Sustainable Textile Technology for High-Performance Water-Repellency

Stay Dry – Ecologically
Introduction

HeiQ is a Swiss specialty textile effects company with 30 employees, 15 nationalities, in 7 countries on 4 continents.

HeiQ was founded in 2005 as Spin-off of the Swiss Federal Institute of Technology (ETH).

HeiQ offers innovation R&D, customized manufacturing and ingredient branding in one.

HeiQ promotes the product families:

- **ADAPTIVE**
  - Dynamic Cooling

- **PURE**
  - Naturally Fresh

- **BARRIER**
  - Water-Repellent

- **GLIDER**
  - Move Free
HeiQ’s Global Presence

Serving you around the clock!
HeiQ Entrepreneurial Spirit

2013  Finalist Swiss of the Year
2011  European Environmental Press Award
2010  Swiss Technology Award
2010  Swiss Equity Fair Winner
2009  Finalist E&Y Entrepreneur Of the Year
2008  KTI Technology Entrepreneur
2007  McKinsey / ETH Venture Prize
2007  Venture Leaders Award
2006  W.A. DeVigier Foundation Award
2006  IMD Startup Award
2005  Siska-Heuberger Prize
Repellency Revisited

- Durable Water Repellency (DWR) is an essential feature of outdoor apparel
- DWR apparel today faces many challenges:
  - Fluorine phase-out
  - NGO campaigns
  - Comfort limitations
- Time to revisit assumptions behind DWR
- Opportunity to gain market share with fresh approaches
Challenges

• Systematic elimination of fluorinated polymers, and telomer surfactants use in textiles. Concern over environmental and health impacts. Potential for bioaccumulation and mammalian toxicity from manufacturing by-products:
  • PFOA perfluorooctanoic acid
  • PFOS perfluorooctane sulfonate

• Regulatory actions have been rapid and strong:
  • US EPA: Phase out of PFOA and PFOS fluorinated substances by 2015
  • EU: PFOS banned since 2008, PFOA is a candidate for SVHC (REACH)

• NGO campaigns: Overwhelming pressure for brands to specify fluorine-free treatments.

• C8 based fluorinated chemistry is already being supplanted in the market

• Alternatives?
  • C6 fluorinated products – less effective, more expensive, still fluorine
  • Fluorine-free products – limited range of alternatives and open for innovation...
DWR conventions

Shell layer

Mid layer

Base layer

Skin
DWR conventions

Shell layer

Mid layer

Base layer

Skin
DWR conventions

- **Woven Fabric**
  - PA/PES/Lycra with C8 or C6 fluorochemical treatment
  - Fluorine PTFE
  - PU
  - PET

- **Membrane or Coating**
  - PA
  - PES

- **Charmeuse/scrim**
  - or Solvent-based PU coating
DWR conventions

Water repellency
- Spray test (AATCC 22)
- Bundesman (ISO 9865)

Hydrostatic water pressure test
- Water column test (e.g., ISO 811)

Water vapor permeability
- Vapor transmission (e.g., ASTM E 96)

Woven Fabric

Membrane or Coating

Charmeuse/scrim

Windproof

Water repellency

Hydrostatic water pressure

Water (Sweat) vapor
DWR conventions

- **Windproof**
- **Water repellency**
- **Hydrostatic pressure**

Woven Fabric

Membrane or Coating

Charmeuse/scrim

Water vapor
DWR – Hydrostatic Pressure

- Pressure rating in mmH$_2$O (‘water column’)

- Natural pressure from falling raindrops:
  - Up to 5000 mmH$_2$O

- Typical membrane specs:
  - 10000 through 40000 mmH$_2$O

High specification of hydrostatic pressure can hinder breathability
DWR conventions

windproof

Water repellency

Hydrostatic pressure

Woven Fabric

Membrane or Coating

Charmeuse/s scrim

Water vapor
DWR – Breathability

• Human sweat rates
  ▪ Up to 1L/h with intense activity
  ▪ Up to ca. 12000 g/m²/24hrs

