Handbook for zero microplastics from textiles and laundry
Good practice guidelines for the textile industry

1. Explanation of the topic and purpose of the guidelines

Polyester and acrylic are the main synthetic fibres identified as microfibers pollutants coming from the textile industry and found into the oceans\(^1\). Some characteristics of the production process of synthetic fibres and resulting characteristics of the fibres may be responsible of creating more microfibers release during laundry. The aim of these guidelines is to provide the synthetic fibres manufacturers, the textile auxiliaries manufacturers and others textile industries with good practices to reduce the microfibers production and their release to the environment. This should be done as far as possible and it needs to be suitable with their manufacturing process and final product requirements.

This guideline is indicated for any industry in the textile chain (synthetic fibres manufacturer, textile auxiliary manufacturer, spinning/weaving/knitting companies, finishing (chemical or mechanical) companies and textile retailers. This document can be useful for continuous synthetic fibres manufacturers in case the fabric they produce is finished by any mechanical treatment responsible of cutting and raising the fibres from the fabric surface to give a warm and softer hand.

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2. Key issues identified

The key issues identified for the textile industry include material and process modification at four different stages which are the fibre, the yarn, the fabric and the garment. These issues are detailed in the figure below.

- **Fibre**
  - Fibre fineness
  - Fibre irregularities
  - Fibre length

- **Yarn**
  - Number of plies
  - Twist value
  - Yarn count

- **Fabric**
  - Dyeing process
  - Knitting/weaving velocity
  - Sizing agent
  - Fabric structure
  - Fabric density
  - Mechanical & chemical finishing

- **Garment**
  - Garment washing in factory and waste water management
3. Good practices

Good practices are given for each step in the production of synthetic fibres. For each practice presented in the next part, the main barriers are identified and the policies which could be implicated are mentioned. The practices are advices that should be taken as far as possible. Moreover, they should besuitable with the production process and the final product requirements.

POLYMER SYNTHESIS AND CHIPS PRODUCTION

Process description:

Preparation of viscous PES liquid from solid polymers or from monomers. The viscous fluid is then extruded, dried and broken into chips.

Good practices guidelines: N/A

Main barriers: N/A

MELT SPINNING PROCESS

Process description:

The chips of PES are heated and extruded through a spinneret (metal disk with fine holes). The hardening PES liquid coming outside the holes is forming the resulting PES filaments. The filament (called tow at this step) are then wounded on a spool.

Good practices guidelines:

The melting process conditions (lower and graduated melting temperatures) could be adjusted in order to preserve the fibres mechanical properties (tensile strength...).

The fibre fineness should be increased to reduce yarn propensity to form protruding microfibers.
The fibre irregularities would increase the friction between fibres and avoid the release of microfibers from the yarn. The holes of the spinneret could present some irregularities instead of having a circular diameter.

**Main barriers:**

- Working at lower temperatures will increase the production times.
- The modification of the yarn characteristics would probably not answer the customer requirements.

**DRAWING, STRETCHING, TEXTURING, INTERMINGLING AND DRYING**

**Process description:**

Drawing is made on the spool to increase the strength of the fibre. Stretching increase the fibre length from three to four times its original length. Texturing gives the fibres a crinkled structure. Intermingling is done to provide a specified number of knots per meter on the fibre length. Drying is the last step before cutting the filaments into specific lengths of a few centimetres.

**Good practices guidelines:**

The different processes conditions should be adjusted in order to preserve a good fibre tensile strength. A high tensile strength of the yarn will reduce its probability of breakage and release during washing.

The cutting length of the resulting fibres should not be too low to avoid the release of microfibers from the yarn.
Main barriers:

Process modification feasibility depends on the client requirements and products specifications.

SPINNING (YARN)

Process description:

The cut filaments are carded to parallelize the fibres and a rope-like material is obtained. The rope is introduced in a spinning machine to reduce its diameter until obtaining a yarn and giving it a twist for more cohesion.

Good practices guidelines:

Yarns with **continuous fibres** have lower incidence on microfibers formation than yarns made of discontinuous or staple fibres.

**Plied yarns** have lower incidence on microfibers formation than single yarns.

Yarns with **high twist** have lower incidence on microfibers formation than yarns with low twist.

A **low linear density of the yarn** (yarn count) is better than high yarn count as the number of microfibres released will increase with the yarn count due to a larger amount of fibres per cross section.

Main barriers:

The yarns specification has to respond to client requirements and the final product properties depends on these parameters.
DYEING

Process description:

The spools of twisted yarns are introduced in a dyebath containing specific dyes to the polymer type. Then the spools are dried before knitting or weaving.

Good practices guidelines:

Avoid garment dyeing, as it has more impact on the microfibers release than yarn dyeing.

Main barriers: N/A

KNITTING AND WEAVING

Process description:

The dyed spools can be knitted (on circular or rectilinear machine) or woven. During this step, the yarn is submitted to mechanical actions and erosion onto the machine parts (needles, yarn carrier, weft thread transporter, warp threads movements, etc.).

Good practices guidelines:

The fibres are damaged during the knitting process by the action of the yarn carrier and the needles. The yarn carrier velocity may be reduced to reduce the fibres damage.

For the weaving process, the quantity or the nature of the sizing agent could be optimized and the velocity of the weft transporter could be reduced.

High density fabrics (number of yarns per unit length) are better (tighter structure) than low density fabrics to avoid the microfibers release.
Plain weave fabrics have lower incidence on microfibers formation than twill weave fabrics.

