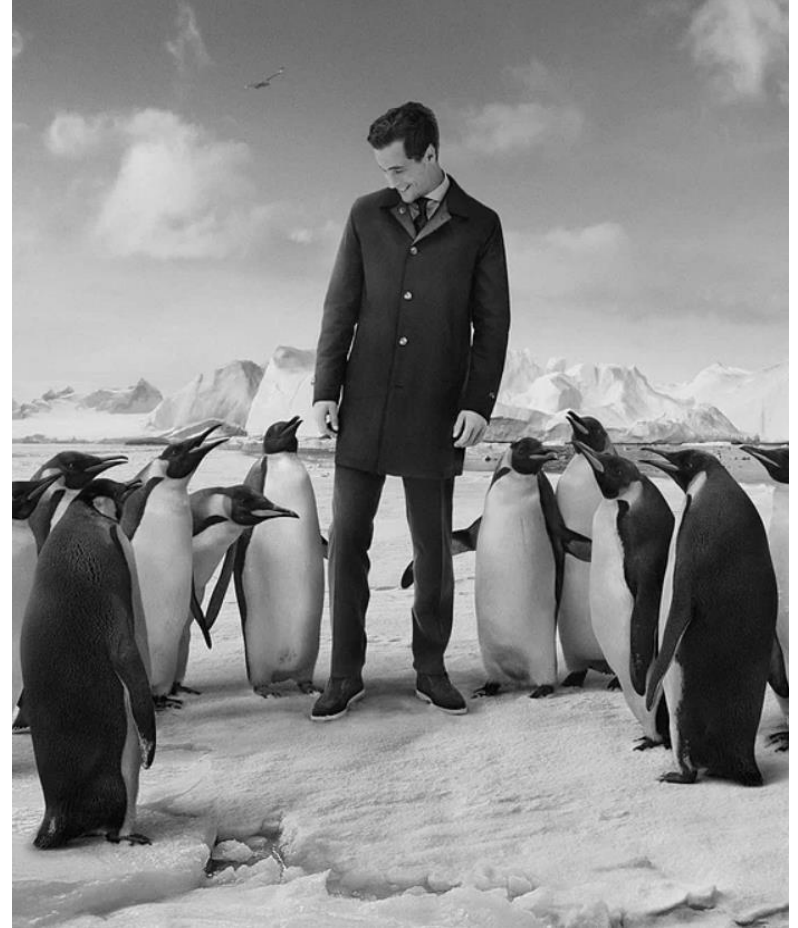


Although the skin temperature is higher, the relative humidity under the jacket is lower with G+® during all the test phases.

The test is performed during physical activity on treadmills, in a climatic chamber at a controlled temperature (14 C°) and relative humidity (50%). Source: Tessile & Salute and Politecnico di Torino



Loro Piana Reference



First shoes with G+® membrane

G+® Graphene Plus membrane integrated into Norda trail running shoes, able to confer thermal comfort, lightness and antimicrobial effects.

TECHUNTER  WE EXPLORE
PERFORMANCE APPAREL



[Graphene is like the Holy Grail of the industry – so eager is everyone to use it in their products. However, not all manufacturers have come to increase the efficiency of their products, despite the high cost of using graphene. How did you come to the G+® in the winter 001? Did the use of the graphene membrane impose any limitations?]

Our G+® graphene membrane featured in the winter version of the norda™ 001 was among the first technologies we considered along with Dyneema®. We wanted a membrane that would act on the whole foot, not by trapping the heat inside but by distributing it evenly during the active phase. The advantage of using the G+® graphene membrane is adding waterproofness up to 10,000mm & breathability but not adding bulk to the shoe or changing the fit and sizing.





Thanks to the collaboration with an important player in the sector, Directa Plus is able to offer viscose, cotton or denim fabric, dyed with G+[®].

