Cellulose Fibers Conference 2025 (Cologne, Germany, 12-13 March)
Abstract for an Oral Presentation

Date: 27.09.2024 Dr. Inge Schlapp-Hackl

Make-over of pulping strategies for the production of high performance Lyocell-type recycled fibres

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The use of waste and side streams as substrate for man-made cellulosic fibers has received increased attention during the past years. Besides cellulose and other natural polymers, these alternative substrates often contain contaminations such as synthetic polymers, dyes, coatings, or other additives.[1-3] The quantity of additives or impurities is often small, but can impact the process and product quality severely. A pre-treatment is indispensable and refining strategies must be implemented to allow fibre production by means of Lyocell-type spinning processes.

So far, our investigations have focused on the production of novel cellulosic Ioncell® textile fibres by the use of waste textile materials like cotton roll towels, hemp, viscose or Modal fibers. The quality and durability of Ioncell® fibres were determined, and a new technique for fibre production was introduced. Now, we extend the variety of materials and started to investigate the **Recycling of Banknotes, Books of Former Ages and Ancient Wood from a Sunken Ship**. Depending on the substrate, lignin, hemicelluloses, additives, like inks and dyes, binders, wax, are present. The materials are cut into pieces, shredded, grinded and pre-processed via well-known pulping processes (e.g. kraft pulping).[4, 5] The pulping processes are tailored towards the properties of the starting material. For instance, in case of some impurities (e.g. pigments, vat dyes) the implementation of a flotation step was fruitful.[6] Cellulose is recovered and new fibers are produced by means of the Ioncell® process.[7] The fiber properties are evaluated in detail and benchmarked against commercial fibers and fibers made from other recycled materials.

This study guides future recycling strategies for challenging multi-component waste materials.

Figure1: Illustration of the recycling strategies: banknotes to fibers (left), books to fibers (middle), ancient sunken ship (right).

(1) Bulian, F.; Graystone, J. *Wood coatings: Theory and practice*; Elsevier, 2009.
(2) Mariappan, T. Fire retardant coatings. *New technologies in protective coatings* **2017**, *28* (5).
(3) Gürses, A.; Açıkyıldız, M.; Güneş, K.; Gürses, M. S. *Dyes and pigments*; Springer, 2016.
(4) Kleppe, P. J. Kraft pulping. *Tappi* **1970**, *53* (1), 35-47.
(5) Sixta, H.; Potthast, A.; Krotschek, A. W. Chemical pulping processes. *Handbook of pulp* **2006**, *1*.
(6) Peleka, E. N.; Gallios, G. P.; Matis, K. A. A perspective on flotation: A review. *Journal of Chemical Technology & Biotechnology* **2018**, *93* (3), 615-623.
(7) Sixta, H.; Michud, A.; Hauru, L.; Asaadi, S.; Ma, Y.; King, A. W.; Kilpeläinen, I.; Hummel, M. Ioncell-F: a high-strength regenerated cellulose fibre. *Nordic pulp & paper research journal* **2015**, *30* (1), 43-57.