**Main barriers:**

The reduction of the velocity of the weaving and knitting process will increase the production time of the factory.

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**MECHANICAL FINISHING**

**Process description:**

Napping is done to obtain a fuzzy effect on the fabric surface. The process consists in raising the fibres from the textile surface with revolving cylinders with bristles. Then, during shearing, the protruding fibres are cut at the same height.

**Good practices guidelines:**

The napping process conditions may be modified to reduce the mechanical action of the cylinders on the fabric and reduce the fibres weakening.

If not already done, the cut fibres resulting from the shearing process may be recollected and this waste management should be done in the factory.

Singeing mechanical finishing is a good option to avoid the microfibers formation on fabric surface.

**Main barriers:**

The difficulties to adjust the napping machine parameters or the modification on the machine won’t respond to the client requirements.

**Implications for policy and practice:**

Set a policy for napping process conditions and waste management after shearing process.
FINISHING

Process description:

The finishing step is performed in a textile companies which apply textile auxiliaries products to provide a functionality to the fabric (water repellence, softness, antimicrobial, etc.).

Good practices guidelines:

Finishing agents with smoothening or softening properties capable of protecting the fabric surface can be used during the finishing process. The finishing agents should also have good washing fastness to 1) avoid dragging more fibres during laundry, 2) be effective during the whole product lifetime and 3) avoid contaminating domestic waste water.

Main barriers:

The protective finishing agent must be compatible with the others finishing treatments of the textile.

Implications for policy and practice:

The environmental impact of the finishing agent must be evaluated as well and some policies could regulate its maximum concentration per square metre of fabric.

MANUFACTURING

Process description:

The manufacturing process is the last step where the fabric is cut following a pattern and then sewed into a garment.

Good practices guidelines:

In general, most of the microfibres are released during the first wash of the garment. A preliminary washing of the manufactured garment can be done before selling it in order
to eliminate the microfibers broken during the textile processes and present on the fabric surface. These microfibers would be then recollected by an efficient water treatment system.

Main barriers:

Textile manufacturing companies may not have the required facilities for industrial washing and water treatment. It might require high investment for small manufacturers.

The actual water treatment plants may not be equipped with a system capable of collecting the shortest microfibers.

Implications for policy and practice:

To set a new policy for textile water treatment plants allowing the controlled release of shortest microfibers.
Good practice guidelines for detergents manufacturers

1. Explanation of the topic and purpose of the guidelines

Part of the microplastics pollution found in the oceans comes from the washing in laundry machine of synthetic fabrics. The microfibers release comes from the breakage of the fibres forming fabrics, which can be produced during the washing cycle. Therefore, laundry products and the washing conditions can be involved in this issue. The aim of these guidelines is to provide detergents manufacturers some good practices and advices in order to produce laundry products able to participate in the reduction of the microfibers released during the automatic washing of fabrics.

2. Key issues

This guideline is indicated for laundry products manufacturers, from detergents to laundry aids. Also, it can be of interest for raw materials manufacturers and suppliers. The main key issues developed in this guideline are presented in the following table:

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Table 1. Main key issues of this guideline
3. Good practice

After carrying out several experimental tests with the aim of identifying which kind of laundry products have influence in the microfibers release and how the pollution of microplastics in oceans issue can be mitigated from a detergency approach, some recommendations for detergents manufacturers have been elaborated.

✔ Focus the production of detergents for synthetics on liquid light duty detergents. In our experiences, the use of heavy-duty detergents produces a bigger microfibers release, due to they are more aggressive with fabrics; especially in the case of powder detergents, which increase the friction in the fibres facilitating their breakage.

✔ Focus the production of other laundry products for synthetics on liquid formats. The previous recommendation is extensible to all laundry products; for instance, when a powder oxy-product was compared with a liquid one, the powdered aid produced a bigger amount of microfibers released than the liquid one.

✔ Recommend powder products (detergents and aids) only for cotton. Since most of products for delicates and synthetics are liquid and the final decision is in the consumer hands, a way to reinforce this practice could be to advice the use of powder products only in cotton fabrics.
Focus the production of detergents effective at low temperatures. The temperature is a factor to be taken into account regarding the release of microfibers; to wash clothes at low temperature can decrease the number of microfibers released during the laundry. In addition of helping in the mitigation of this issue, it also supposes a reduction in the energy consumption.

Use of additives capable of protecting fibres from their breakage. After testing several additives with fabric care, it has been observed that some of them are capable of reduce the number of microfibers released during the washing cycle.

Main barriers: it is very difficult to obtain a detergent capable of removing stains efficiently and, at the same time, capable of protecting the fibres from their breakage. However, the idea is to use additives for minimizing the influence of the detergent in the emission of this pollutant, not for avoiding it. More research is needed for develop new additives proper for this purpose.

Implications for policy and practice: the environmental impact of these additives should be evaluated and the concentration allowed regulated.
Long-term Recommendation

- **Develop detergents not or less aggressive with textile finishing products.** Some textile additives can be used to protect fabrics from their fibres breakage and these finishing products may be detached from the fabric surface during the washing cycle. The idea here, would be to develop detergents capable of minimize or even avoid this to happen.

  - **Main barriers:** first is needed to find proper textile finishings and, then, some research will be necessary for obtaining this kind of detergents.

  - **Aware the consumer about this issue.** For example, including information about this topic in the label or even using it as a claim in products that follow these recommendations; this way not only the consumer is become aware about that, but also it may suppose an added value for the product.