# MIDWOR-LIFE

## Mitigation of environmental impact caused by DWOR textile finishing chemicals studying their non-toxic alternatives

**Coordinator:**

**Partners:**

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## Mitigation of environmental impact caused by DWOR textile finishing chemicals studying their non-toxic alternatives

# A review of the work done in Actions A1, A2 and B1


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**R&D – Advanced Materials**

**Surface Technologies – Dyeing and Finihing**

LEITAT managing your technologies | Technological Center member of TECNIO



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## OBJECTIVE

The main objective of the MIDWOR-LIFE is **to mitigate the environmental, health and safety impacts of current** Durable Water and Oil Repellents **(DWOR)** and their alternatives **by analysing** their **environmental impact** and **technical performance** in order to assess manufacturers on the best available technologies to provide liquid repellency on textiles.

**Policy recommendations will be set in order to promote the widespread implementation of the less toxic and most effective DWOR alternatives** to fulfill REACH Regulation.

- Evaluate the environmental impact of current DWORs and their available alternatives.
- Evaluate the risks posed by current DWORs and their alternatives for human and environmental health.
- Evaluate the technical performance of DWORs alternatives and compare them to current DWORs.
- Elaborate a road map and policy recommendations.

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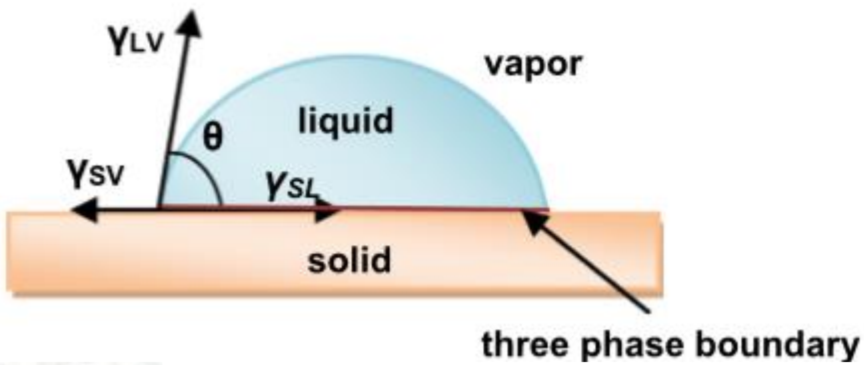
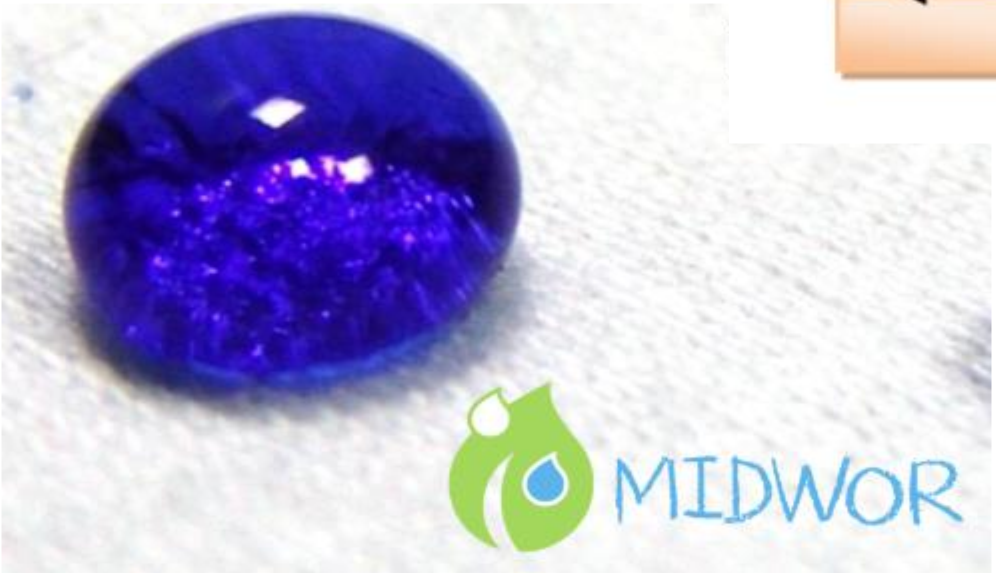
## THEORY

**CONTACT ANGLE →** When a **droplet rests on a surface**, there is a **contact angle measured** at the edge of the droplet, and it can be **defined as the tangent angle of the liquid-vapor interface at the three phase boundary.**

*E. Celia et al./Journal*





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# THEORY OF HYDROPHOBIC SURFACES. LOTUS EFFECT

## THEORY

**WETTING →** Wetting is the ability of a liquid to maintain contact with a solid surface, resulting from intermolecular interactions when the two are brought together. The wetting property of a material is determined by two intrinsic properties.