The main properties are:

- Thermal conductivity
- Antimicrobial properties (antibacteric and antiviral)
- Antistatic properties

translated into:

- **Heat homogenization and equalization**, therefore thermal comfort
- **No-odor**
- Surface electrostatic charges dissipation, for a constant sense of well-being



thermal
comfort



antistatic



antibacterial



antiviral



Applications

- Linings for technical, casual and fashion clothing
- Home textiles
- Medical

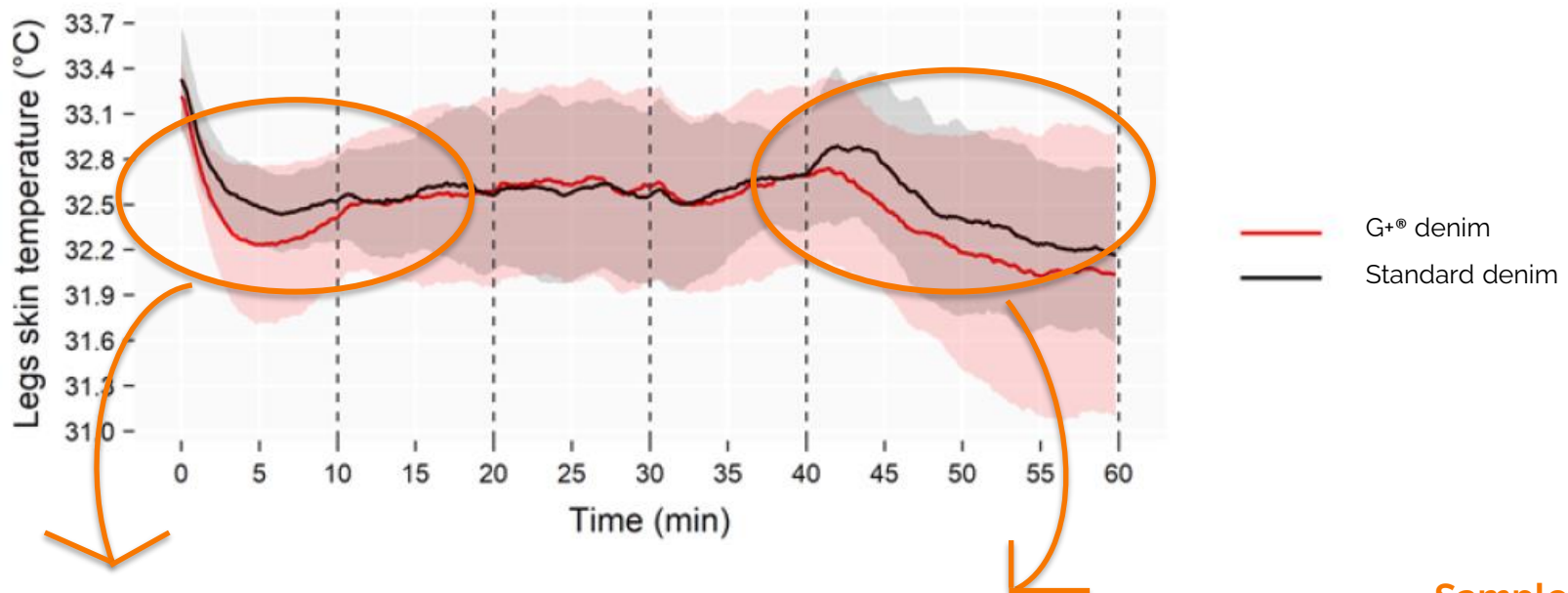


G+® dyeing references



In-vivo test in a climatic chamber of a G+® dyed denim

Average skin temperature under the trousers of the testers and 95% confidence interval for the five testers



HIGHER THERMAL COMFORT WITH G+®

The **skin temperature** of the area under the trousers is **lower with G+®** denim during the first and last phases of the test.

Sample 1



100% cotton G+® dyed denim



Directa Plus has developed a water-based special coating process to obtain high-performance PU, enhanced with G+® Graphene Plus.

The main features are:

- Antibacterial
- Antiviral
- Antistatic
- UV fastness

Applications -> External

- Furnishing, accessories
- Automotive
- Clothing (details)



