Challenges and possible solutions for sustainable textile fiber production

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It is now widely recognized that there is an urgent need for a sustainable textile value chain, new processes for environmentally friendly production of textile fibers and a paradigm shift in the textile industry away from the linear business model towards a circular resource model for clothing and textiles. Yet not to mention that the textile industry faces numerous negative social impacts due to extremely precarious working conditions, low pay, unsafe working conditions, high labor pressure and more, to which the high environmental emissions associated with textile production also contribute.

The Ellen MacArthur Foundation's widely acclaimed report, "*A new textiles economy: redesigning fashion's future*", highlights that a new textiles economy relies on four ambitions. In my presentation, I will focus particularly on three of these ambitions: the elimination of substances of concern, especially microfiber emissions; the use of renewable resources; and third, the radical improvement of textile recycling through sustainable reprocessing.

Interestingly, according to the *Pulse of the Fashion Industry report (Boston Consulting Group, 2017)*, natural fibers cause very high environmental impacts, with silk having a particular impact in terms of natural resource depletion and global warming, cotton contributing to water scarcity, high fertilizer and pesticide use, and wool leading to high greenhouse gas emissions. It is known that environmental impacts can be reduced by using organic cotton compared to conventional cotton, as the former uses less water, pesticides, and fertilizers.

Apart from the well-known disadvantages of lack of biodegradability and unsustainable raw materials, polyester fibers have the advantage over cotton in that they have a lower water footprint and can be washed at lower temperatures, dry quickly and require little ironing. In addition, very effective chemical recycling technologies and advanced technology of replacing petroleum-based raw materials with bio-based raw materials, such as bio-based FDCA (2,5-furandicarboxylic acid) for the production of PEF (polyethylene furanoate), greatly improve the sustainability of polyester textiles by significantly reducing greenhouse gas emissions. However, the biggest threat currently posed by the use of polyester fibres in textiles is the formation of significant amounts of microplastics. Several recent studies have shown that one load of laundry containing polyester, acrylic or nylon clothing releases 700,000 microplastic fibres that can enter the human food chain (*EU Commission: Science for Environment Policy, 07 June 2018, Issue 509*).

Man-made cellulose fibres produced from wood pulp derived from sustainable forestry or other lignocellulosic raw materials are significantly more sustainable than synthetic fibres and cotton, especially when integrated into pulp production, as demonstrated by extensive LCA studies (*Lenz Ber (2010), 80, 1-59*). This even applies to the viscose process despite the use of toxic chemicals. With the development of the lyocell fibre technology, a much more sustainable technology is now available for the production of high-quality textiles, which also has the potential to upcycle cellulose-based waste textiles, especially those made of natural cellulose fibers or viscose, into higher-value fibres.

My presentation will give an overview of the different technologies for the production of man-made cellulose fibers (MMCFs), which are currently being developed mainly in Scandinavia. The potential of these processes for the future requirements of sustainable textile fibers is highlighted. Selected examples will be used to demonstrate the significant advantage of chemical recycling of cellulosic waste textiles compared to mechanical recycling. The production of high-quality textile fibres also from recycled raw materials is the prerequisite for extending the longevity of clothing and thus represents an important contribution to improving sustainability. Recent research results from Ioncell® technology show that it is possible to produce cellulose-based fibers with properties that can otherwise only be achieved by polyester fibers. Achieving mechanical properties of textile fibers made from renewable raw materials that are superior to those of currently produced man-made cellulose fibers must be the goal of future research in order to cover this high-value textile fiber segment with sustainably produced fibers.