- Micro/Nano structure (roughness of the surface)
- Surface energy

Y.Y. Yan et al. / Advances in Colloid and Interface Science 169 (2011) 80–105

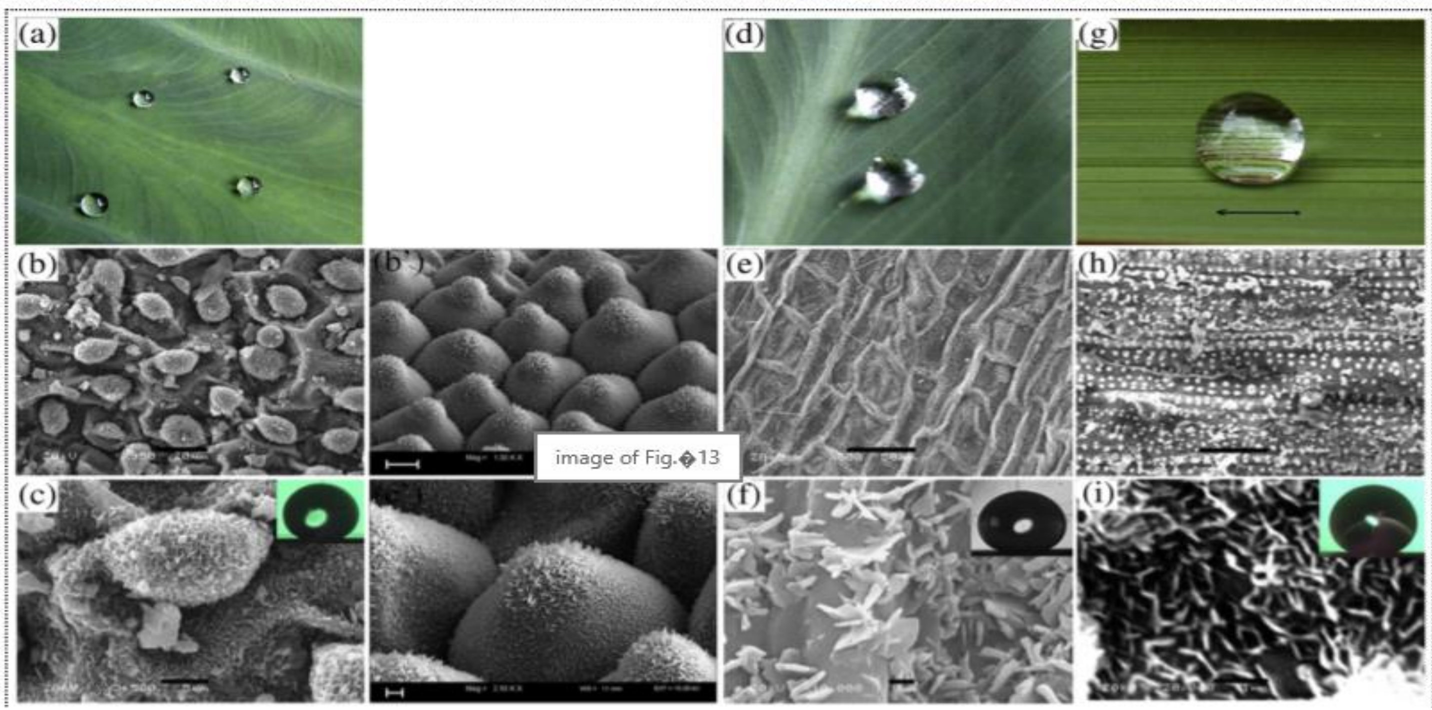


Image of superhydrophobic surfaces (>140°). Different plant leaves

## LOTUS LEAF EFFECT

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## THEORY OF OIL REPELLENT SURFACE

## Surface free energy vs. Surface Tension: The target

In order **to develop materials capable to show repellency** to some liquid, we have to **consider the surface free energy** of that material, **and the surface tension** of the liquid we want to repel.

To achieve repellency, the surface free energy of the substrate should be lower than the surface tension of the liquid.

Hydrophobicity: water has a high surface tension **(72 mN/m).** Therefore, surface free energy of the surface must be lower than **24-36 mN/m** for the fabrication of hydrophobic surface.

Oleophobicity: Surface tension of oils are usually between **20-30 mN/m**. So, the surface free energy of the substrate should be **lower than 20 mN/m**

**FLOUROCARBONS (OR PERFLUORINATED CHEMICALS) SHOW LOW SURFACE ENERGIES. BELOW 20 mN/m AND THIS IS THE REASON WHY THEY ARE USED TO DEVELOP DURABLE WATER AND OIL REPELLENT SURFACES (DWOR)**

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Main **environmental concern** raised by these DWORs is that its **fluorinated chains** may be **severed from the polymeric backbone,** releasing perfluoroalkyl substances (PFAs).

These substances will **degrade to form highly persistent perfluoroalkyl acids (PFAAs) which are also bioacumulative.**

Public Health England

# PFOS and PFOA

# Toxicological Overview

**Key Points**

***Kinetics and metabolism***

- PFOS and PFOA are readily absorbed following ingestion
- Following absorption PFOS and PFOA are mainly distributed to the serum and liver
- Both are only very slowly eliminated from the body in humans

***Health effects of acute exposure***

- There are insufficient data available on acute toxicity in humans to draw conclusions
- Dermal or ocular exposure to PFOS or PFOA may cause irritation
- Animal studies suggest both PFOS and PFOA are moderately toxic following ingestion, causing effects on the liver and gastrointestinal tract

***Health effects of chronic exposure***

- Toxic effects following repeated oral exposure includes effects on the liver, gastrointestinal and thyroid hormone effects
- Hepatotoxicity is the main effect reported in animals exposed to PFOS or PFOA via ingestion
- A small number of occupational studies have reported an association between exposure to PFOS or PFOA and several forms of cancer.
- Animals studies suggest that both PFOS and PFOA may be carcinogenic at relatively high dose levels

  Animal studies indicate no marked effects on reproductive function nor development at levels below those producing maternal toxicity

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# MIDWOR-LIFE

## Mitigation of environmental impact caused by DWOR textile finishing chemicals studying their non-toxic alternatives

### ACTION A

# PREPARATORY ACTIONS

### Presented by:

AGRUPACIÓ D'EMPRESES INNOVADORES

LEITAT Technological Center — managing your technologies — member of TECNIO

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# MIDWOR-LIFE

## Mitigation of environmental impact caused by DWOR textile finishing chemicals studying their non-toxic alternatives

### PREPARATORY ACTIONS

A1. Selection of most representative textile materials and finishing technologies

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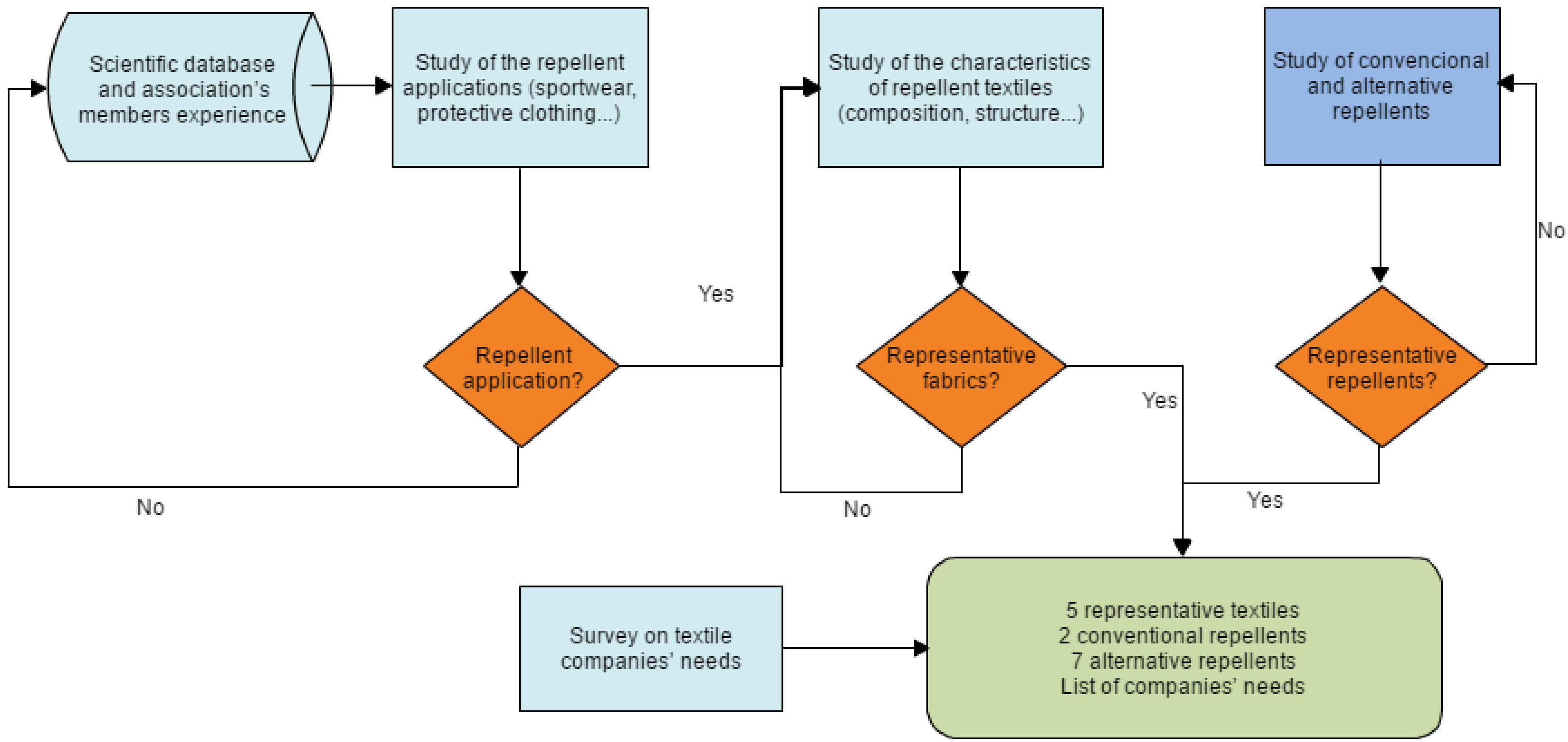
# A1. Selection of most representative textile materials and finishing technologies

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## OBJECTIVE

To identify and select the different textile materials and finishing technologies and products which will be employed in the project. This action is divided in three tasks which are the textile material selection and the finishing technologies selection..