• Typical spec range:
  ▪ 3000 – 9000 g/m²/24hrs
  ▪ Desiccant methods

Balance between membrane composition, thickness and porosity required to achieve desired hydrostatic and breathability properties
DWR conventions

- Windproof
- Water repellency
- Hydrostatic pressure

Woven Fabric

Membrane or Coating

Charmeuse/scrim

Water vapor
Repellency Test Methods: Spray Test

250ml of water is uniformly sprayed on a fabric specimen mounted at an angle of 45°

The Spray rating is determined by comparing fabric appearance with descriptive and photographic standards

Very Good performance if 100/100 after 20 Home Laundries

ISO (AATCC) 5 (100)  4 (90)  3 (80)  2 (70)  1 (50)

ISO 4920/AATCC 22 method: Spray test equipment configuration
DWR – Water repellency

- Padding treatment of woven top-layer

- Chemistry choices:

<table>
<thead>
<tr>
<th>Fluorine</th>
<th>Fluorine-Free</th>
</tr>
</thead>
<tbody>
<tr>
<td>C8</td>
<td>Paraffin</td>
</tr>
<tr>
<td>C6</td>
<td>Silicone</td>
</tr>
<tr>
<td>C4</td>
<td>PU (Barrier ECO)</td>
</tr>
</tbody>
</table>
Fluorine polymers up close

C8

C6

C4

Fluorinated chain
Spacer group (hydrophilic)
Backbone
Fluorine polymers up close

C8

C6

C4

Fluorinated chain
Spacer group (hydrophilic)
Backbone
Fluorine polymers up close

Typical for C4 is a saturation of the backbone with water after a short time. Strong Laundry Air Dry (LAD) effect.
Testing F-free treatments

• Home laundry cycles are a key part of assessing performance...

• Caution! -- Detergent components may interact with fluorine free films
  ▪ Hydrophilic residues may be retained on surface

• Detergent interaction is not relevant for conventional fluorinated treatments

• Consequences for testing fluorine vs F-free:
  ▪ Choice of washing settings (quantity and type of detergent)
  ▪ Role of post wash rinsing to remove detergents
  ▪ Care recommendations (reduced detergent use during care phase)
What is really needed?

What functions do people want from repellency garments?

- **Dry**: Stay dry in the rain (DWR)
- **Breathability**: Do not get wet from own perspiration and condensation
- **Fit**: Flexible, light to wear
- **ECO**: Low footprint chemistry
What functions do people want from repellency garments?

- **Dry**: Stay dry in the rain (DWR)
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- **Fit**: Flexible, light to wear
- **ECO**: Low footprint chemistry
The original
Fluorine free...
How does a duck stay dry without fluorine?

“It’s like water off a duck’s back…”

Ducks stay dry – even during rain. Feathers are naturally extremely water-repellent

Their secret lies in a fatty secretion and in numerous linked 3D micro feather strands possessing a very small contact surface

How can garments stay durably dry without fluorine?

HeiQ Barrier Eco – a hydrophobic textile effect providing durable water-repellent performance with the help of special 3D hyper-branched polymers
Bio-Inspiration – Water-Repellency with Hyper-Branchery

HeiQ Barrier Eco imitates the efficiency of a duck’s feathery coat – water repellency completely free of fluorocarbon

Its technology mechanism lies in 3-dimensional hyper-branched polyurethane polymers – comparable to multi-branched corals:
HeiQ innovation

• New fluorine-free treatments

• DWR treatments mostly emphasize chemistry. However, effective repellency is best achieved through chemistry + structure...