high abrasion
resistance



antistatic



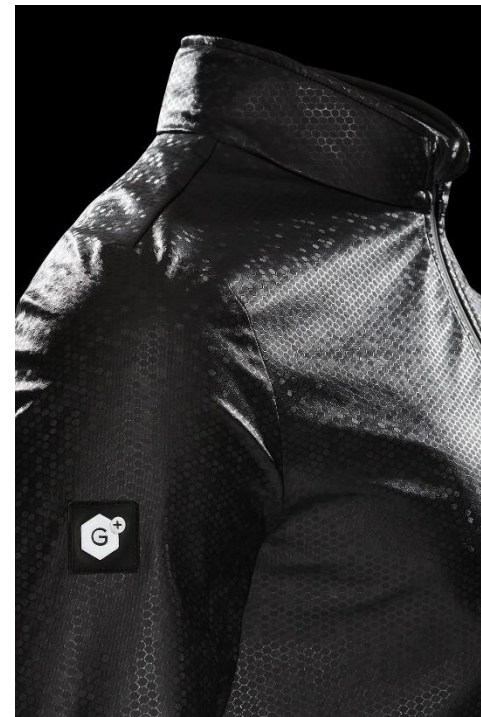
antibacterial



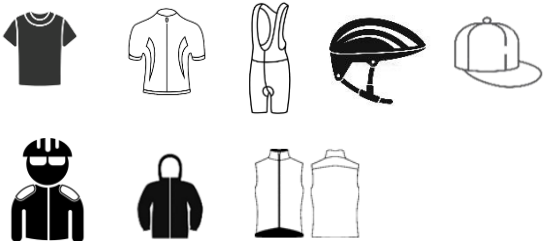



antiviral



G+® Coatings references



G+® technologies: applications

G+® TECHNOLOGY	PROPERTY	ITEM
G+® PRINTING	HEAT EQUALIZATION HEAT DISSIPATION (open system as a t-shirt) HEAT RETENTION (closed system as a jaket) ANTISTATIC ANTIBACTERIAL AND ANTIVIRAL	
G+® MEMBRANES	HEAT EQUALIZATION HEAT RETENTION ANTISTATIC ELECTRIC HEATING ANTIBACTERIAL	
G+® DYEING	HEAT EQUALIZATION HEAT RETENTION ANTISTATIC ANTIBACTERIAL AND ANTIVIRAL	 • LINING VISCOSE / COTTON
G+® COATING	ABRASION RESISTANCE ANTISTATIC ANTIBACTERIAL AND ANTIVIRAL UV FASTNESS	

Contacts

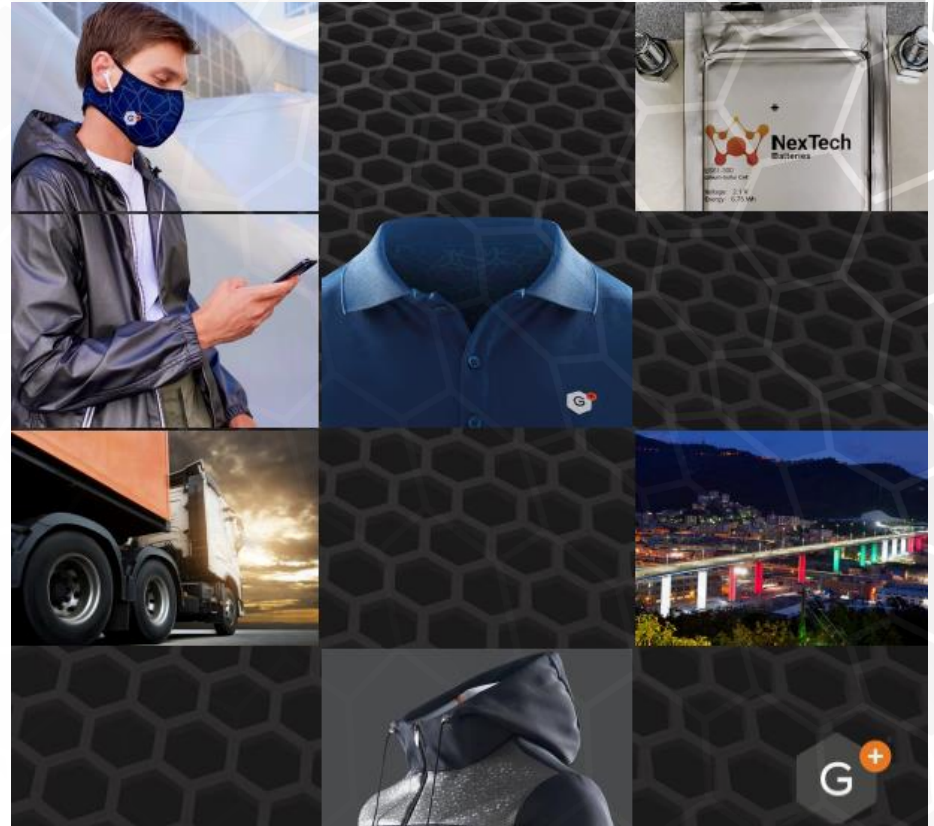
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