## TASKS

*Task A.1.1 Selection of textile materials*

Study of the repellent products available on the market will be done determining their composition, weave structure and weight. In total, 5 fabrics' type will be selected.

**Leader:** AEI TÈXTILS
**Participants:** CLUTEX, CS-POINTEX, LEITAT

**Start:** 1/09/2015 **End:** 31/03/2016

**Expected results:** 5 textile fabrics of different composition, structure and weight selected.

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## TASKS

*A1.2 Selection of finishing technologies*

2 conventional finishing will be selected through a study of repellent finishing products available on the market .

7 alternative finishing products will be selected for their further technical, toxicological and eco-toxicological comparison with conventional products.

**Leader:** AEI TÈXTILS
**Participants:** CLUTEX, CS-POINTEX, LEITAT

**Start:** 1/09/2015 **End:** 31/03/2016

**Expected results:** 2 conventional long chain fluorocarbon based repellent DWOR selected
7 alternative repellent products identified and selected

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## TASKS

*A1.3 Survey on textile companies*

Survey of the needs of textile companies. Each cluster will develop the survey within their members.

Main information to be collected will be related to the use of DWOR products and their experience with different finishing processes.

**Leader:** AEI TÈXTILS
**Participants:** CLUTEX, CS-POINTEX

**Start:** 1/09/2015 **End:** 31/03/2016

**Expected results:** List of companies' needs as a result of a survey to at least 60 companies

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## DONE (from month 1 to month 12)

1. Research on DWORs producers
2. Meetings/phone calls with DWORs producers.
3. Meetings/phone calls with finishers
4. Bibliographic research on repellent finishing's: papers, patents, etc.
5. Preparation of a questionnaire for companies (finishers, fabrics providers and DWORs producers:
6. Translation of the questionnaire: Spanish, Italian, Czech.
7. Creation of a database of finishers and DWORs producers in Spain, Italy and Czech Republic
8. Disseminate the questionnaire amongst finishers, fabrics providers and DWORs producers
9. Start the selection of current DWORs and alternatives
10. Report on the survey study results on textile companies
11. Submit Deliverable A1.1 and A1.2

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## Most representative finishing technologies

| Num | Technology | Chemistry | Comments |
|---|---|---|---|
| **1** | CONVENTIONAL | Long Chain Fluorocarbon (c8) | - |
| **2** | CONVENTIONAL | Long Chain Fluorocarbon (c8) | - |
| **3** | ALTERNATIVE | Short Chain Fluorocarbon (c6) | PFOA-free |
| **4** | ALTERNATIVE | Short Chain Fluorocarbon (c6) | PFOA-free. Nano-dispesion of fluoropolymer |
| **5** | ALTERNATIVE | Short Chain Fluorocarbon (c6) | PFOA-free dendrimer and 3D hyperbranched polymer |
| **6** | ALTERNATIVE | Short Chain Fluorocarbon (c6) | PFOA-free |
| **7A** | ALTERNATIVE | SOL-GEL | SOL GEL without fluorine. PFOA-free |
| **7B** | ALTERNATIVE | Short Chain Fluorocarbon (c6) | PFOA-free |
| **8** | ALTERNATIVE | Hybrid fluor silicone | Structured coating: C6 + silicone |
| **9** | ALTERNATIVE | Silicone | Completely Fluor-free |

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## Most representative sectors. And selection of fabrics.

| *FABRIC SELECTION BY TEXTILE REPRESENTATIVE SECTOR* | | | |
|---|---|---|---|
| **Number** | **weight** | **composition** | **Sector** |
| **1** | 230 g/m$^2$ | 100% PES | Automotive |
| **2** | 220 g/m$^2$ | 90% PA/10%El | Sport (cycling) |
| **3** | 195 g/m$^2$ | 100% PES | Sport (mountain) |
| **4** | 180g/m$^2$ | 100% WO | Fashion (suit) |
| **5** | 175g/m$^2$ | 100% CO | Fashion (shirt) |
| **6** | 170g/ m$^2$ | 65%PES/35%CO | Fashion (trouser) |
| **7** | 250 g/m$^2$ | 49%PP / 47%PES / 4%CO | Home (sofa) |
| **8** | 175g/m$^2$ | 100% PES | Workwear (polo) |
| **9** | 250 g/m$^2$ | 80COP / 18%PES / 2%antistatic | Workwear (trouser) |

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# MIDWOR-LIFE

## Mitigation of environmental impact caused by DWOR textile finishing chemicals studying their non-toxic alternatives

**PREPARATORY ACTIONS**

A2. Pre-screening of functionality and environmental impact of DWOR

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# A2. Pre-screening of functionality and environmental impact of DWOR

## OBJECTIVE

To do a pre-screening of the technical performance and environmental impact of the selected DWOR repellents and their alternatives. LEITAT is the leader of this action.

## TASKS

*A2.1 Technical pre-screening of the repellent products*

Study of the technical performance of DWOR selected on previous action. State of the art on values of hydrophobicity and oleophobicity (Spray Test, Drop test, oil test…). Search on TDS available, manufacturers contacts, information of finishers from clusters…

**Leader:** LEITAT
**Participants:**

**Start:** 01/03/2016
**End:** 30/06/2016

**Expected results:** State of the art of hydrophobicity and oleophobicity values of 2 conventional and 7 alternatives of DWOR identified.

