Cellulose Fibers Conference 2023 (Cologne, Germany, 8-9 March)
Abstract for an Oral Presentation

Date: 30.11.2022 Dr. Inge Schlapp-Hackl

Up-cycling of textile waste by means of Ioncell®

Using the emerging Ioncell® process, the chemical recycling of cellulose-based materials consisting of cotton, hemp and viscose has been investigated to produce second-generation fibres of high quality for different applications.

Driven by the growing world population and the rising global purchasing power, the textile and fashion industry consume resources at an alarming pace. Cotton is the most common natural fiber, representing one quarter of the total textile fiber production. During the cultivation season 2018/19, 26.1 million tons had been harvested using 33 million hectares of arable land. Cotton cultivation requires enormous amounts of irrigation water, fertilizers, and pesticides, which may accumulate as sediments and finally lead to the desertification of precious arable land. Due to widespread mulching of cotton crops with plastic films its cultivation also contributes to plastic pollution. Before cotton entered the European textile market, hemp fibers had been very popular. Compared to cotton, hemp is a fast-growing plant and the cultivation requires negligible quantities of pesticides and fertilizers and a significantly lower amount of water. The most common man-made cellulose fiber (MMCFs) is viscose, a low DP material made of plant-based cellulose and it accounts for less than 10% of the total amount of textile fibers. However, for the manufacturing of viscose fibers the use of toxic chemicals and a high energy and water consumption are required.

The increasing consumption of goods does not only deplete our natural resources but it also creates record amounts of waste. Globally, 73% of all produced garments end up in landfill or are incinerated causing a tremendous sacrifice of natural-polymers suitable for re-utilization and an increase of the carbon dioxide footprint, respectively. Less than 1% of fabrics are recycled into new clothing, and 13% of the recycled materials are reused in a different way as low-value products such as insulation material, wiping clothes etc. Recycling of textile waste into new textile products can be classified into mechanical and chemical recycling. The high mechanical stress during the mechanical recycling shortens the staple length of fiber and the quality of yarn is reduced in terms of strength compared to the original yarn. Chemical recycling of cellulosic-based substrates often requires a purification and bleaching step. Thereafter, cellulose is dissolved and regenerated into new man-made cellulose fibers of high quality comparable to commercially available fibers.

To tackle the problems of the textile industry, the European commission stated a strategy for the creation of “Sustainable and Circular textiles”. The strategy follows the motto #ReFashionNow, which aims on the improvement of textile quality, durability, longer use, repair and reuse. A common industrial technology roadmap on circularity is developed promoting fiber-to-fiber recycling research and innovations.

Ioncell®, a technology developed for the sustainable production of MMCFs, offers the possibility to recover resources from different lignocellulosic waste materials (e.g., cardboard boxes, newspapers, textile waste) via fibre-to-fibre recycling to establish a circular economy. Moreover, the resulting fibres are often stronger than the original textile fibres providing textiles of higher quality.

Herein, we present the potential of the Ioncell® process for the recycling of textile waste via three case studies: viscose, hemp, and cotton roll towels. The produced fibres have been turned into yarn and further used to produce small demonstrators (Figure 1).

Figure1: Illustration of a prototype made of recycled hemp.

The properties of the starting materials and 2nd generation fibres have been evaluated in detail and compared with commercially available fibres. The results demonstrated clearly that the chemical recycling of the diverse materials by means of the Ioncell® process causes an improvement of the fibre properties due to a higher orientation and crystallinity of the cellulose matrix. For instance, the tenacity values of cotton fibres are on average doubled and the elongation at break is improved.