<table>
<thead>
<tr>
<th>Fluorine-Free</th>
<th>Chemical repellency</th>
<th>Structure repellency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paraffin</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>Silicone</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>PU (Barrier ECO)</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
Fluorine-Free by HeiQ: Barrier ECO

Hydrophobic, hyper-branched polyurethane polymers with a large number of functional branches

Self-assembling polymer technology with rapid crystallization

Maximum anchorage to textile fibers thanks to the formation of a durable polyurethane backbone polymer film

Building a 3D surface structure to provide enhanced water repellency
Product Description – HeiQ Barrier ECO

HeiQ Barrier ECO is a topical textile treatment typically applied by padding (30-80 g/l)

Suitable for all types of textile fibers

HeiQ Barrier ECO provides garments with durable water-repellent properties while maintaining important textile parameters such as color-fastness, pilling and snagging properties
## Repellency Effects Compared

<table>
<thead>
<tr>
<th></th>
<th>Ecological Water Repellent</th>
<th>High-performance Oil &amp; Water Repellent</th>
<th>Ecological Oil &amp; Water Repellent</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Basis</strong></td>
<td>HeiQ Barrier ECO</td>
<td>C8-fluorocarbons</td>
<td>C6-fluorocarbons</td>
</tr>
<tr>
<td>Basis</td>
<td>Hydrocarbon polymer (hyper-branch structure)</td>
<td>Fluorocarbon polymer (C8 components)</td>
<td>Fluorocarbon polymer (C6 components)</td>
</tr>
<tr>
<td><strong>Contains Fluorine</strong></td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>PFOA residues</strong></td>
<td>No</td>
<td>Traces (&lt; 40ppb)</td>
<td>No</td>
</tr>
<tr>
<td>Water repellency (spray)</td>
<td>++</td>
<td>+++</td>
<td>++</td>
</tr>
<tr>
<td>Water repellency (rain)</td>
<td>++</td>
<td>+++</td>
<td>++</td>
</tr>
<tr>
<td>Oil repellency</td>
<td>*</td>
<td>+++</td>
<td>++</td>
</tr>
<tr>
<td>Durability (laundry)</td>
<td>++</td>
<td>+++</td>
<td>++</td>
</tr>
<tr>
<td>Durability (abrasion)</td>
<td>+++</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>Handle impact</td>
<td>Low</td>
<td>Medium/High</td>
<td>Medium</td>
</tr>
</tbody>
</table>

* Oil repellency is only possible with fluorine-based products.
Ecological Footprint

• No fluorine: no PFOS, no PFOA
• No formaldehyde
• No waste water burden
• No organic halogen compounds
• No water toxicity
• No oral toxicity
• No AOX value

HeiQ Barrier ECO
Fluoro-free & performance
Working with HeiQ Barrier ECO

- Durable water repellent treatment – highest wash durability with complementary binder system
- Strong abrasion resistance
- Perceptible soft handle
- No compromise on breathability due to paraffin free technology
- Good laundry-air-dry (LAD) behavior
- Complies to EU REACH
- bluesign approved
- Oekotex conform
Consumers Buy Innovation Stories – HeiQ Creates Them Together With You

Boost your Communication!
HeiQ’s Marketing Support

With our Marketing Support our goal is to:

• Help you to sell more

• Help you to sell at a higher margin

• Help you to differentiate from your competitors
Video Hangtag – Gateway to Consumer at POS

Your direct end-consumer-communication at POS

• Added value
• Information
• Identification
• Complementing sales staff

Capture consumer interest & win consumer trust

QR code links to Technology
Video and more information ➔ Online Experience

Scan QR code with one of the following Apps on your smartphone, e.g.:
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• DWR apparel today faces many challenges:
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  • NGO campaigns
  • Comfort limitations

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Repellency Revisited

HeiQ building fresh tools to help redefine DWR:
• 100% Fluorine-free
• Rain resistance & breathability
• Light weight & comfort
Thank You For Your Interest

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HeiQ Materials AG - Develops and manufactures high-performance textile effects. End-to-end offering including innovative product development, analytics and validation, custom manufacturing, sales, marketing and regulatory affairs support.