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## TASKS

### *A2.1 Technical pre-screening of the repellent products*

| Num | Technology | Company | Brand | Chemistry | Comments |
|---|---|---|---|---|---|
| **1** | CONVENTIONAL | RUDOLF | RUCOGUARD AFB CONC | Long Chain Fluorocarbon (c8) | - |
| **2** | CONVENTIONAL | PULCRA | REPELLAN® EPF-A | Long Chain Fluorocarbon (c8) | - |
| **3** | ALTERNATIVE | HUNTSMAN | PHOBOL CP-U | Short Chain Fluorocarbon (c6) | PFOA-free |
| **4** | ALTERNATIVE | ARCHROMA | NUVA N1811 | Short Chain Fluorocarbon (c6) | PFOA-free. Nano-dispesion of fluoropolymer |
| **5** | ALTERNATIVE | RUDOLF | RUCOGUARD AFC6 | Short Chain Fluorocarbon (c6) | PFOA-free dendrimer and 3D hyperbranched polymer |
| **6** | ALTERNATIVE | PULCRA | REPELLAN XC-6 PLUS | Short Chain Fluorocarbon (c6) | PFOA-free |
| **7A** | ALTERNATIVE | NANO-X | X-TEX EC5028 | SOL-GEL | SOL GEL without fluorine. PFOA-free |
| **7B** | ALTERNATIVE | NANO-X | SILIXAN S570 – 10/w | Short Chain Fluorocarbon (c6) | PFOA-free |
| **8** | ALTERNATIVE | DAYKIN | UNIDYNE TG-5601 | Hybrid fluor silicone | Structured coating: C6 + silicone |
| **9** | ALTERNATIVE | PROTEX | DRYOL S 600 | Silicone | Completely Fluor-free |

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| Num | Brand | Application | Conditions | Oil repellency (AATCC) | | Water repellency (AATCC) | | Fabric substrates |
|---|---|---|---|---|---|---|---|---|
| | | | | *B* | *A* | *B* | *A* | |
| **1** | RUCOGUARD AFB CONC | Padding | 40 g/L *(with 50 g/L of Rucodry DHN)*<br>*Drying: 130ºC / 4 min*<br>*Polymerization: 160ºC /1.5 min* | - | - | 90 | 90 | All |
| | | Padding | 10 g/L *(with HDMS and Phosphate)*<br>*Drying: 100ºC / 10 min*<br>*Polymerization: 160ºC / 1 min* | 8 | 8 | 100 | 100 | |
| **2** | REPELLAN EPF-A | Spraying<br>Foaming<br>**Padding** | 20-30 g/L<br>*Drying: 120ºC*<br>*Polymerization: 170ºC / 1 min* | 8 | 8 | 100 | 100 | Cotton<br>PES |
| | | Coating | 30-60 g/L<br>*Drying: 120ºC*<br>*Polymerization: 150ºC / 3 min* | 8 | 8 | 100 | 100 | |
| **3** | PHOBOL CP-U | Padding | 30-80 g/L | 5 | >3 | 90 | >80 | All |
| **4** | NUVA N1811 | Padding | 30 g/L<br>*Polymerization: 165ºC / 1 min* | 6 | >4 | 100 | >80 | |
| **5** | RUCOGUARD AFC6 | Padding | 20-50 g/L | 5 | 2<br>*(3 wash.)* | 100 | 100<br>*(3 wash.)* | All |
| **6** | REPELLAN XC-6 PLUS<br>(data from ECO-100 brand) | Spraying<br>Foaming<br>Padding<br>Coating | 30-100 g/L<br>*Drying: 110ºC*<br>*Polymerization: 150ºC / 3 min* | OK | | 100 | 70<br>(5 wash.) | Cellulosic, polyester, polyamide, wool and aramide fibres |
| **7B** | SILIXAN<br>S570 – 10/w | Spraying<br>Padding<br>Coating | | | | | | |
| **8** | UNIDYNE<br>TG-5601 | Padding | 20-80 g/L<br>*Drying: 110ºC / 1-2 min*<br>*Polymerization: 170ºC / 1-3min* | 6 | | 100 | | Cotton |
| **9** | DRYOL<br>S 600 | Padding | 50-75 g/L<br>*Drying: 110ºC /2 min*<br>*Polymerization: 150ºC / 1.5 min* | No oleoproof effect | | 100 | 90<br>(5 wash.) | PES<br>Cotton |

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## TASKS

*A2.2 Environmental pre-screening of the repellent products*

Review of the environmental impact of the selected DWOR products from a theoretical perspective, using different bibliographic sources such:

- Chemical databases
- Specific information from manufacturers.
- LCA databases
- Scientific publications related finishing products for textile sector.

This environmental pre-screening will help to develop the LCA of the selected DWOR products( Action B3) and also will give an idea of the main restriction the alternative products and conventional DWOR are submitted to.

**Leader:** CETIM
**Participants:**

**Start:** 01/03/2016
**End:** 30/06/2016

**Expected results:** Public environmental data of the 2 conventional and 7 alternatives of DWOR identified.

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## State of the art of environmental data

Environmental pre-screening addressed in **4 groups**, based on its chemistry:

1. Conventional DWORs based on **long-chain fluorocarbon** (C8)
2. Alternative DWORs based on **short-chain fluorocarbon** (C6)
3. Alternative DWORs based in **SOL-GEL**
4. Alternative DWORs based in **Silicones**

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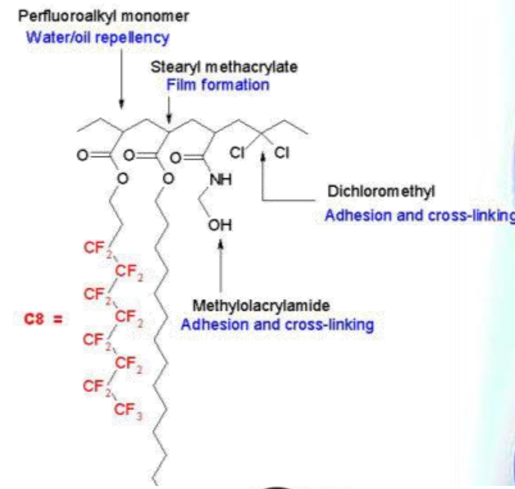
## Conventional DWORs based on long-chain fluorocarbon (C8) – (I)

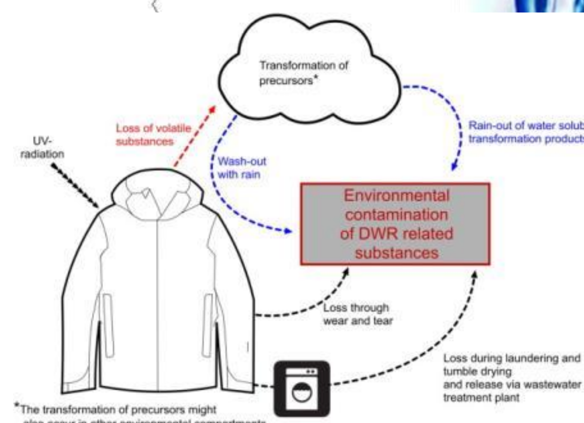
Main **environmental concern** raised by these DWORs is that its **fluorinated chains** may be **severed from the polymeric backbone,** releasing perfluoroalkyl substances (PFAs).

Later these substances will **degrade to form highly persistent perfluoroalkyl acids (PFAAs).**

**Three main sources** of PFAs emissions related with the **textile industry**:

- DWOR & perfluorocarbon (PFC) **manufacturing processes**: Two main process, Electrochemical fluorination and Telomerisation.
- **DWOR application** in textile process: Due to the applying process (bath immersion and drying).
- **Use & disposal** of textile products: Considered a diffuse source which might account up to 85% of total fluorochemical emissions (450-2.700 t of PFOS between 1970-2002).

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## Conventional DWORs based on long-chain fluorocarbon (C8) – (II)

Among the different perfluoroaklyl acids (PFAAs), two compounds are the most concerning and studied; Perfluorooctanoic acid (PFOA) and Perfluorooctane sulfonic acid (PFOS).

### Perfluoroalkyl Acids (PFAAs)

- Perfluoroalkyl carboxylic acids (PFCAs)
  - **Perfluorooctanoic acid (PFOA)**
  - Perfluorononanoic acid (PFNA)
  - Perfluorohexanoic acid (PHHxA)
- Perfluoroalkane sulfonic acids (PFSAs)
  - Sodium perfluorooctanoate (Na-PFOA)
  - Ammonium perfluorooctanoate (APFO)
  - Ammonium perfluorononanoate (APFN)
- Perfluoroalkyl carboxylates (PFCAs)
  - **Perfluorooctane sulfonic acid (PFOS)**
  - Perfluorohexane sulfonic acid (PFHxS)
  - Perfluorobutane sulfonic acid (PFBS)

PFOA: Listed as Substance of Very High Concern. Proposed for restriction and inclusion in Stockholm POPs list

PFOS: Listed in Annex B of Stockholm convention. Limit <1 µg/kg in textiles & coated materials

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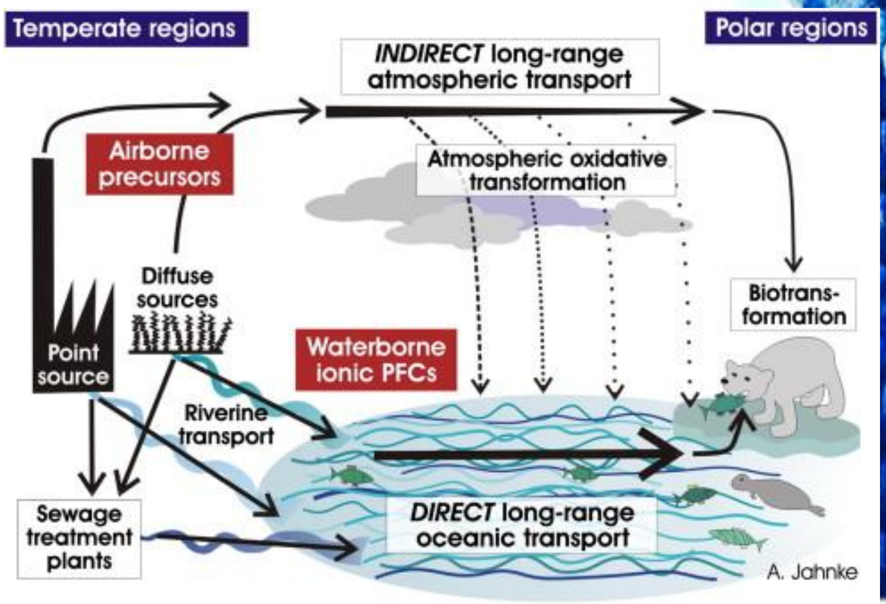
## Conventional DWORs based on long-chain fluorocarbon (C8) – (III)

Stability of **C-F bond** is responsible for the **long-range transportation** properties of perfluorocarbon substances (PFCs) and also of the **bioaccumulation** along the food chain.

- C8-PFCs are not degradable under aerobic or anaerobic conditions (WWTP), either by physical processes in the environment (i.e. photolysis).
- PFCs have been **detected in places far away from the emission sources** (such the Arctic region). Unlike other POPs, detected compounds are mostly **partially-degraded forms from comercial PFCs**.
- **Half-life degradation** in the range of **hundreds to thousands** of years (depending on molecular weight).
- **Water bodies and sediments are the main sink** of PFCs. Fish are the main source of human exposition to PFCs
- **PFCs are ubiquitously present in terrestrial top predator species** (including humans).

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## Alternative DWORs (I): Short chain (C6) based DWORs

**Most extended alternative** to long chain PFCs since 2000s decade, due to its **superior performance** compared with other alternatives.

- Alternative DWORS based on C4 or C6 chemistry
- **Degradation leads to the same families of compounds** than C8-PFCs but with lower number of carbons. Most important are perfluorohexane sulfonic acid (PFHxS) & perfluorohexanoic acid (PFHxA)

**Controversy regarding the risk of short chain PFCs.** Still lack of toxicological and environmental data to draw clear conclusions.

- **Lower toxicity** than long chain PFCs
- **Lower bioaccumulation & biomagnification** across the food chain
- **Lower half-lives** and **faster elimination** rates.
- **Concerns due to its chemical similarity** with long-chain PFCs.
  - i.e: Some authors suggests than **PFHxS** has similar toxicity to PFOS/PFOA and might be considered as long chain precursors
  - i.e: Short-chain perfluoroalkane sulfonates **(PFAS)** have higher solubility, which leads to **greater transportation potential** in water bodies.

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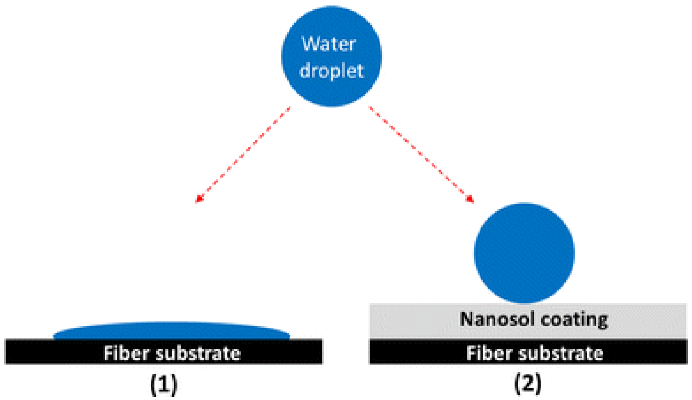
## Alternative DWORs (II): SOL-GEL based DWORs

Overall **environmental impact** of sol-gel DWORs is considered **low** compared with perfluorocarbon-based DWORs (both long and short-chain).

- Different sol-gel based in the metallic oxide and sol precursors.
- **Organosilicones** are a **wide used** precursors of a sol.
- **Perfluorinated compounds** also have been used, in order to achieve ultrahydrophobic, oleophobic and soil repellent properties.




- **SOL-GEL** does **not suppose any significant hazard** to the environment or human health
- Only when sol-gel includes perfluoroalkyl compounds, might be considered harmful for the environment.
- **Perfluorinated chains** can be severed from the sol-gel structure forming **persistent compounds.**

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## Alternative DWORs (III): Silicone based DWORs

Pointed out as one of the **most environmentally friendly alternatives** for achieving water repellency.

Residual cyclic methyl siloxanes are the main environmental hazard, mainly octamethylcyclotetrasiloxane (D4) & decamethylcyclopentasiloxane (D5):

- ? Still **controversy regarding its harmlessness** among the references consulted.
- Most of the reports suggests that they presents **no risk for humans or environment.**
- **Levels in garments are very low,** as residual silicone compounds evaporates at the curing stage of the textile process
- **Degradation** is the environment occurs **fast** (weeks in the atmosphere and days in soil)

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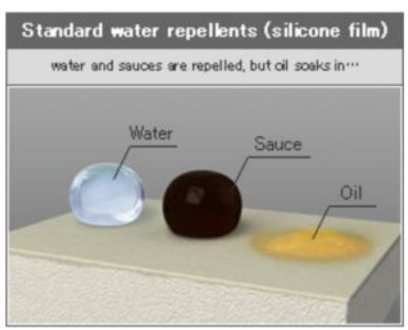
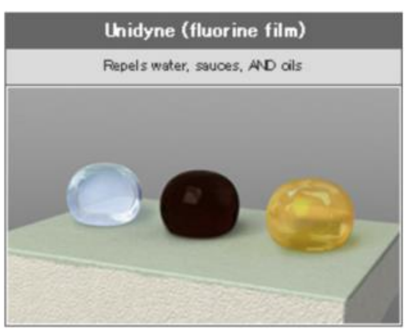
## Alternative DWORs (III): Silicone based DWORs

Perfluorosilicones are a type of silicones where the methyl groups of the polydimethylsiloxane (PDMS) backbone have been replaced by **fluoroalkyl acrylate copolymers(usually C6-PFCs)** in order to improve its oil repellency.

- **C6 perfluoroalkyl chains**, which will eventually be released to the environment as the silicon backbone is degraded.
- Thus they must be considered as a **source of perfluoroalkyl acids and other derived compounds,** with risks addressed in previous slides
- **Release** of this compounds will be **in lower amounts than short-chain DWORs**

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# A2. Pre-screening on functionality and environmental impact of DWOR

## Overall environmental impact of different DWORs

| Environmental Impacts & Textile performance | Type of DWOR | | | | |
|---|---|---|---|---|---|
| | Long Chain | Short Chain | SOL-GEL | Silicones | Perfluoro -silicones |
| Textile performance | 👍👍 | 👍👍 | 👍 | 👍 | 👍👍 |
| Long range transportation | 👎👎 | 👎👎 | 👍 | 👍 | 👎 |
| Toxicity (fauna & humans) | 👎👎 | 👎? | 👍 | 👍? | 👎 |
| Bioaccumulation | 👎👎 | 👎? | 👍 | 👍 | 👎 |
| Degradation rates (environment and body) | 👎👎 | 👎? | 👍 | 👍 | 👎 |

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# MIDWOR-LIFE

## Mitigation of environmental impact caused by DWOR textile finishing chemicals studying their non-toxic alternatives

### ACTION B

# IMPLEMENTATION ACTIONS

### Presented by:

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# MIDWOR-LIFE

## Mitigation of environmental impact caused by DWOR textile finishing chemicals studying their non-toxic alternatives

### PREPARATORY ACTIONS

B1. Demonstration of DWOR and alternative material processing

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# B1. Demonstration of DWOR and alternative material processing

## OBJECTIVE

To perform the application trials at pre-industrial and at industrial scale. The textiles and chemicals selected during preparatory actions will be used. LEITAT is the leader of this action.

## TASKS

*B1.1 Pre industrial demonstration of DWOR and alternative material processing*

On this task, the pre-industrial application of the selected DWOR and alternatives materials onto 5 textile materials previously selected in the preparatory action A1 will be performed.

Application by padding → Padding parameters adjustment, 2 concentration per each DWOR

**Leader:** LEITAT
**Participants:** AEI TEXTILS, CLUTEX, CS-POINTEX

**Start:** 1/03/2016
**End:** 1/03/2018

**Expected result**: 5 fabrics will be treated each with 9 DWOR finishing (2 conventional + 7 alternatives)

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## TASKS

*B1.2 Industrial demonstration of DWOR and alternative material processing*

On this task, the industrial application of the selected DWOR and alternatives materials will be performed on 6 different pilot textile industries members of clusters AEI TEXTIL, CS-POINTEX and CLUTEX. The process operation and workers will be analyzed and observed during this task in order to evaluate the toxicological and ecotoxicological impact of the industrial process.

**Leader:** CS-POINTEX
**Participants:** LEITAT, AEI TEXTILS, CLUTEX,

**Start:** 1/03/2016
**End:** 1/03/2018

**Expected result:** 6 fabrics treated with 7 repellent finishing (1 conventional and 6 alternative), at industrial scale in the manufacturing companies.

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## TASKS

*B1.3 Fabrics Characterization.*

The objective of this task is to characterize the fabrics obtained at pre-industrial and industrial scales
Some of the tests performed will be:

- Drop Test.
- Hydropbobicity test
- **Oleophobicity test (EN ISO 14419)** ✓
- **Water Repellence: Spray Test (AATCC Test Method 22)** ✓
- **Water and oil contact angle measurement** ✓

**Leader:** LEITAT
**Participants:**

**Start:** 1/03/2016
**End:** 1/03/2018

**Expected result:** Characterization of the fabrics treated at pre-industrial and industrial scale..

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## TASKS

### *B1.1 Pre industrial demonstration of DWOR and alternative material processing*

| *FABRIC SELECTION BY TEXTILE REPRESENTATIVE SECTOR* | | | |
|---|---|---|---|
| **Number** | **weight** | **composition** | **Sector** |
| **1** | 230 g/m$^2$ | 100% PES | Automotive |
| **2** | 220 g/m$^2$ | 90% PA/10%El | Sport (cycling) |
| **3** | 195 g/m$^2$ | 100% PES | Sport (mountain) |
| **4** | 180g/m$^2$ | 100% WO | Fashion (suit) |
| **5** | 175g/m$^2$ | 100% CO | Fashion (shirt) |
| **6** | 170g/ m$^2$ | 65%PES/35%CO | Fashion (trouser) |
| **7** | 250 g/m$^2$ | 49%PP / 47%PES / 4%CO | Home (sofa) |
| **8** | 175g/m$^2$ | 100% PES | Workwear (polo) |
| **9** | 250 g/m$^2$ | 80COP / 18%PES / 2%antistatic | Workwear (trouser) |

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## TASKS

### *B1.1 Pre industrial demonstration of DWOR and alternative material processing*

| Num | Technology | Company | Brand | Chemistry | Reception |
|---|---|---|---|---|---|
| **1** | CONVENTIONAL | RUDOLF | RUCOGUARD AFB CONC | Long Chain Fluorocarbon (c8) | Sent |
| **2** | CONVENTIONAL | PULCRA | REPELLAN® EPF-A | Long Chain Fluorocarbon (c8) | Sent |
| **3** | ALTERNATIVE | HUNTSMAN | PHOBOL CP-U | Short Chain Fluorocarbon (c6) | Recived |
| **4** | ALTERNATIVE | ARCHROMA | NUVA N1811 | Short Chain Fluorocarbon (c6) | No response First trials with Nuva N4547 |
| **5** | ALTERNATIVE | RUDOLF | RUCOGUARD AFC6 | Short Chain Fluorocarbon (c6) | Sent |
| **6** | ALTERNATIVE | PULCRA | REPELLAN XC-6 PLUS | Short Chain Fluorocarbon (c6) | Sent |
| **7A** | ALTERNATIVE | NANO-X | X-TEX EC5028 | SOL-GEL | NOT available |
| **7B** | ALTERNATIVE | NANO-X | SILIXAN S570 – 10/w | Short Chain Fluorocarbon (c6) | Sent |
| **8** | ALTERNATIVE | DAYKIN | UNIDYNE TG-5601 | Hybrid fluor silicone | Recived |
| **9** | ALTERNATIVE | PROTEX | DRYOL S 600 | Silicone | Recived |

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## TASKS

*B1.1 Pre industrial demonstration of DWOR and alternative material processing*

- *Product #4: We've just started first trials with Nuva N4547 onto 100%WO fabric*

| PRODUCT | FORMULA | | | | | PADDING APLICATION | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Components | % | g/l | ml/l | NOTAS | v (m/min) | pressure (bar) | Drying | Curing |
| NUVA N4547 | NUVA N4547 | | 70 | | | 3 | 3,5 | 120°C - 1min | 150° - 3min |
| | acetic acid 60% | | | 0,5 | pH adjustment 4-5 | | | | |

✓ *Contact angle: From 90 º (non-treated) to 105º (treated with Nuva N4547)*
✓ *Spray Test: From 70 (non-treated) to 80 (treated with Nuva N4547)*
✓ *Oil Test: Pending.*

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## TASKS

### *B1.1 Pre industrial demonstration of DWOR and alternative material processing*

- *Product #9: Silicone-based from PROTEX*

| Exp. | Fabric | Conc. [g/L] | DRYOL FIX 146 | P (bar) | pH | Drying | Curing | Pick-up | SPRAY TEST | OIL TEST |
|---|---|---|---|---|---|---|---|---|---|---|
| 9.1.1 | 1 | 30 | 15 | 3 | 4,78 | 110ºC - 8 min | 150ºC - 1,5 min | 58,4% | 3 | 0 |
| 9.1.2 | 1 | 60 | 30 | 3 | 4,78 | 110ºC - 8 min | 150ºC - 1,5 min | 52,7% | 3-4 | 0 |
| 9.5.1 | 5 | 30 | 15 | 3 | 5,83 | 110ºC - 3 min | 150ºC - 1,5 min | 47,0% | 4-5 | 0 |
| 9.5.2 | 5 | 60 | 30 | 3 | 5,83 | 110ºC - 3 min | 150ºC - 1,5 min | 45,0% | 4-5 | 0 |

| Interpretation of ISO index or rating of wettting equivalent to AATCC standard photographies | | |
|---|---|---|
| ISO 0 | AATCC 0 | Complete wetting of the top surface. |
| ISO 1 | AATCC 50 | Complete wetting of the top surface on the sprayed areas. |
| ISO 2 | AATCC 70 | Partial wetting of the top surface. |
| ISO 3 | AATCC 80 | Wetting of the top surface on the sprayed areas. |
| ISO 4 | AATCC 90 | Slight adherence or wetting of the top surface. |
| ISO 5 | AATCC 100 | No adherence or wetting of the top surface. |

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## TASKS

*B1.2 Industrial demonstration of DWOR and alternative material processing*

Some companies has shown interest in participating as a finisher.

- From Spain:
  - Vincolor → In conversation
  - Hydrocolor → ACCEPTED

- From Check Republic:
  - Nanomembrane → In conversation
  - Inotex → In conversation

- From Italy:
  - Biella Manifatture Tessili (Marzotto Group)→ACCEPTED
  - Tintoria Finissaggio 2000 →ACCEPTED

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## NEXT STEPS IN ACTION B1

- We are working doing the trials at lab scale as planed.

- Some providers have accepted to send us other finishing products under development (after signing a NDA), to validate technical performance and environmental profile.

- Define the processes to be scaled-up. Definition of which company will develop each process (depending facilities).
    - VINCOLOR will develop DWOR onto upholstery fabric.

- Arrange the industrial scale applications and measurements in-situ.
    - Depending on companies availability, it should be between March'17 to September'17

- Characterization of developed DWORS at industrial scale and comparison with lab trials.

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# MIDWOR-LIFE

## Mitigation of environmental impact caused by DWOR textile finishing chemicals studying their non-toxic alternatives

### IMPLEMENTATION ACTIONS

### B2. Risk assessment of Durable Water and Oil Repellents in textile finishing process

LEITAT managing your technologies | Technological Center member of TECNIO Be tech. Be competitive

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# B2. Risk assessment of Durable Water and Oil Repellents in textile finishing process

## OBJECTIVES

The objective of this action is to **assess the risks** posed by DWORs additives and their alternatives **for human health and environment** when they are used as hydro- and oleo-repellent textile finishing products. These studies will be carried out in **all relevant exposure scenarios** in the textile finishing industry **at the different life cycle stages** (production, use and disposal). The risk analysis will include the following steps:

1. **Identification of the hazards**
2. **Derivation of Reference Safe Dose**: Derivation of approximated DNEL/PNEC values (highest doses/concentrations at which no adverse effects are to be expected).
3. **Exposure assessment**
4. **Characterization of the risks** posed by DWORs additives at the different exposure scenarios.

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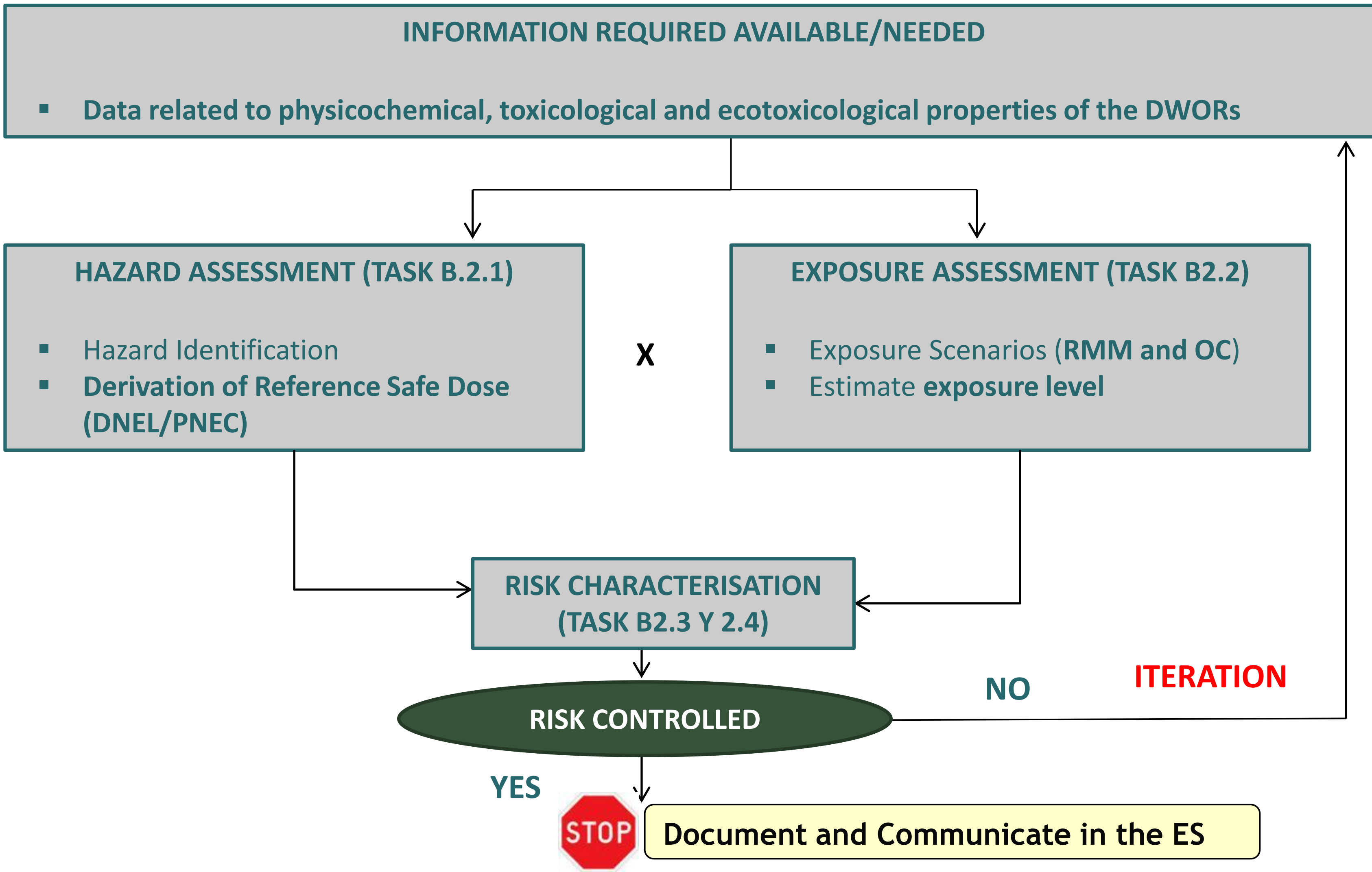
# B2. Risk assessment of Durable Water and Oil Repellents in textile finishing process

## OVERVIEW OF THE RISK ASSESSMENT ANALYSIS




The iteration should continue until the Risk Characterization shows that the risks are controlled

# MIDWOR-LIFE

## Mitigation of environmental impact caused by DWOR textile finishing chemicals studying their non-toxic alternatives

### IMPLEMENTATION ACTIONS

## B3. Comprehensive analysis of environmental impact of the best available technologies

CETIM
Centro Tecnológico de
Investigación Multisectorial

Barcelona – September 27th, 2016

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# B3. Comprehensive analysis of environmental impact of the best available technologies

## Objective of Action B3

Determine the **environmental impact of conventional and alternative DWOR finishing products** in the textile industry using Life Cycle Assessment (LCA) methodology

**Leader:** CETIM

**Participants:** All partners

**Start:** 1/03/2016

**End:** 31/08/2018

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# MIDWOR-LIFE

## Mitigation of environmental impact caused by DWOR textile finishing chemicals studying their non-toxic alternatives

ACTION C

# MONITORING OF THE PROJECT IMPACT OF PROJECT ACTIONS

**Presented by:**

LEITAT Technological Center
managing your technologies
member of TECNIO

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# C. MONITORING OF THE PROJECT IMPACT

Monitoring actions:

- Action C.1: Monitoring the project impacts on the environment

- Action C.2: Monitoring the socio-economic impact of the project on local economy and population.

- Action C.3: Monitoring the cost-efficient replicability or transferability of the project

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# C1. Monitoring the project impacts on the environment

**Leader:** LEITAT
**Participants:** -

**OBJECTIVE**

To compare the environmental impact of the selected DWOR and their alternatives introduced in the textile finishing industry

**TIMETABLE**

**Start:** 01/01/2017
**End:** 31/08/2018

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## TASKS

### C1.1 Selection of the environmental monitoring indicators

- Use of resources
- Emissions (e.g. ozone depletion, Global Warming indicators, …)
- Toxicity and ecotoxicity indicators

Environmental indicators selected will be aligned with the LCA indicators of Action B3

| Area | Indicators from the LIFE program |
|---|---|
| Environment & Health | Chemicals released (PFOA) in tonnes/year at the end of the project |
| | Chemicals substitution in tonnes/year at the end of the project |

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## TASKS

C1.2 Definition of the starting situation (baseline scenario)

- Based on the results of the preparatory actions A1 and A2


C1.3 Environmental monitoring

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# C2. Monitoring the socio-economic impact on local economy and population

**Leader:** CS-POINTEX
**Participants:** LEITAT, CLUTEX

**OBJECTIVE**

To evaluate the socioeconomic impact expected on local economy and community by the implementation of the proposed WOR alternatives and the related environmental and risk assessment measures into EU textile finishing industry.

**Start:** 01/01/2017
**End:** 31/08/2018

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# C2. Monitoring the socio-economic impact on local economy and population

## TASKS

- Definition of socioeconomic indicators:

| Area | Indicators from the LIFE program | Target by the end of the project |
|---|---|---|
| Information and awareness raising of the general public | Nº of distinct individuals that visit the project website | 3000 |
| | Nº of scientific publications prepared *(Action D4)* | 2 |
| | Nº of international events attended *(Action D4)* | 7 |
| | Nº of project panels/notice boards, … displayed *(Action D2)* | 7 |
| | Nº of individuals surveyed regarding awareness of the environmental problem addressed *(Action A1)* | 60 |
| Capacity building | Nº of professionals reached in networking activities *(Action D5)* | 20 |
| | Nº of relevant projects contacted *(Action D5)* | 10 |
| Jobs | Nº of fully employed persons associated to MIDWOR project (in partners staff and subcontractors) | - |

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# C3. Monitoring the cost-efficient replicability or transferability of the project

**Leader:** LEITAT
**Participants:** -

**OBJECTIVE**

Economic evaluation of the application of DWOR alternatives in order to ensure the cost-efficient replicability or transferability of the project.

**Start:** 01/01/2016
**End:** 31/08/2018

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# C3. Monitoring the cost-efficient replicability or transferability of the project

**TASKS**

Main **cost categories** from every life stage will be assessed including:

- investment
- operation
- maintenance
- end-of-life disposal expenses
- External environmental costs

Based on Life Cycle Costing Methodology (LCC)

LCC will analyze the direct and indirect cost and benefits of the project in order to evaluate the global economic sustainability.

| Area | Indicators from the LIFE program |
| --- | --- |
| Contribution to economic growth | Total project related expenditure during the project (personnel costs, travel expenses, equipment, …) |
| | New sectors from the NACE code list where the project results are expected to be replicated/transferred. |

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## WHAT WILL WE DO WITH RESULTS OBAINED?

The results obtained in the project will be transferred to the industry to improve the knowledge on the use of DWOR's, through:

- WORKSHOPS,
- Collaborating updating and maintaining ECOTEXNANO TOOL (http://www.life-ecotexnano.eu/)
- Doing police recommendations
- Developing a ROAD MAP for the use of non-toxic DWOR's in textile industry, or mitigate their use
- Suggest the most promising research lines

The textile industry will improve they knowledge by knowing the results obtained per each particular case studied (different chemistry, fabrics, scenarios…), in terms of:

- Technical performance, and costs of implementation
- Human and environmetal riskk
- LCA

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# MIDWOR-LIFE

## Mitigation of environmental impact caused by DWOR textile finishing chemicals studying their non-toxic alternatives

http://www.midwor-life.eu/

**THANK YOU FOR YOUR ATTENTION!**

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